

Fostering self-regulated learning

Edited by

Slavica Šimić, Orna Heaysman and
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Fostering self-regulated learning

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Editorial: Fostering self-regulated learning

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Editorial on the Research Topic Fostering self-regulated learning

In recent years, scientific research and literature have paid great attention to the ability of students to self-regulate their learning. Numerous theories and models of self-regulated learning (SRL) have been developed (Boekaerts, 2011; Butler and Cartier, 2018; Efklides, 2011; Hadwin et al., 2011; Pintrich, 2000; Winne and Hadwin, 1998; Zimmerman, 2000). Researchers agree that SRL is a cyclical, multidimensional process that includes the interaction of personal (cognitive, metacognitive, motivational, emotional), behavioral, and environmental factors (Panadero, 2017), which enable students to better manage their learning. The ability to self-regulate learning contributes to positive educational outcomes, but also to the development of lifelong learning skills, which facilitate coping with the demands of modern society. However, most students' learning is not optimally self-regulated (Kramarski and Michalsky, 2009). Teachers, as agents of SRL, can promote it in a variety of direct and indirect ways: by teaching students effective learning strategies or by structuring stimulating learning environments (Dignath-van Ewijk and Van der Werf, 2012). Most teachers agree that students need help to become self-regulated learners and express positive beliefs about SRL. However, they feel uncertain about how to promote students' SRL, thus they stimulate SRL to a limited extent (Dignath and Büttner, 2018; Dignath-van Ewijk and Van der Werf, 2012; Karlen et al., 2020; Kistner et al., 2015; Perry et al., 2008; Spruce and Bol, 2015; Šimić Šašić, 2023; Vandeveldel et al., 2012). Teaching students how to self-regulate their learning improves their performance. However, it is still unclear which specific learning strategies should be taught and how they should be taught in order to improve student performance (Heaysman and Kramarski, 2022). Research also shows that the effectiveness of strategies varies according to discipline (reading, writing, mathematics, science; De Boer et al., 2012).

Encouraging SRL depends on numerous factors related to the teacher (teacher beliefs, gender, teaching experience, competences, etc.), class, school, subject, but also the students themselves (abilities, age, SES, etc.; Chatzistamatiou et al., 2013; De Smul et al., 2018; Dignath-van Ewijk, 2016; Dignath-van Ewijk and Van der Werf, 2012; Elmas et al., 2011; Fauzi and Widjianti, 2018; Hargreaves, 2005; Karlen et al., 2023; Lombaerts et al., 2007, 2009; Moos and Ringdal, 2012; Peeters et al., 2015; Šimić Šašić, 2021, 2023; Vandeveldel et al., 2012; Yan, 2018). Therefore, the results of studies on fostering SRL are often inconclusive.

Overview of the Research Topic

Most studies on the promotion of SRL by teachers have been conducted on prospective teachers, as part of the evaluation of teacher training programmes to foster SRL; however, there is little research in the area of teachers' practice in promoting SRL. Therefore, the aim of this Research Topic was to gather new knowledge about the factors influencing the activation of SRL from the perspective of teachers, students, classes, schools, and even from the perspective of educational policies of different education systems (countries). Of particular interest was to examine the effects of different strategies for improving SRL, taking into account different characteristics of students, fields/disciplines, and levels of education (early childhood education, primary, secondary, or higher education), and to examine the mechanisms of these effects. It was necessary to investigate how students and teachers perceive the effectiveness of different methods of promoting SRL.

Therefore, this Research Topic aimed to offer a synthesis of the latest research on the promotion of SRL and to collect original contributions that can offer new insights and stimuli for future research. This Research Topic includes 18 theoretical and empirical, qualitative and quantitative articles and contributions from 68 authors. The research brings innovative concepts and methodology, applied in the classical classroom environment as well as in the online learning environment, from preschool to higher education levels, in different fields of learning, from different parts of the world.

To interpret the diverse approaches to fostering SRL represented in this Research Topic, we draw on Dignath and Veenman's (2021) distinction between direct and indirect methods of promoting self-regulation. Direct approaches involve explicitly teaching SRL strategies to students (e.g., metacognitive training, strategy instruction), while indirect approaches create supportive environments and conditions that implicitly foster self-regulatory behaviors (e.g., through feedback systems, relationship-building, or classroom structures). Some combine both approaches. This framework helps illuminate patterns across our thematic categories. The papers can be divided into four categories: teacher perspective, training effectiveness, student perspective, and validation of measurement instruments (see Figure 1 for a visual summary of the Research Topic, and Table 1 for a detailed summary).

Teacher's perspective

Teachers play a key role in fostering SRL. While teachers universally recognize the importance of SRL, research reveals a complex landscape of implementation challenges and contextual variations.

The studies in this section reveal that teachers' fostering practices vary between direct and indirect approaches or lack clarity about both. Understanding this distinction helps explain the contradictions in findings. Several studies point to concerning gaps in teachers' SRL knowledge and implementation. Amir explored the innovative concept of "literacy resilience" as a key link between language literacy and SRL and sought to explore teachers' perceptions of its importance and their assessment of students' literacy resilience. Teachers emphasize

the high importance of language literacy but perceive low levels of development in students, suggesting a gap between recognized importance and current development. She also found a significant lack of teachers' knowledge of literacy skills and SRL strategies. Similarly, the study by Manuel et al. aimed to explore the prevalent types and levels of feedback and how this feedback is used to promote the development of students' SRL skills. Participants predominantly used traditional, transmission-based teaching approaches, demonstrating limited understanding of various self-regulation skills that could improve academic achievement, particularly in native English speakers. Findings suggest a mismatch between teachers' perceptions of their feedback practices and the actual implementation of these practices in promoting students' SRL skills. These findings emphasize the gap between teachers' SRL knowledge and their practice.

However, these findings stand in contrast to other research showing teachers' confidence in SRL implementation. Greenquist-Marlett et al. found that teachers were generally confident in incorporating SRL into their teaching. They investigated how teachers from preschool to fifth grade apply SRL in their teaching, how their use of SRL strategies is related to their self-efficacy or confidence in teaching, and how teachers differ in their use of SRL depending on the type of school (public vs. private). Teachers often used SRL in implicit ways, setting goals based on students' needs, monitoring students' progress, and thereby adapting their teaching. Public school participants relied on time management and monitored student progress in more summative ways than their private school counterparts.

This apparent contradiction in findings suggests that teacher effectiveness in promoting SRL may depend heavily on contextual and individual characteristics. Zhao et al. investigated the characteristics of teachers in online SRL in the dual role of student and educator. Data analysis revealed uneven development in different dimensions of online SRL among teachers, higher levels of self-efficacy and motivation of secondary school teachers compared to preschool and primary school teachers, higher levels of self-efficacy in teachers from urban areas, positive correlation of teacher self-efficacy with educational qualifications, and negative correlation with years of service.

The learning environment itself may also play a critical role in shaping teacher practice. To understand the qualities of effective learning environments for this aim, in a study by Barz et al., the researchers analysed pre-service teachers' SRL profiles in asynchronous and synchronous digital learning environments, and compared their influence on training effectiveness. Their findings emphasize a person-centered approach to developing digital learning environments.

Beyond individual teacher characteristics and learning environments, interpersonal dynamics emerge as crucial mechanisms. Zhu et al. examined the influence of parent-child, teacher-student, and peer relationships on learning engagement and the mediating role of intentional self-regulation. The findings reveal that parent-child, teacher-student, and peer relationships have similar significant positive effects on learning engagement in middle school students. Intentional self-regulation has a partial mediating effect between all three types of relationships and learning engagement, with the strongest effect being found in teacher-student relationships. However, the unique effect of peer

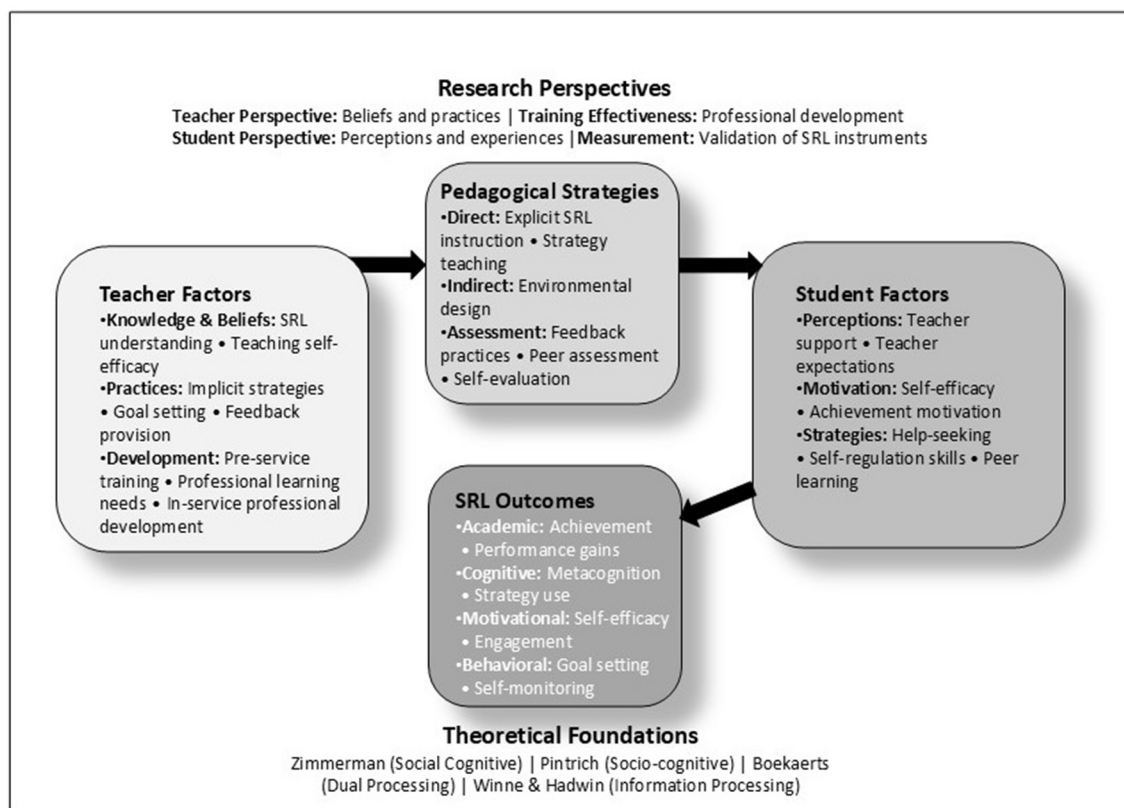


FIGURE 1
Fostering self-regulated learning: A conceptual model.

and parent relationships on learning engagement is significantly greater than that of teacher-student relationships.

It is necessary to identify significant contextual determinants of students' SRL and further differentially examine which specific variables of SRL these determinants have an impact on. With their study, [de Ruig et al.](#) addressed teacher self-efficacy as well as teacher-student interactions as two potential contextual predictors that might foster students' metacognitive, motivational, and behavioral self-regulatory skills. Their findings suggest that teacher self-efficacy plays a particularly crucial role in the development of students' SRL.

Since teachers play a key role in teaching SRL to their students, it is imperative to provide teachers with SRL knowledge and practice already at the training stage.

Training effectiveness

All the papers presented above recognized the need for targeted interventions and professional development for teachers. [Stephenson et al.](#)'s research investigated the details and effects of a short online Professional Learning Program designed to develop teacher education students' knowledge about promoting SRL in the classroom. The results showed that by the end of the program, over 85% of the participants could provide teacher instructions that included explicit SRL promotion and/or promoted

students' SRL knowledge. [Backers and Van Keer](#) explored the roles, responsibilities, and challenges faced by coaches in running professionalisation programs focused on SRL. They identified four roles for process coaches: trainer, expert, coordinator, and learner. In these roles, process coaches experienced different challenges and tensions; for example, they faced challenges in defining their role as content experts or group learning facilitators. The professional development programmes examined here primarily focus on direct approaches, explicitly teaching teachers how to promote SRL strategies, though coaches also consider indirect environmental factors.

Student perspective

The results of these studies contribute to the understanding of fostering SRL from a student's perspective and highlight the importance of student evaluations of fostering SRL. They also provide guidance to teachers on how to organise teaching with the aim of encouraging SRL. From the student viewpoint, both direct interventions (e.g., peer assessment) and indirect environmental factors (relationships, teacher expectations, sense of belonging) emerge as significant influences on SRL development.

Research demonstrates that students' perceptions of their teachers play a crucial role in their self-regulatory development.

TABLE 1 A summary of the research topic papers.

Authors (A–Z)	Short title of manuscript	Main topic/aim	Target group	Direct/indirect approach	Research methods
1. Amir	Literacy resilience	Investigating “literacy resilience” as connecting literacy and SRL	Teachers	n/a	Quantitative
2. Backers and Van Keer	Professionalizing schools on self-regulated learning	Examining leaders’ roles and responsibilities in guiding SRL-focused PD	School leaders	Combined	Qualitative
3. Barz et al.	Fostering SRL using digital learning environments	Analyzing pre-service teachers’ SRL profiles in digital learning environments	Pre-service teachers	Comparing direct/indirect	Quantitative
4. Evans et al.	Developing a scale to explore self-regulatory approaches	Developing a scale about SR assessment and feedback (SRAF)	Higher ed. teachers	Indirect	Quantitative
5. Greenquist-Marlett et al.	Teachers’ perceptions of their SRL practices	Investigating teachers’ SRL strategies in K–5 contexts and how it is linked to self-efficacy and effectiveness	Teachers	N/a	Qualitative
6. Kumyoung	Development of a causal model of SRL	Examining a casual model of SRL	Higher ed. students	N/a	Quantitative
7. Manuel et al.	Encouraging self-regulated learning	Investigating how feedback promotes learners’ SRL skills	Teachers	N/a	Qualitative
8. de Ruig et al.	Understanding the interplay	Identifying contextual determinants of students’ SRL	Teachers	Combined	Mixed-method
9. Ortega-Ruipérez and Correa-Gorospa	Peer assessment to promote SRL with technology	Investigating how technology facilitates SRL using peer assessment activities	Higher ed. students	Direct	Qualitative
10. Šimić Šašić and Atlaga	Student perception of teacher encouragement of SRL	Examining how students perceive teacher encouragement of SRL and its association with their own SRL	School students	Indirect	Quantitative
11. Stephenson et al.	Helping teacher education students’ understanding of SRL	Investigating the effect of SRL Teacher Promotion Framework (SRL-TPF), which focused on SRL promotion	Higher ed. students	Direct	Mixed-method
12. Sun et al.	Shyness and academic procrastination	Investigating the correlation between shyness and academic procrastination and the internal mechanisms	School students	Indirect	Quantitative
13. Wang et al.	Enhancing engagement through teacher expectations	Examining the longitudinal effect of students’ perceptions of teacher expectations on their academic engagement	School students	N/a	Quantitative
14. Wolff et al.	Using the fused graphical lasso to explore the motivational self-system	Testing the effect of an intervention to improve SRL in biology courses using joint estimation of graphical models	Higher ed. students	Direct	Quantitative
15. Won and Chang	Antecedents and consequences of academic help-seeking in online STEM learning	Investigating the role of academic help-seeking in online STEM learning	Higher ed. students	N/a	Quantitative
16. López-Angulo et al.	Validation of the self-regulation of learning instrument for undergraduates	Designing and validating the SRLI-U scale that assesses SRL among Undergraduates	Higher ed. students	N/a	Quantitative
17. Zhao et al.	Variations in online SRL abilities	Understanding teachers’ Online SRL abilities	Teachers	N/a	Quantitative
18. Zhu et al.	Fostering learning engagement	Examining the impact of relationships on engagement and the mediating role of SRL	School students	Indirect	Quantitative

Šimić Šašić and Atlaga examined how students perceive the teacher’s encouragement of SRL and its connection with their own SRL. Students perceive that teachers moderately to relatively highly encourage SRL. Student perception of the teacher’s encouragement of SRL is a significant predictor of student SRL. Proactive SRL strategies (focus on adoption, elaboration, and goal setting) are explained to a much greater extent. Extending this understanding of teacher influence, the study by Wang et al. examines the

longitudinal effect of middle school students’ perceptions of teacher expectations on their academic engagement, as well as the mediating role of intentional self-regulation in this dynamic. The results showed that students’ perception of teacher expectations significantly predicted their academic engagement, with higher perceived teacher expectations leading to increased academic engagement. Furthermore, the study revealed that intentional self-regulation played a pivotal mediating role in the

relationship between students' perceptions of teacher expectations and academic engagement.

These findings underscore the need to identify which specific factors contribute most to students' SRL development. A causal model of SRL can provide insight into what factors contribute to SRL, thus directing teachers to place their efforts in the most important factors. In a study by Kumyoung et al. examining a causal model of SRL, it was found that self-efficacy, achievement motive, and learning by imitation variables had a favorable impact on SRL. The researchers inferred that increasing self-efficacy, achievement motive, and learning by imitation among students may be an effective strategy for enhancing the efficiency of SRL. This research suggests that teachers should organize teaching and learning activities that promote achievement motivation and develop self-efficacy.

Recognizing that social factors like learning by imitation contribute to SRL, research has examined specific social learning strategies. Won and Chang investigated the role of academic help seeking, which is recognized as a learning strategy by SRL models, in online STEM learning and its contextual antecedents. Findings indicate that academic help-seeking is related to successful online STEM learning. This study also revealed a pathway through which sense of belonging and environmental fixed mindset are related to students' choice, retention intentions, and academic performance in STEM fields. Beyond help-seeking, peer interactions offer another avenue for developing self-regulatory competencies. Researchers have developed different approaches to promote SRL. Mostly, self-regulatory skills are fostered directly by offering training programs to the learners or to the teaching personnel. However, less is known about more indirect ways of fostering self-regulatory competencies. Thus, Ortega-Ruipérez and Correa-Gorospe conducted a systematic review in order to examine the effects of peer assessment in virtual classrooms of higher education on university students' metacognition and critical thinking. They found that peer assessment appears to be an effective and practical way to promote students' metacognitive skills.

While social strategies can support SRL development, individual characteristics may present obstacles that require attention. A study by Sun et al. examined the influence of shyness on academic procrastination and the role of self-regulation and self-directed attention in their relationship. They found that shyness significantly predicted academic procrastination, self-regulation mediated the relationship between shyness and academic procrastination, and higher levels of self-directed attention strengthened the predictive effect of shyness on self-regulation.

Given this understanding of contributing factors, barriers, and strategies, researchers have begun testing targeted interventions to enhance SRL. Wolff et al. investigated the effects of a randomized controlled trial designed to test the effect of a brief intervention used to improve SRL in an entry-level biology course using conjoint assessment of graphical models. The network structures of the experimental and control groups' motivational variables showed a high level of concordance in the relative magnitudes of edge weights; however, there were non-trivial differences in edge weights between groups that could be attributed to treatment and differences in predictability.

Validation of measuring instruments

SRL skills are crucial for academic success at all levels of education. It is important to use valid and reliable measurement instruments to allow evaluating, monitoring, and intervening in SRL. For this purpose, in a study by López-Angulo et al., the researchers designed and validated the SRLI-U scale that assesses SRL among undergraduates, based on Zimmerman's model. Evans et al. also developed a scale to be implemented in the higher education context. However, their instrument does not address students; it rather aims at measuring academics' understanding of and training needs in assessment and feedback practices that focus on the systematic development of students' self-regulatory learning skills.

Conclusions

This Research Topic makes a distinctive contribution to the field by focusing specifically on the fostering of SRL, shifting the research lens from examining how SRL affects academic success or how students perform self-regulation, to investigating how teachers, schools, and educational systems can actively promote and develop SRL competencies. This emphasis on fostering mechanisms represents a crucial but underexplored dimension in SRL research. The research presented in this Research Topic draws on contemporary theories and models of SRL (according to Panadero, 2017) and models of teacher facilitation of SRL (Karlen et al., 2020; Peeters et al., 2015; Kramarski and Heaysman, 2021). Research conducted with teacher samples still indicates that teachers recognize the importance of fostering SRL, but they lack the necessary knowledge and insufficiently foster SRL, most often using implicit strategies. Teacher self-efficacy is shown to be a significant predictor of encouraging SRL. Interpersonal relationships also play an important role in fostering SRL, as do feedback and teacher expectations that influence student engagement in learning. To better create a supportive synergy for enhancing students' learning engagement, families and schools need to provide consistent learning support. Research systematically reports on the effectiveness of teacher training in the area of developing and promoting SRL strategies. The results of the research presented in this Research Topic also indicate that special attention should be paid to teachers at lower levels of education (preschool and primary school levels), teachers from rural areas, and teachers with more years of experience. The results also contribute to understanding the promotion of SRL from the perspective of students and highlight the importance of student evaluations of the promotion of SRL. They also emphasize seeking academic help, learning by imitation, and peer assessment.

Interpreting findings through Dignath and Veenman's (2021) framework of direct vs. indirect fostering approaches reveals important patterns. Teacher's Perspective studies predominantly identified gaps in direct strategy instruction, while teachers showed more confidence in indirect methods such as goal-setting and progress monitoring. Training Effectiveness interventions focused primarily on equipping teachers with direct instructional strategies. Student Perspective research, however, highlighted the power of

indirect approaches: relationships, teacher expectations, and peer assessment structures—suggesting these environmental factors may be underutilized. This pattern indicates that while research and training emphasize direct methods, indirect approaches warrant greater attention and systematic investigation.

Directions for future research

While this Research Topic offers valuable insights, several important gaps remain that warrant attention in future research. First, the published papers predominantly focus on quantitative research methodologies. There is a clear need for more qualitative and mixed methods studies, especially when investigating research questions that have not been extensively explored yet. Emerging areas such as the intersection of SRL and artificial intelligence, for example, would benefit from in-depth qualitative investigations that can capture the complexity and nuances of these novel contexts. Second, in terms of generalizability, it is necessary to conduct more intercultural comparisons. The studies in this Research Topic included relatively few cross-country investigations with regard to their samples, limiting our understanding of how cultural contexts shape SRL promotion and development. Third, despite the demonstrated importance of teacher competencies in fostering SRL, there remains insufficient research on professional development programmes for teachers, particularly regarding the long-term effectiveness and sustainability of such interventions.

Papers within this Research Topic offer a synthesis of the latest knowledge in this research area, contribute to the consolidation of current knowledge, highlight limitations and critical issues of current research, and offer new ideas and thinking to support future research. We hope it will stimulate much future research.

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Literacy resilience: bridging linguistic literacy and self-regulated learning for enhanced educational success

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This paper introduces the innovative concept of “literacy resilience (LR)” as a crucial link between linguistic literacy and self-regulated learning (SRL). The foundation of this concept rests on two fundamental assumptions. First, every educational interaction is a literate interaction, combining the skills of reading, writing, listening, and speaking. Second, self-regulated learning (SRL) is a multidimensional process, encompassing personal, behavioral, and environmental factors, enabling students to enhance their learning management. These principles led to the development of “literacy resilience.” This research aims to investigate “literacy resilience” as a critical connection between linguistic literacy and self-regulated learning, and explore teachers’ perceptions of its importance and their evaluation of students’ literacy resilience levels. The study surveyed 349 teachers across various fields using a dedicated questionnaire. Findings reveal a notable discrepancy between teachers’ perceptions of literacy resilience’s importance and their assessment of students’ levels. While teachers emphasize its high importance, they perceive students’ levels to be low, suggesting a gap between recognized importance and current development. Moreover, there is a significant lack of teachers’ knowledge of both literacy skills and SRL strategies. These findings highlight a potential discrepancy between teachers’ recognition of literacy resilience’s importance and students’ perceived competence, suggesting a need for targeted professional development initiatives.

KEYWORDS

linguistic literacy, literacy resilience, professional development, self-regulated learning (SRL), teachers’ perceptions

1 Introduction

Two basic assumptions form the basis of the present study. First, every educational interaction is essentially a literate interaction. This means that students are expected to skillfully and flexibly navigate between different modes, both spoken and written, in order to express thoughts and feelings, formulate ideas and opinions, defend arguments, present information clearly and concisely, and participate effectively in quality communication tailored to specific goals, circumstances and target audiences (Berman and Ravid, 2008; Tolchinsky, 2022).

The second assumption is that every learning interaction involves processes related to self-regulated learning (SRL) and executive functions. SRL is essential in the students’ learning process, allowing them to manage and monitor their entire learning process (Adams, 2020; Jansen et al., 2019; Lichtinger and Kaplan, 2011; Pintrich, 2000; Pintrich and Zusho, 2002; Zimmerman, 2000, 2002, 2008). Executive functions are high-level cognitive processes necessary to direct behaviors and goal-directed tasks (Ober et al., 2020; Mohseni et al., 2020;

Ravid and Tolchinsky, 2002; Landi, 2012; Oakhill and Cain, 2007; Flower and Hayes, 1981; Kaplan et al., 2009).

These assumptions form the basis of “literacy resilience,” which is examined both from a linguistic literacy perspective and from a metacognitive perspective. The research focuses on the learners’ ability to navigate educational tasks that require literacy skills and self-regulated learning (OECD, 2019a, 2019b, 2021). While educators recognize the importance of fostering SRL and linguistic literacy (Heaysman and Kramarski, 2022; Kistner et al., 2010; Panadero and Järvelä, 2015; Šimić Šašić et al., 2023; Amir, 2024a, 2024b; Tolchinsky, 2022), this study reveals a gap between this recognition and the teachers’ perceptions of their students’ literacy resilience levels (Berman and Ravid, 2008; Tolchinsky, 2022).

This study establishes a theoretical relationship between linguistic literacy, self-regulated learning (SRL) skills, executive functioning, and meta-strategic knowledge. Literacy resilience refers to the learner’s ability to persevere in the face of linguistic challenges and navigate effectively through a combination of linguistic literacy skills and SRL processes. This article provides a comprehensive definition of literacy resilience and conducts an analysis to assess its importance as perceived by teachers, along with their perceptions of their students’ levels of literacy resilience.

2 Theoretical background

2.1 Linguistic literacy

Linguistic literacy is the ability to identify, understand, interpret, produce, and communicate through texts in various contexts. It includes both the comprehension and evaluation of spoken and written texts, as well as the ability to produce them (Sälzer and Roczen, 2018). Proficient linguistic literacy requires a rich linguistic repertoire to navigate between communication modalities, convey focused meanings, respond logically to texts, and organize content appropriate to context (Berman and Ravid, 2008; Ravid and Tolchinsky, 2002; Tolchinsky, 2022).

Our understanding of linguistic literacy has evolved with social and technological changes. Today, it also includes dealing with digital texts and meta-cognitive aspects of reading and writing (Binkley et al., 2019; OECD, 2019b, 2021; Pintrich, 2000; Zimmerman, 2023). The recognition of the importance of meta-cognitive aspects in linguistic literacy leads to an examination of the central role of self-regulated learning in developing and applying literacy skills (Saks and Leijen, 2018).

2.2 Self-regulated learning (SRL)

Self-regulated learning is a process in which learners control their learning through goal setting, planning, monitoring, and evaluation. It is essential for academic success and lifelong learning (Pintrich, 2000; Zimmerman, 2000). SRL includes cognition: strategies for understanding and problem-solving, metacognition: awareness and regulation of cognitive processes and motivation: beliefs about abilities and tasks (Bandura and Cervone, 1986; Flavell, 1979). This process is particularly crucial in complex tasks such as writing, where

self-regulation and transcription skills play a vital role in development (Graham and Harris, 2000).

Research shows that students who regulate their learning achieve higher academic performance (Veenman and Beishuizen, 2004). SRL skills assist in time management, goal setting, adapting learning approaches, and persisting through challenges (Bandura, 1991; Zimmerman and Kitsantas, 2007).

The impact of SRL extends to various domains, including writing instruction, where cognitive self-regulation has been shown to significantly improve writing skills in planning, monitoring, and evaluating writing (Boscolo and Hidi, 2007; Fidalgo et al., 2017; Fidalgo and Torrance, 2017; Lichtinger and Kaplan, 2011, 2015). Furthermore, observational learning in writing, which involves SRL processes, has been found to enhance writing performance (Braaksma et al., 2012; Rijlaarsdam et al., 2006; Rijlaarsdam et al., 2009; Rijlaarsdam et al., 2018).

SRL aids in monitoring comprehension and identifying difficulties in reading (Mohseni et al., 2020). Integrating SRL strategies in literacy instruction leads to more effective learning (Amir et al., 2021; Nurjanah and Pratama, 2020; Zare, 2007).

Educators play a crucial role in fostering SRL through opportunities for self-assessment, goal setting, and reflection (Zumbrunn et al., 2011). Recent studies emphasize the importance of self-efficacy, motivation, and support for basic psychological needs in academic achievement, reinforcing the significance of SRL in education (Basileo et al., 2024).

The integration of linguistic literacy and self-regulated learning creates an essential basis for the development of a new concept: literacy resilience.

2.3 Defining literacy resilience

Although the concept of resilience has been studied for decades, there remains a lack of consensus regarding its definition, conceptualization, and measurement (Vella and Pai, 2019). Resilience is a term that arises in various contexts, including the emotional, mental, and social realms. In the research literature, there is an ongoing debate about whether resilience should be classified as a personality trait, a process, or an outcome (Pooley and Cohen, 2010). When resilience is regarded as a trait, an individual characteristic, it has been defined as adaptive resistance to stress (Ahern et al., 2008). However, when conceived as an outcome, resilience alludes to proficient, stable, and consistent adaptation under challenging conditions (Masten, 2001).

Research on resilience has mainly focused on developmental and clinical psychology (Jowkar et al., 2014; Richardson et al., 1990). In the context of education, the term “academic resilience” as an increased likelihood of achieving success in school despite environmental adversities resulting from personal traits, conditions and early experiences, such as stress and academic research (Mallick, 2016; Wang et al., 1997). Furthermore, within the framework of perceived academic resilience, motivation appears as a key component (Radhamani and Kalaivani, 2021). This suggests that resilient students tend to be more motivated and achieve success despite the presence of stressful events and conditions that put them at risk, such as dropping out of school. Research in this area has largely focused on ethnic minority groups (e.g., Davis and Paster, 2000; Masten, 2001), mental

health (Jowkar et al., 2014), and potential sources of support that can foster academic resilience and hope in coping with academic challenges (Radhamani and Kalaivani, 2021).

Studies that examined the relationship between academic resilience and achievement indicated a positive and distinct relationship between academic resilience and academic achievement among students (Mwangi et al., 2015; Zuill, 2016). Also, academic self-efficacy was correlated with academic resilience, and a significant predictor of academic resilience (Fallon, 2010).

It is crucial to delve into the concept of resilience beyond its conventional definitions, particularly in educational environments where students encounter a range of challenges related to literacy skills. The research perspective outlined in the article on resilience within the educational context revolves around the notion of “literacy resilience.” This concept encompasses the abilities necessary to tackle academic tasks that demand literacy skills, which students must possess in conjunction with self-regulated learning (SRL) skills.

The term “literacy resilience” (LR) is based on a theoretical relationship between linguistic literacy and regulated learning skills (SRL). In this article, I define the term “literacy” (LR). To the best of my knowledge, this term as I define it is not found in the professional and research literature. Figure 1 shows the Key Elements of Literacy Resilience which the broad definition of literacy resilience that will be presented later is based.

When students are given a task that requires literacy skills, for example, to compare different topics, to merge information, to assert a claim and substantiate it, to what extent is the student responsible for the task from start to finish and to deal with the task alone, without the mediation of an adult? To what extent do they know how to identify what is difficult for them regarding the specific task? To what extent do they know how to choose strategies that can help them? And no less important, to what extent do they know how to manage their time and prioritize?

A student who can be responsible for the task from beginning to end, knows how to identify what is difficult for him, how to ask

questions relevant to the task, how to choose appropriate strategies for the task, and manage the task correctly, also in terms of the time available to him, can be said to have reading resilience, that is, he has the tools, and ways to overcome the literacy challenges and know how to deal with the difficulties.

These components helped me refine the definition of Literacy resilience (LR).

The learner’s ability to deal on his own with assignments that require a variety of literacy skills, and to have self-direction and self-ability to deal with oral and written texts. Meanwhile, the learner must carry out the tasks himself from start to finish, know how to identify difficulties, ask relevant questions that may advance him in the performance of the task, and hold a reflective dialogue with himself.

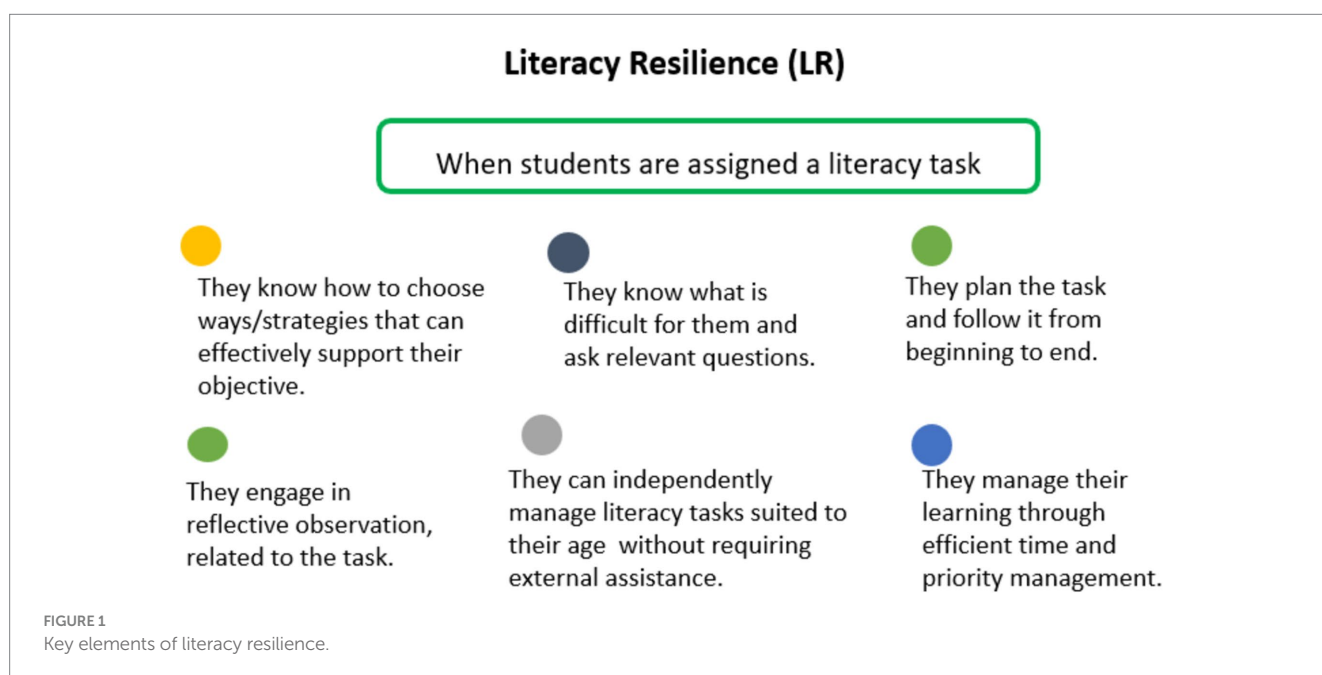
Linguistic literacy skills anchored in SRL are the cornerstones of a learner’s literacy resilience, as shown in Figure 2.

As shown in Figure 2, literacy resilience has two anchors: one related to literacy skills and the other related to SRL skills. Only the combination of them constitutes the foundation for building literacy resilience.

Literacy skills are cognitive skills that include meta-linguistic and meta-textual awareness, and the skills of SRL include, among others, executive functions and emotional functions.

This resilience is evident in the learner’s independent handling of assignments requiring diverse literacy skills, self-directed engagement with oral and written texts, proficient learning management, autonomous planning, and the execution of literacy tasks from initiation to completion. Additionally, it entails the learner’s awareness in identifying challenges, selecting appropriate strategies, and engaging in reflective dialogue about his learning.

Students who have literacy resilience are aware of their ways of learning and know how to identify which ways of learning are effective for them. When the learners have metacognitive control, they can decide on the literacy strategies they should take, and in what order to carry them out, and conduct a meta-linguistic and meta-textual dialogue about the effectiveness of these and other



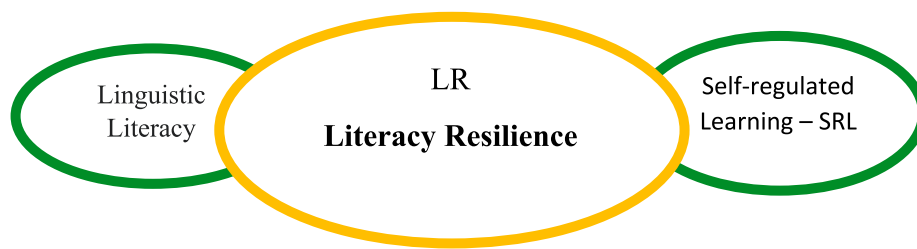


FIGURE 2
The literacy resilience model.

literacy strategies. For instance, in the domain of reading comprehension, the learner must possess the ability to approach the text, understand the genre, and discern the reading objectives (Banditvilai, 2020). They should be able to identify their strengths and weaknesses to the subject, formulate questions that assist in tackling difficulties, apply prior knowledge, determine what to read first, select appropriate strategies, and navigate the reading effectively, among other tasks. A reader who is adept at engaging in a meta-cognitive dialogue with themselves and their environment concerning a task that demands literacy skills can be said to possess literacy resilience. This means they exhibit awareness and self-control in addressing the literacy-related challenges of the task. Even when faced with a complex assignment, such a learner is unlikely to give up, and they are skilled at posing questions and identifying areas of difficulty.

Learners who lack metacognitive awareness are unable to reflect on their cognitive processes and be aware of their literacy activities. In such a case it is difficult to expect that actions will be taken, for example, in the structuring of meaning from the text, or to deal with difficulties when failing or disrupting understanding. Literacy resilience is gradually built and is the result of mastery of the different skills and modalities: speaking, listening, reading, and writing combined with metacognitive, meta-linguistic, and meta-textual awareness and self-management. These abilities involve the learner's behaviors and thoughts and his self-efficacy to cope with the difficulties and literacy tasks in effective ways. Literacy resilience allows the learner to be independent and gradually reduces the need for mediation by a teacher or other adult (Amir, 2024a, 2024b).

Literacy skills and a sense of self-efficacy for coping with literacy tasks are important for creating a learning space and fostering literacy resilience (Amir, 2024a). Their importance is even deeper when students do not show independence spontaneously but are dependent on the mediation of the teacher and have difficulty performing tasks on their own. This is especially true when it comes to complex tasks that require searching for information, assessing the reliability of information, reading many sources, integrating and synthesizing information from various sources, skills of research, critical reading, production of texts, etc. The ability to cope with literacy difficulties independently combined with high self-efficacy constitutes literacy resilience, which may also contribute greatly to the emotional resilience of the learner. Literate resilience, therefore, is also related to meta-linguistic and meta-textual awareness, executive functions, and emotional functions.

2.4 Teachers' perceptions regarding self-regulated learning (SRL)

Teachers' perceptions significantly influence their classroom actions and curriculum planning (Albion and Ertmer, 2004; Park et al., 2006; Kimpston and Anderson, 1986; Louws et al., 2017; Pajares, 2003; Summers, 1977). Teachers' beliefs about teaching SRL predict their classroom behavior, whether or not they have implemented practices that promote self-direction (Dignath-van Ewijk and van der Werf, 2012; Lawson et al., 2019). For example, Dignath-van Ewijk (2016) found a correlation between teachers' belief in the importance of SRL, its use, and self-efficacy for teaching it. Studies have shown that teachers generally attach great importance to SRL (Dignath-van Ewijk and van der Werf, 2012), with some finding no differences between age groups (Huh and Reigeluth, 2018). Despite this recognized importance, many teachers do not teach SRL; some lack knowledge (Dignath and Veenman, 2021; Glogger-Frey et al., 2018), while others do not believe in its explicit instruction (Lawson et al., 2019; Vosniadou et al., 2020). Some believe SRL skills develop spontaneously or cannot be taught at all. Therefore, it's crucial to identify and develop positive beliefs about teaching self-direction in learning across different age groups (Heaysman and Kramarski, 2021).

2.5 The importance of linguistic skills according to teachers' perception

Teachers play a significant role in developing learners' linguistic literacy skills, including learning management and SRL skills (Karlen et al., 2020). Their perceptions of linguistic literacy and its characterizing skills, alongside the learning environment they create, are of great importance. As agents of knowledge and skills, teachers shape their students' habits of using information and linguistic literacy skills. Understanding teachers' perceptions of linguistic literacy and their assessment of students' literacy levels is crucial. Studies show that increased exposure to the field's teaching importance and participation in relevant training or professional development enhances teachers' positive perceptions (Heaysman and Kramarski, 2022).

This study aims to illuminate perceptions of elementary, middle, and high school teachers regarding literacy resilience's importance for learning. Examining these perceptions is crucial as they significantly influence instructional practices and the learning environment. Understanding these views can reveal gaps between the importance teachers attribute to these skills and their classroom implementation.

Assessing teachers' views on students' literacy resilience levels can provide insights into the current state of literacy education and highlight areas needing additional focus. Examining perceptions across different education levels and disciplines can uncover patterns or disparities that could inform targeted professional development initiatives. This research aims to contribute to the broader understanding of literacy resilience in educational settings and its potential impact on students' academic success and lifelong learning skills. These perceptions have led to the formulation of the following research questions:

2.6 Research questions

RQ1: The importance of literacy resilience:

- What is the importance of literacy resilience for the educational success of students, according to the teachers' perception?
- Will there be differences between teachers of different age groups in their perception of the importance of literacy resilience?
- Will there be differences between teachers from different disciplines in their perception of the importance of literacy resilience?

RQ2: The literacy resilience level of students:

- To what extent do teachers perceive their students as literately resilient?
- Will there be differences between the perceptions of teachers in different education levels (elementary, middle, and high school) regarding their students' literacy resilience?
- Will there be differences between teachers from different disciplines in their perception of their students' literacy resilience?

3 Methods

3.1 Participants

The participants were teachers who chose to attend a lecture or a PD (Professional Development) course about literacy that was provided by the researcher through the Ministry of Education. Before the lecture or course began, the teachers were invited to fill out the questionnaire voluntarily, and anonymously. Out of the 512 teachers who attended the lectures or courses, 409 teachers responded to the questionnaire; of whom 26 teachers whose discipline was "other" were excluded because their discipline was unspecified, leaving a total of 383 participants. The teachers varied in age, tenure, teaching subject, and school level. The gender distribution (As seen in Table 1, 87.2% women) is similar to that of the general population of teachers in Israel, in which 82% are women (Central Bureau of Statistics, 2020). See Table 1 for teachers' background characteristics.

3.2 Research instruments

The research methodology included a survey of 349 teachers in various fields who filled out a valid questionnaire dedicated to the

study. The questionnaire consists of Likert scale questions with the following ratings: 1 (neither/neither), 2 (to a small degree/infrequently), 3 (to a large degree/frequently), and 4 (to an extremely great degree/always). Each question was based on one of the aforementioned facets of the definition of literacy resilience (see Figure 1). To validate the questionnaire, I took the following steps:

An initial version was drafted. Three experts in the field of literacy evaluated the statements and recommended corrections. The statements were corrected according to their comments. The final version was tested using Cronbach's α for internal reliability.

3.2.1 Components of the questionnaire

- Demographic questions regarding the participants' background characteristics: gender, education level, teaching profession, age group, and teaching experience.
- Teachers' perspectives on the significance of literacy resilience for academic achievement. Five statements were composed for this section of the questionnaire, for example: (1) To what extent is literacy mastery a critical factor in students' success with learning tasks? (2) How important is it for students to be able to complete assignments independently? The "Perception of the importance of literacy resilience" index was calculated using the mean of the statements. The Cronbach's α for internal reliability test confirmed high reliability – = 0.938.
- Teachers' perceptions of their students' literacy resilience, both in terms of linguistic literacy skills and SRL. Thirteen statements were formulated for this portion of the questionnaire. For example: (1) When you assign students a task that requires literacy skills (such as combining information, comparing, making informed choices of sources of information, expressing a reasoned position, etc.), to what extent do you believe/appreciate that they take full responsibility for the assignment? (2) When allowing students to complete an assignment that requires literacy skills on their own, to what extent do you believe/appreciate that they can identify what is difficult for them? (3) When allowing students to independently complete a task requiring literacy skills, to what extent do you believe/appreciate that they can manage their learning in terms of time and prioritization?

The "literate resilience" index was calculated using the average of the statements. The Cronbach's α for internal reliability test confirmed high reliability – = 0.913.

3.3 Research procedure

In the initial phase, a pilot version of the questionnaire was distributed to 30 teachers who attended a lecture about linguistic literacy. The questionnaire was distributed at the beginning of the lecture. It was explained that no personal details are included and the questionnaire is anonymous. After the first phase, several questions were reformulated. After determining the final version of the questionnaire, it was distributed to teachers who attended various lectures or PD courses on the subject of linguistic literacy in the same manner, right before the lecture or PD course began.

TABLE 1 Background characteristics.

		%	N
Gender	Women	87.2%	334
	Men	12.8%	49
Age group	25up to	5.5%	21
	26–35	17.2%	66
	36–45	39.4%	151
	46–55	30.0%	115
	And over 55	7.8%	30
Tenure	5–1	4.2%	16
	10–6	21.9%	84
	15–11	27.4%	105
	16 and over	46.5%	178
School	Elementary	25.8%	99
	Middle school	41.0%	157
	High School	33.2%	127
Teaching subject	Sciences	8.9%	34
	Mathematics	12.5%	48
	Language	44.1%	169
	Social domains	34.5%	132
Total		100.0%	383

3.4 Data analysis

Following [De Coninck et al. \(2020\)](#), scales were constructed and validated using a Factor Analysis to identify the number of factors and confirm they are in line with a theoretical model. Following [Costello and Osborne's \(2005\)](#) recommendations for non-normally distributed items and correlated factors, the Principal-Axis Factoring (PAF) method was used with direct oblimin rotation (oblique rotation). The latter allows factors to be correlated and produces estimates of correlations among factors. Initially, the [Kaiser \(1960\)](#) criterion was used to exclude factors with eigenvalues smaller than one, followed by a Scree plot analysis ([Cattell, 1966](#)) to determine factor numbers. Finally, all items with loadings of 0.35 or less were excluded from further analysis, as were items with strong cross-loadings on more than one factor ([Costello and Osborne, 2005](#)). All analyses were conducted using SPSS 25.0 and are summarized in [Table 2](#). Next, internal consistency of the scales were determined. Cronbach's α common threshold of 0.70 ([Taber, 2018](#)) was used to determine a factor's internal consistency.

To validate the measurement instrument, Cronbach's alpha was used to assess the internal consistency of the items within each factor. As reported earlier, the 'Perception of the importance of literacy resilience' index showed high reliability ($\alpha = 0.938$), as did the 'literate resilience' index ($\alpha = 0.913$). These high alpha values indicate strong internal consistency of the items in each measure, supporting the reliability of the instrument. These reliability measures provide confidence in the coherence of the scales used in this study.

To answer the two research questions, first, a descriptive statistical analysis was conducted for each section of the questionnaire, including

the mean, standard deviation, and range (minimum and maximum). Second, for each of the indices, three level-based categories were established: low, medium, and high. In the initial phase, the mean of each participant's statements for each index was determined. In the second step, the averages in each index into three categories were sorted: low, medium, and high. The low level included averages between 1 and 1.99, medium between 2 and 2.99, and high between 3 and 4. Thirdly, the frequency of each category was determined (low, medium, and high). Lastly, using ANOVA, the prevalence between age groups was compared. Pearson correlation analysis was used to determine association between the indices.

4 Findings

4.1 RQ 1: The level of importance teachers place on their students' literacy resilience

The first research question examined the degree to which educators value the literacy resilience of their students. It was separated into three sections.

(RQ1a) *According to the teachers' perceptions, what is the significance of literacy resilience for the educational success of students?*

To this end, participants rated the importance of literacy resilience in terms of academic achievement. The findings indicate that teachers place a high value on literacy resilience ($M = 3.52$, $SD = 0.76$, $min. = 1.00$, $max. = 4.00$).

TABLE 2 Results of a factor analysis indicating two factors (N = 383).

Items	Factors	
	Perceived level of literacy resilience	Perceived importance of literacy resilience
When students are given to complete on their own an assignment that requires literacy skills (such as merging information, comparison, informed choice of information sources, expressing a reasoned position, etc.), to what extent do you think/estimate that they need full mediation?	0.58	
When students are given to complete on their own a task that requires literacy skills (such as merging information, comparing, intelligently choosing sources of information, expressing a reasoned position, etc.) to what extent do you think/estimate that they show responsibility for the task from beginning to end?	0.82	
When students are given to complete on their own an assignment that requires literacy skills, to what extent do you think/estimate that they know what is difficult for them?	0.56	
When you let the students complete a task that requires literacy skills on their own, to what extent do you think/estimate that they know how to ask for help and ask questions when they have difficulty?"	0.77	
When students are given to complete on their own an assignment that requires literacy skills, to what extent do you think/estimate that they know how to choose ways and strategies that can help them?	0.81	
When students are given to complete on their own an assignment that requires literacy skills, to what extent do you think/estimate that they know how to manage their learning: time, prioritization?	0.95	
When students are given an assignment that requires literacy skills, to what extent do you think/estimate that they check their answer to make sure it is correct?	0.64	
When students are given to complete on their own an assignment that requires literacy skills, to what extent do you think/appreciate that they use different ways to answer the questions according to the assignment?	0.79	
When students are given an assignment that requires literacy skills, to what extent do you think/appreciate that they do self-reflection after the assignment?	0.70	
When the students are given to complete on their own an assignment that requires literacy skills, to what extent do you think/estimate that they know how to ask questions that may help them in completing the assignment?	0.69	
When students are given an assignment that requires literacy skills to complete on their own, to what extent do you think/estimate that they check themselves to be sure they will meet the deadlines?	0.89	
When students are given to complete on their own an assignment that requires literacy skills (such as blending information, comparison, informed choice of information sources, expressing a reasoned position, etc.), to what extent do you think/estimate that they Need explanations and scaffolding to do the assignment?	0.56	
When students are given to complete an assignment that requires literacy skills on their own, to what extent do you think/estimate that they do self-feedback following the assignment?	0.69	
To what extent is literacy control (such as the ability to extract information from texts, merge information, compare, express a reasoned position) a key element in the students' success in academic tasks?		0.92
To what extent do you find a connection between mastery of literacy skills and student success?		0.96
Cronbach's α	0.938	0.913

Examining the prevalence of averages by category (low, medium, and high), it was discovered that the majority of teachers (87.47%) rated the importance of literacy resilience as high, while most of the remainder (8.60%) rated it as medium. Few teachers rated the significance as low (4.44%).

Figure 3 displays the data by education level, while Figure 4 displays the data by discipline.

(RQ1b) *Will the importance of literacy resilience be perceived differently by teachers teaching at different education levels (elementary school, middle school, high school)?*

To determine whether there are differences between the education levels, a one-way ANOVA analysis of variance was performed. The findings indicate that there are no significant differences between

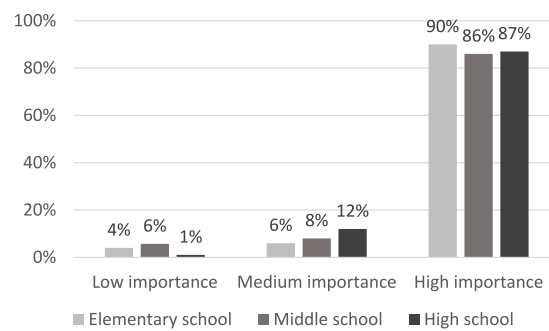


FIGURE 3

The prevalence of the level of importance teachers place on literacy resilience across education levels ($N = 383$).

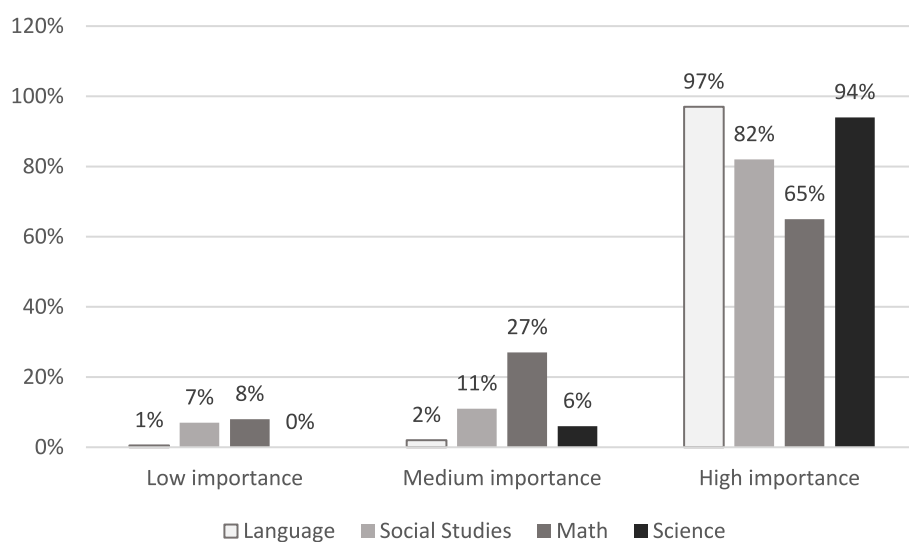


FIGURE 4

The prevalence of the importance teachers place on literacy resilience in different disciplines ($N = 383$).

teachers in different education levels (elementary school, middle school, high school) in the perception of the significance of literacy resilience: [$F(2,381) = 0.273$; $p < 0.05$].

(RQ1c) Will there be differences in the importance of literacy resilience as perceived by teachers from different disciplines?

To determine if there are differences between the disciplines, a one-way ANOVA analysis of variance was performed. The results indicate that there were significant differences in the perception of the importance of literacy resilience across disciplines: [$F(3,380) = 10.075$; $p < 0.001$]. Further tests revealed that the perceived importance of literacy resilience was higher among Science ($M = 3.89$) and Language ($M = 3.7$) teachers than Math teachers ($M = 3.1$). No differences were found compared to the social domain teachers.

4.2 RQ 2: Teachers' perceptions of their students' literacy resilience

The second research question examined how teachers perceive their students' literacy resilience. To this end, the participants ranked

the students' literacy resilience based on their literacy level and their SRL skills. Similarly, this question is divided into three parts:

(RQ2a) How do teachers perceive their students' level of literacy resilience?

The findings indicate that teachers perceive students' literacy resilience to be low ($M = 1.64$, $SD = 0.56$, $min = 1.00$, $max = 3.38$).

Examining the prevalence of averages by category (low, medium, and high), it was found that 73% of teachers perceive the level of literacy resilience of students to be low, 24% perceive it to be medium, and no teachers (3%) perceive it to be high.

(RQ2b) Will there be differences in how teachers of different education level (elementary school, middle school, high school) perceive their students' literacy resilience?

The prevalence of the level of student resilience was measured, as perceived by teachers, according to education levels, as seen in Figure 5.

To determine whether there are differences between the education levels, a one-way ANOVA variance analysis was performed. The

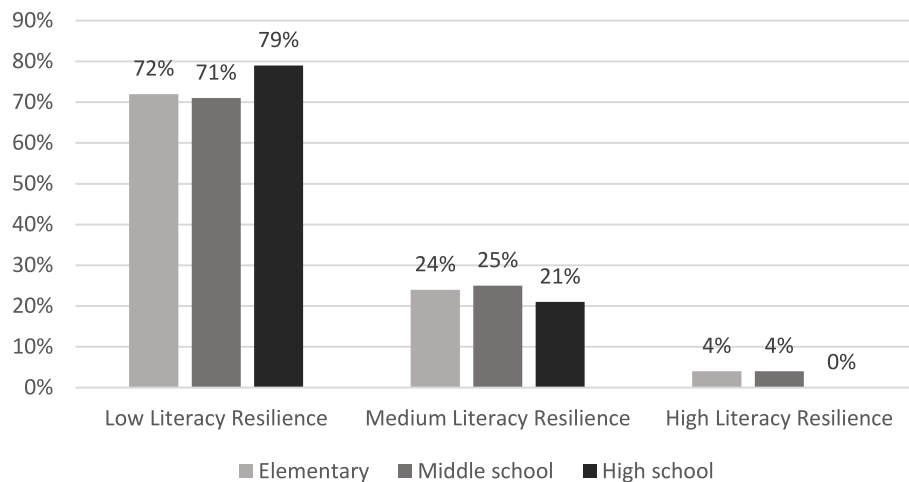


FIGURE 5

The prevalence of the level of student resilience, as perceived by teachers, according to education levels.

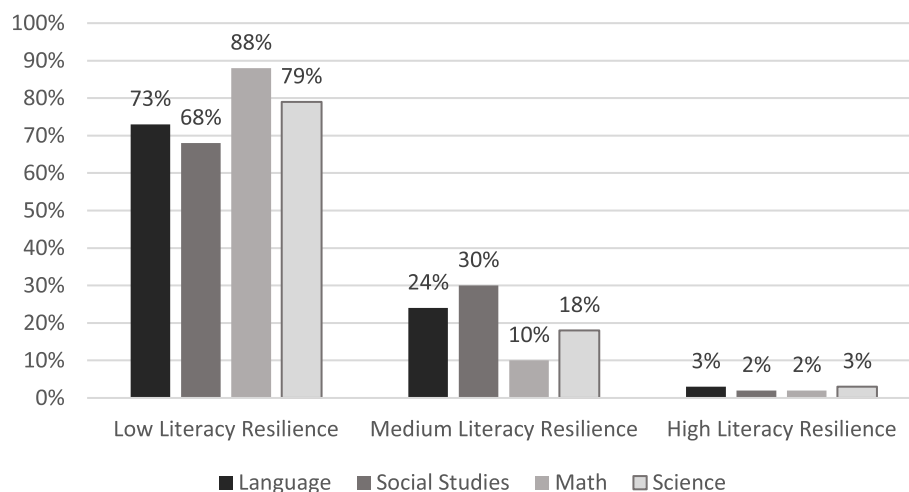


FIGURE 6

The prevalence of teachers' perceptions of their students' level of literacy resilience across disciplines.

results indicate that there are no significant education level differences in teachers' perceptions of their students' literacy resilience [$F(2,381) = 0.273$; $p > 0.05$].

(RQ2c) *Will teachers from different disciplines perceive their students' literacy resilience differently?*

The prevalence of teachers' perceptions of their students' level of literacy resilience across disciplines was measured, as seen in Figure 6.

A one-way ANOVA was conducted to determine whether or not there were differences between the various disciplines. The results indicate that there are no significant differences between disciplines in teachers' perceptions of their students' literacy resilience [$F(3,380) = 1.596$; $p > 0.05$].

Table 3 summarizes the findings regarding teachers' perceptions of the importance of literacy resilience and their assessment of their students' literacy resilience levels in different subject areas and education levels.

As can be seen in Table 3, while teachers generally attribute high importance to literacy resilience, they perceive their students' levels of literacy resilience as low.

4.3 RQ 3: Relationship between indices

There was no significant correlation between teachers' perceptions of the importance of literacy resilience and students' levels of literacy resilience, as perceived by their teachers ($r_{\text{Pearson}} = 0.049$; $p > 0.05$).

TABLE 3 The perception of literacy resilience and its importance according to discipline and education level.

			N	Perceived level of literacy resilience			Perceived Importance of Literacy Resilience			post hoc
				M	(SD)	Statistic	M	(SD)	Statistic	
Teaching subject	Science	(A)	34	1.5	(0.5)	F = 1.596	3.8	(0.5)	F = 10.075***	B < A,C
	Math	(B)	48	1.5	(0.4)		3.1	(1.0)		
	Language	(C)	169	1.6	(0.6)		3.7	(0.5)		
	Social domains	(D)	132	1.7	(0.6)		3.4	(0.9)		
Education level	Elementary	(A)	99	1.6	(0.6)	F = 0.273	3.6	(0.7)	F = 2.738	
	Middle School	(B)	157	1.7	(0.6)		3.5	(0.8)		
	High School	(C)	127	1.7	(0.5)		3.4	(0.7)		

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

5 Discussion

This article had two elementary goals: first, to define literacy resilience; and second, to examine teachers' perceptions of literacy resilience in three dimensions: (a) the degree of importance they attach to literacy resilience; (b) the level of literacy resilience of the students, as perceived by the teachers; and (c) the perceived level of literacy resilience of students about education level and teachers' discipline.

The first research question addressed the importance that teachers attribute to literacy resilience. It was found that the majority of teachers, 87.47%, attribute high value to literacy resilience. In light of this, it is encouraging that most teachers attach importance to literacy resilience among students.

Although there are no studies specifically focusing on literacy resilience, this finding is consistent with studies examining the importance of SRL. For example, the study by Šimić Šašić et al. (2023) indicates that most teachers agree that students should be helped to become self-regulated in their learning. However, teachers only partially understand what self-regulated learning constitutes.

It should be noted that no differences were observed between age groups, indicating that teachers believe literacy resilience is very important for students' learning. However, findings from a follow-up study, though not yet published, referenced in the study (Hamman et al., 2000; Heaysman and Kramarski, 2022; Moely et al., 1992; Šimić Šašić et al., 2023), show that teachers hardly create a learning environment fostering self-regulated learning, although there is a variation between teachers to some extent. And if they do, they mostly do it implicitly and not explicitly.

Assuming that teachers can influence SRL in direct and indirect ways (Kistner et al., 2010; Šimić Šašić et al., 2023; Dignath-van Ewijk, 2016; Dignath-van Ewijk and van der Werf, 2012; Lawson et al., 2019), the more teachers have a clearer understanding of the rationale and the pedagogical actions derived from the concept of literacy resilience, and the more they are offered teaching-learning-assessment materials in the spirit of the principles that will foster literacy resilience, it will be easier for teachers to assimilate these principles in the classroom.

Significant differences were found between teachers from different disciplines. It makes sense that language teachers would place greater emphasis on literacy resilience than math teachers since literacy is the primary aspect of language. Both science and math teachers place importance on literacy resilience. From studies done on mathematics

teachers in what is known as SRL, they are aware of the importance of SRL (Kistner et al., 2010). Math teachers can promote self-regulated learning either directly by teaching learning strategies or indirectly by arranging a learning environment that enables students to practice self-regulation and by systematic professional development.

These findings may explain the importance that math teachers place on literacy resilience; however, perhaps this finding should be tested in a follow-up study.

In examining the second research question pertaining to the level of literacy resilience of the students, it was discovered that the vast majority of teachers, regardless of education level or discipline, perceive the level of literacy resilience of the students to be low. According to the teachers, students require a great deal of assistance when completing assignments, as they have difficulty identifying their difficulties in a focused manner, are unfamiliar with suitable coping strategies for tasks requiring linguistic literacy skills, and do not manage the tasks adequately on their own. Teachers of students of all ages perceive the level of their students' literacy resilience to be low.

This finding has implications for both the pedagogical-didactic and professional development aspects of teacher education. They present teachers with significant challenges of theoretical and practical knowledge as well as beliefs (Dignath and Büttner, 2018; Lawson et al., 2019). Therefore, it is essential to build literacy infrastructures throughout the elementary-middle-high school learning continuum based on aspects of literacy resilience, including the development of linguistic literacy skills and SRL.

Examining the relationship between the variables revealed no correlation between the importance teachers place on literacy resilience and the perceived level of literacy resilience of students. Perhaps this means that regardless of the level of importance teachers place on literacy resilience, they still perceive the students' level of literacy resilience as low, because beliefs of the teacher are not enough: they need knowledge and practice in order to elevate their students' literacy resilience.

Why is it crucial to foster literacy resilience? The ever-changing reality of recent years demonstrates even more clearly the need for learners to develop skills and practices that will accompany them throughout their lives and assist them in navigating an information- and discourse-rich world. To cultivate the image of the ideal graduate, one of the elementary goals of education is to instill in students' lifelong skills for independent learning. Independent learner development is the pinnacle of education and a global trend reflected in international policy

documents (OECD, 2021). Literacy resilience enables students to become independent learners. A learner with literacy resilience will be able to navigate the technology-rich 21st century, manage his learning, plan a complete learning process from beginning to end, know how to ask questions, know where to find information, employ appropriate strategies, and monitor the process. It is an active process of independent learning in which learners act as their learning agents and are conscious of the process: they plan and manage the learning, observe their actions, evaluate their situation, and direct their actions accordingly. Most independent learning does not occur naturally; therefore, it is essential to cultivate it explicitly and deliberately (Dignath and Veenman, 2021; Vandeveldt et al., 2011). Since the learning discourse is based on literacy skills, the student must have literacy resilience to be an independent learner. Therefore, teachers play an important role in imparting the skills of an independent learner based on linguistic literacy skills (Demirel and Akkoyunlu, 2017).

6 Practical recommendations

To enhance educational outcomes and support the development of students' literacy resilience, several practical recommendations can be drawn. Firstly, it is essential to recognize that literacy refers to a student's capacity to address educational tasks that require reading, writing, speaking, and listening skills (Tolchinsky, 2022). Simultaneously, Self-Regulated Learning (SRL) is crucial for lifelong learning and equipping students to face modern challenges in both educational and non-educational contexts (Šimić Šašić et al., 2023). Integrating these aspects, literacy resilience involves a proactive approach where students develop awareness, self-control, and adaptive strategies to overcome literacy-related obstacles.

Teachers must recognize the importance of fostering SRL (Heaysman and Kramarski, 2022; Kistner et al., 2010; Panadero and Järvelä, 2015; Šimić Šašić et al., 2023) alongside linguistic literacy (Amir, 2024a, 2024b; Tolchinsky, 2022). Linguistic literacy includes navigating between spoken and written discourse to convey clear meanings, focus on goals, and respond logically to speech or written text (Berman and Ravid, 2008; Tolchinsky, 2022). Despite this, studies indicate that teachers often feel uncertain about promoting SRL and stimulate it to a limited extent (Kistner et al., 2010; Šimić Šašić et al., 2023; Vandeveldt et al., 2012).

To achieve academic success and develop lifelong learning skills, students need literacy resilience. Understanding this concept can significantly impact teaching practices and the academic dialogue teachers conduct. It is essential for teachers, pedagogic managers, and policymakers to be informed about both the theoretical and practical aspects of literacy resilience. Teachers' perceptions of students' literacy resilience involve assessing how well students manage literacy-related challenges, apply metacognitive knowledge, and engage in SRL. This assessment can be based on observing how students approach assignments, employ reading and writing strategies, address areas of difficulty, and persist in the face of challenges.

Teachers' perceptions influence their teaching practices, lesson planning, and classroom interactions. Understanding these perceptions provides insights into the effectiveness of literacy instruction and helps educators tailor their methods to better support the development of literacy resilience, ultimately improving overall literacy and learning outcomes. Developing literacy resilience necessitates changes in lesson planning and classroom dialogue,

requiring a comprehensive understanding of integrating SRL skills into reading and writing instruction. Teachers' professional development should address the beliefs that influence their classroom conduct (Heaysman and Kramarski, 2022).

It is important to identify and develop positive beliefs about SRL and literacy skills. Many elementary school teachers believe that students are too young to learn SRL skills or that SRL is an innate characteristic that cannot be taught. Some also believe that such instruction will benefit struggling students the most (Lawson et al., 2019; Vosniadou et al., 2020). Therefore, it is crucial to cultivate positive beliefs about teaching SRL, particularly regarding literacy skills (Heaysman and Kramarski, 2021).

The concept of literacy resilience should be integrated across all disciplines, not just language, to enhance the transfer of skills between disciplines (Avidov-Ungar and Amir, 2018; Heaysman and Kramarski, 2022). Teachers should also develop their ability to assess and evaluate their students' literacy resilience accurately. The reliance on teachers' perceptions, rather than actual student ability, may be a limitation of the current study. Since literacy is embedded in every discipline, establishing a common language and school culture regarding literacy resilience is crucial (Avidov-Ungar and Amir, 2018).

7 Research limitations and recommendations for future research

This study introduces the innovative model of literacy resilience and reveals a significant discrepancy in teachers' perceptions: while most teachers attribute high importance to literacy resilience, they perceive their students' levels as low. This disparity suggests a potential gap in addressing literacy resilience within educational settings. A primary limitation of the study is its reliance on teachers' perceptions and self-reports, without directly examining teaching methods or students' perspectives.

Another limitation of this study is that we did not explicitly test for the normality of our data distribution or report skewness and kurtosis indices. While parametric tests like ANOVA were used based on the assumption of normal distribution, which is common in large samples due to the central limit theorem, future research could benefit from a more detailed examination of data distribution. This could include reporting skewness and kurtosis indices and potentially using non-parametric tests if significant deviations from normality are found. Despite this limitation, the large sample size ($N = 383$) in our study provides some robustness to our findings, as parametric tests are generally considered robust to moderate violations of normality in large samples.

To address these limitations and further our understanding of literacy resilience, future research could investigate several directions or possibilities. One key direction might involve exploring how teachers' beliefs translate into instructional approaches and classroom practices through intervention programs and direct observations, providing crucial insights into the practical implementation of literacy resilience strategies. Another possibility could be examining students' perspectives on their own literacy resilience, offering a more comprehensive view of this concept in practice and enabling a comparison between teacher and student perceptions.

An additional study, already in progress, examines the impact of teachers' deeper understanding of the rationale and pedagogical actions derived from the concept of literacy resilience. Based on the assumption that teachers can influence self-regulated learning (SRL)

in direct and indirect ways (Kistner et al., 2010; Šimić Šašić et al., 2023; Dignath-van Ewijk, 2016; Dignath-van Ewijk and van der Werf, 2012; Lawson et al., 2019), this research investigates how the provision of teaching-learning-assessment materials in line with principles that foster literacy resilience affects teachers' ability to integrate these principles in the classroom. This study is expected to provide important insights into how the concept of literacy resilience can be translated into effective educational practice.

Furthermore, expanding the research population to include other countries would provide global insights into the study's findings. These research directions could broaden our understanding of the concept of literacy resilience and the integration between linguistic literacy and self-regulated learning (SRL). Moreover, they could contribute to developing more effective strategies for fostering literacy resilience in diverse educational contexts.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

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Encouraging self-regulated learning: examining the feedback approaches and teaching strategies employed by English Home Language teachers

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The additive approach to multilingualism followed in South African public schools complicate teaching and learning in English Home Language. Many non-native speaking learners underperform since they must learn in an unfamiliar language, which differs from theirs socially and culturally. Throughout the teaching and learning process, learners encounter diverse language challenges. Consequently, teachers play a crucial role in aiding learners to surmount these hurdles by offering both sufficient and effective feedback. Proficient feedback practices have the potential to bolster the self-regulation capabilities of non-native speakers and underperforming learners, thereby preparing them for a lifetime of learning. The aim of this study was to investigate the predominant types and levels of feedback utilized in the classrooms of intermediate phase teachers within English Home Language education, as well as how this feedback is employed to promote the development of learners' self-regulated learning skills. The empirical study was approached by means of a qualitative research design in the form of an instrumental case study. Observations and individual, semi-structured interviews were used to collect data from 15 purposively selected teachers from five different schools in the Ennerdale region in Gauteng, South Africa. The findings indicate that while there is some promotion of self-regulated learning skills, discrepancies exist between participants' perceptions of how their feedback practices foster these skills, as revealed in interview data, and their actual teaching methods. Participants predominantly employ traditional, transmission-based teaching approaches, demonstrating limited comprehension of the diverse self-regulated skills that could enhance academic achievement, particularly in English Home Language. Moreover, there is a deficiency in pedagogical knowledge regarding the application of these skills within their teaching practices. These findings suggest a misalignment between teachers' perceptions of their feedback practices and the actual implementation of these practices in promoting self-regulated learning skills among students in English Home Language education. The predominance of traditional teaching approaches and limited understanding of self-regulated learning skills among teachers highlight potential barriers to the effective cultivation of these skills in the classroom. This misalignment is significant as it indicates a gap between teachers' intentions and their instructional practices, which can hinder students' ability to develop essential self-regulated learning skills necessary for academic success. Furthermore, the deficiency in pedagogical knowledge regarding the application of these skills underscores the need for targeted professional development initiatives to support teachers in integrating effective feedback practices that promote self-regulated learning. Overall, these findings underscore the importance of aligning teachers' perceptions and practices with the promotion of self-regulated learning

skills, particularly in the context of English Home Language education. Addressing these discrepancies through targeted interventions and professional development can ultimately enhance students' academic achievement and overall learning outcomes.

KEYWORDS

English Home Language, feedback practices, self-regulated learning, teaching strategies, teachers

1 Introduction

South African intermediate phase learners are performing below expectations, according to studies conducted in 2014 by the Southern and East African Consortium for Monitoring Educational Quality 111 (SACMEQ 111) (2011) and the Progress in International Reading Literacy Study (PIRLS, 2016; Howie et al., 2017). The most recent PIRLS (2021) results exposed that the majority (81%) of South African Grade 4 learners cannot read for meaning in any language, including their home languages (Department of Basic Education, 2023).

A contributing factor to the substandard performance of Intermediate Phase learners are the language challenges that teachers and learners experience resulting from the increased linguistic diversity in many South African classrooms. In South Africa the Intermediate Phase consists of grades 4, 5 and 6. The language policy in South Africa follows an additive approach to multilingualism, whereby the first language is used as a foundation to acquire other languages (Department of Basic Education, 2002). The additive approach to multilingualism complicate teaching and learning in English Home Language, since many non-native speaking learners must learn in an unfamiliar language, which differs from theirs socially and culturally (Malebese, 2017). For example, English becomes the Language of learning and teaching (LoLT) of learners even though isiZulu or Sesotho is their home language. Due to a lack of exposure to the English language, many second language learners are thus struggling to understand the language as well as to communicate through it. The reason being that on a Home Language level, language proficiency provides basic interpersonal skills required in both social situations as well as cognitive academic skills, which is important for learning across the curriculum (Department of Basic Education, 2011, p. 8).

Cummins (2017) elucidates that Cognitive Academic Language Proficiency and Basic Interpersonal Communication Skills indicate that whereas learners typically need 5–10 years to progress intellectually in English, they can become conversationally fluent in the language in approximately 2 years. Learners encounter a range of linguistic obstacles during teaching and learning; thus, teachers must help them get past these obstacles by giving them sufficient constructive feedback. Through the provision of feedback, teachers can allow learners to reflect on mistakes, work towards improving their learning, and as a result, become self-regulated learners.

Self-regulated learning (SRL) is essential for learning and academic success since it establishes the foundation for motivation in all facets of life (Amri, 2024). Numerous empirical investigations have shown that learners who demonstrate SRL skills are generally more successful because they typically set greater academic goals and are more confident, resourceful, and persistent in performing academically (Zimmerman, 2015; Amri, 2024).

When learners utilise SRL skills, they become less reliant on teachers for guidance and support and can take greater control over their learning processes (Alvi and Gillies, 2020). Therefore, the exposure to and fostering of SRL skills by teachers is of vital importance in general and specifically in English Home Language. We agree with de Kleijn (2023) that teachers' feedback practices and teaching and learning strategies to encourage SRL skills interlink with each other and hold a strong connection which can equip learners to take an active role in their learning to enable learners to monitor and improve their English Home Language proficiency in Basic Interpersonal Communication Skills as well as in their Cognitive Academic Language Proficiency.

There appears to be a scarcity of information in existing literature regarding feedback and SRL in South African schools, as most research on feedback practices was internationally conducted. Although there is some research, such as the study by Du Toit (2012) who focused on constructive feedback as a learning tool to enhance SRL and performance in higher education; Hermerda (2016) who focused on the effectiveness of feedback types and the connection with student performance; and Mabuuke et al. (2017) who focused on feedback and SRL in a problem-based learning environment, no previous studies regarding the feedback practices of intermediate phase teachers to develop SRL specifically in Ennerdale in the Gauteng education district, quintile 1 to 4 schools, could be found. To address the gap in the literature regarding feedback practices that encourage self-regulated learning (SRL) in English Home Language classes, this study aims to: (a) Explore intermediate-phase teachers' perceptions of their feedback practices that promote SRL skills in their English Home Language classes. (b) Identify the specific SRL skills that intermediate phase teachers strive to foster to enhance English Home Language proficiency.

The following research questions guided the study: (a) What are intermediate-phase teachers' perceptions of their feedback practices that encourage SRL skills in their English Home Language classes? and (b) Which SRL skills do they encourage to improve English Home Language proficiency?

In the next section, the theoretical conceptual framework of the study will be discussed.

2 Theoretical conceptual framework

The theoretical conceptual framework of this study includes Hattie and Timperley's (2007) model of feedback, the types of feedback as an important part of the assessment, and Zimmerman and Moylan's (2009) model of self-regulated learning which is rooted in the social cognitive theory of Bandura (1986). The foundation of the social cognitive theory's view on SRL is that human functioning results in

self-motivation through interaction, in classifications of joint interactions between the personal, environmental, and behavioral determinants (Zimmerman, 1989, 2000). We viewed the social cognitive theory perspective of SRL appropriately to explore participants' feedback practices to encourage SRL. The personal determinants represent, particularly in this study, participants' teacher training, and pedagogical knowledge of feedback and SRL, along with thoughts, feelings, beliefs, and other motivational forces that enable them to develop SRL skills through feedback in learners. The environment determinants in this study, include the home language of learners, the language of learning and teaching of the learners, and the parents of the learners, all of which contribute to the social and physical working environment of participants in this study. Behavioral determinants refer to participants' teaching strategies, their choice of tasks, and their efforts to develop learners' SRL skills through feedback in English Home Language classrooms in the intermediate phase (Manual, 2020).

2.1 Hattie and Timperley's model of feedback

According to Hattie and Timperley (2007) the main purpose of feedback is to decrease inconsistencies between current understandings, performance, and a goal. Effective feedback has to answer three major questions asked by a teacher and/or by a learner: Where am I going? (What are the goals?); How am I going? (What progress is made toward the goal?); and Where to next? (What tasks need to be taken on to make better progress?) (Hattie and Timperley, 2007, p. 90). Together, the questions narrow the gap between where learners are and where they aim to be through enabling feedback.

Hattie and Timperley's (2007) model differentiates between four levels of feedback: the level of task performance, the level of process of understanding how to do a task, the regulatory or metacognitive process level, and the self or personal level. Feedback on the task level provides immediate feedback on the correctness of the task errors made as well as instructions to acquire more, different, or correct information on a task (Hattie and Timperley, 2007). Feedback on the self-level seems more effective than task-related feedback because it expresses a more positive, personal evaluation and effect on the learners themselves which culminates in learners taking ownership and responsibility for their learning thus demonstrating self-regulated behavior. Feedback on the self-regulation level develops learners' self-evaluation skills and their confidence to engage further in a task. Yang et al. (2022) investigated the effects of an SRL-based feedback practice on English-as-a-foreign-Language (EFL) learners' writing performance and their use of SRL writing strategies in a tertiary context. For the intervention group, SRL-based feedback activities were implemented, and process-self-regulation feedback was provided, while the control group completed the same writing tasks but received conventional task-level feedback. The study's primary conclusion is that EFL learners' writing performance is much enhanced by SRL-based feedback practice. In particular, the control group received traditional task-level feedback; in contrast, the intervention group, which received SRL-based feedback activities and process-SR feedback, scored worse in the subcategories of vocabulary, organization, and content as well as overall writing scores. This shows that traditional feedback approaches are less effective in improving

writing performance than SRL-based feedback, which supports the review of writing knowledge, application of cognitive strategies, and monitoring and regulation of learning.

2.2 Types of feedback

Svensäter and Rohlin (2023) distinguish between formative and summative assessment and feedback during learning processes. Other commonly used types of feedback described next are oral, written, evaluative, descriptive, peer, and self-feedback (State of New South Wales, Department of Education and Communities, 2015). Despite the advantages of feedback for both teachers and learners, Kanjee and Mthembu (2015) found that Foundation phase teachers, in their study, only had a partial understanding of how to use summative assessment to identify learning gaps, and no teacher demonstrated a sufficient grasp of formative assessment and feedback to use it effectively. Teachers relied solely on traditional questioning methods, seeking responses only from learners who raised their hands. Additionally, the authors found no evidence of descriptive written feedback in learners' books. Instead, teachers' written feedback primarily consisted of ticks, crosses, and short comments indicating work was well done or incompletes. In another study Kanjee (2020) reports that primary school teachers' use of formative assessment forms constitutes mostly of oral feedback that primarily focuses on correcting learners' work or addressing their questions about the assigned task. The most concerning finding from Kanjee (2020) is the extremely low prevalence of descriptive feedback and the predominance of evaluative and procedural feedback for both high and low-performing students. In practice, this suggests that most of the written feedback provided by the 96 teachers from 54 primary schools in Kanjee's (2020) study did little to enhance learning or help learners take responsibility for their learning through feedback.

Panadero et al. (2019) assert that teachers should cultivate self-feedback skills in learners, enabling them to utilize feedback from their social learning environments. This, in turn, helps learners adjust their feedback and evaluation methods to enhance their learning processes and outcomes. These authors aver that teachers can help learners receive self-feedback by using scaffolding such as modeling, clearly defining criteria for evaluating learning activities, providing multiple examples of excellent work, and utilizing a range of instructional resources. Hattie and Timperley's (2007) model, along with the existing literature on types of feedback, guided the researchers in exploring the first aim of the study: understanding intermediate-phase teachers' perceptions of their feedback practices that encourage SRL skills in their English Home Language classes.

2.3 Zimmerman and Moylan's SRL model

Zimmerman (2013) explains that SRL refers to a "self-directive process through which learners transform their mental abilities into task-related academic skills." There are three phases in Zimmerman and Moylan's (2009) model, namely the forethought, volitional, and self-reflection phases. Each of the three phases involves processes and sub-processes representing the skills self-regulated learners need to demonstrate when they receive feedback. These processes and sub-processes in the three phases do not

operate in silos but constantly influence each other in the demonstration of self-regulated behavior. Zimmerman and Moylan's (2009) model illustrates the SRL skills exhibited by self-regulated learners. This model helped the researchers achieve the second research aim by identifying the specific SRL skills that intermediate-phase teachers aim to encourage to improve English Home Language proficiency.

Firstly, the forethought phase has two main processes, task analysis and self-motivational beliefs, which consist of two interlinked sub-processes goal-setting and strategic planning (Panadero and Alonso-Tapia, 2014). When faced with a novel task, self-regulated learners first examine it thoroughly from both a formal and content standpoint. They ask themselves, among other things, what knowledge and skills they need to finish the task successfully, how long they should spend on it, what resources they need, what task strategies to use, and if they will need assistance to finish it (Zimmerman, 2013). In the process of analyzing the task, they set clear, realistic, and achievable academic goals and plan strategically how they will adapt plans and strategies to adjust to their personal, behavioral, and environmental situations to attain those goals. Task analysis, goal setting, and strategic planning are influenced by the second main process, self-motivational beliefs (Zimmerman, 2002). Self-motivational beliefs entail learners' intrinsic motivation to complete the task which is influenced by their self-efficacy beliefs, the task value and interest, the positive outcome expectations the task has, and their goal orientations or reasons for completing the task (Zimmerman, 1990). Learners who believe in their capabilities to complete a task successfully, who understand the value of a task, who have an interest in the task, who understand how completion of the task will be beneficial in the future, and who are motivated by mastery learning will put in the effort to analyze tasks, to set goals and to plan strategically. The opposite holds for learners with low self-motivational beliefs (Schunk et al., 2016).

The second phase in the model is the performance phase or volitional control phase, which entails all the actions self-regulated learners demonstrate while they are completing the tasks. The two main processes in this phase are self-control and self-observation. In the self-control phase, there are eight sub-processes namely task strategies; self-instruction; imagery; time management; environmental structuring; and help-seeking (Zimmerman, 2013; Panadero and Alonso-Tapia, 2014).

Self-observation involves motivational strategies like interest incentives and self-consequences. It means that learners carefully monitor and record their performance to determine whether they are making progress and achieving the expected learning outcomes. Self-monitoring, a type of self-observation, involves personally tracking cognitive performance (Panadero, 2017). For example, a learner might create a performance-tracking schedule to identify strengths and weaknesses. This helps them understand mistakes and avoid repeating them.

Self-evaluation and self-reaction are the two primary activities during the self-reflection phase this stage (Panadero, 2017). According to Panadero and Alonso-Tapia (2014), when an individual's performance is compared to their objectives, it's referred to as self-judgment. With self-judgment learners evaluate and assess their performance by applying their personal standards and set goals as criteria.

After self-evaluation, learners make causal attributions about the task outcomes, while their self-reactions reflect their responses to these outcomes (Zimmerman, 2013). Successful completion results in self-satisfaction and higher self-motivational beliefs to demonstrate the SRL skills in the three phases of Zimmerman and Moylan's (2009) model. Negative appraisal can result in defensive reactions in efforts that learners make to protect their image after the failure of a task, such as blaming others for their mistakes or giving up on difficult tasks. Defensive reactions can be caused by factors such as apathy, lack of interest, or learned helplessness (Panadero and Alonso-Tapia, 2014) and is harmful as learners limit their growth with defensive reactions. Adaptive reaction involves learners independently deciding how to improve their efforts and achieve success after experiencing failure. For example, they might adjust their learning strategies for better performance or sustain their motivation and focus on future learning tasks (Panadero, 2017). The model is also cyclical in the sense that everything a learner has experienced in each phase during the completion of a task influences his or her choices with future tasks and the use of self-regulated learning skills.

2.4 Conceptual links between assessment, feedback, and SRL

Panadero (2017) indicates that assessment outlines how learning outcomes can be demonstrated; and that feedback on and for assessment gauges the learners' abilities to monitor, assess, and control their own learning. This implies that SRL is part of assessment since the abilities to monitor, assess, and control own learning are SRL skills (Erfani and Nikbin, 2015). Timeous and immediate feedback allows the learners a better opportunity to evaluate and monitor their learning as the learning experience is still fresh in their memory, furthermore, the learners are better able to track their learning progress (Mngomezulu et al., 2024).

Feedback is an integral part of assessment and should provide information on what learners know concerning what they should know (Mngomezulu et al., 2024). This view of feedback in assessment implies that feedback strategies should highlight good practice, identify shortcomings, and bring about recommendations for the use of constructive feedback, for learners to improve their performance (Manual, 2020). Feedback, furthermore, plays an important role in aiding learners by clarifying misunderstandings, and finding defects in learning strategies and skills (Mngomezulu et al., 2024). It also contributes to SRL skills such as planning, monitoring, and evaluation of learning as well as the adaptation of learning strategies to task demands and progress (Manual, 2020).

3 Methods

The research paradigm that guided the execution of this study was Interpretivism (Yin, 2018). The interpretive paradigm was suitable since the research outcome was ultimately the product of the researchers' subjective interpretation of the data to understand and explore the extent to which feedback practices of intermediate-phase teachers teaching English Home Language encouraged learners' self-regulated learning skills. The empirical study was approached

employing a qualitative research design in the form of an instrumental case study. One lesson observation and one individual, semi-structured interview was used to collect data from 15 purposively selected English Home Language teachers from five different schools in the Ennerdale region.

3.1 Sample

The purposive sample only included teachers in the intermediate phase, teaching English Home Language in public schools in the Ennerdale region. The teachers selected for the study were all female and were permanently employed at their respective schools.

In School A, Participant 1 has a B. Ed Honours Degree in Education and 22 years of experience teaching English; Participant 2 has a B. Ed Degree and 2 years of experience; and Participant 3 has a Higher Diploma in Education with 9 years of experience.

In School B, Participant 1 holds a B.Ed Honours Degree in Education and has been teaching English for 5 years; Participant 2 has an Advanced Certificate in Education and 6 years of experience; and Participant 3 has a Senior Primary Diploma in Education with 14 years of experience.

In School C, Participant 1 has a Higher Diploma in Education and 32 years of experience teaching English; Participant 2 has an Advanced Certificate in Education with 30 years of experience; and Participant 3 holds a Diploma in Education and has been teaching English for 20 years.

In School D, Participant 1 has a B.Ed Degree and 30 years of experience teaching English; Participant 2 has an Advanced Certificate in Education and 4 years of experience; and Participant 3 also has an Advanced Certificate in Education with 10 years of experience.

In School E, Participant 1 has a Higher Diploma in Education and 26 years of experience teaching English; Participant 2 holds a B.Ed Honours Degree with 6 years of experience; and Participant 3 has a Post-Graduate Certificate in Education and has been teaching English for 2 years.

The highest qualification among the participants is an Honours Degree in Education, while the lowest is a teacher's diploma. Participants with 14 to 32 years of teaching experience still hold a Higher Diploma in Education, whereas the younger participants have degrees. The average teaching experience among the participants is 14 years.

3.2 Research sites

The Ennerdale region falls under the Gauteng Education District. Ennerdale is not only divided geographically by extensions but also socio-culturally. These sociocultural divisions are characterized by different levels of income, housing, employment, education, cultural and language backgrounds as well as the standard of living. For example, the region SA block (which is a geographical extension) is characterized by expensive housing valued from R1 million onwards. Thus, individuals who live there have higher levels of income, and higher levels of employment and are usually young and established professionals such as teachers, lawyers, or bankers. Learners living in this extension, are more proficient in English as they are exposed to English both at home and at school. In contrast, Extension 8

(geographical extension) is characterized by low-cost housing, which includes Reconstruction and Development Programme (RDP) houses. RDP houses are small houses built as part of a government-funded housing project. Individuals who live here are unemployed or have unskilled jobs such as domestic workers. Learners living in this extension do not often speak English in their homes and always communicate using their mother tongue. They only speak English at school (Manual, 2020).

The majority of learners at the participating schools are not native English speakers; they come from diverse linguistic backgrounds. For example, in this study, a learner might have a SeSotho-speaking mother and an IsiZulu-speaking father who migrated to Johannesburg. In such cases, English should ideally be the learner's second additional language. However, English becomes the medium of instruction in school, despite the learner having no prior exposure to the language and insufficient support at home to learn it. Internationally, terms like ESL (English as a Second Language) or EFL (English as a Foreign Language) are used, but these terms do not adequately describe the linguistic repertoires of learners in a multilingual country like South Africa. Therefore, our curriculum uses the term "Additional Language."

We selected three teachers from each of the five public primary schools in the Ennerdale region in the Gauteng Province. Three schools are quintile 4 schools and two are quintile 1 primary schools. The Department of Basic Education categorizes schools in quintiles based on the communities it represents. Quintile 1, 2 and 3 schools are representative of communities with high poverty rates and low education and therefore receives more funding from the state. Quintile 4 and 5 schools are schools with wealthy communities and receive less funding from the state (White and Van Dyk, 2019).

3.3 Data collection

The data collection methods utilized in the study comprised observations and individual, semi-structured interviews. The first author of this article acted as an observer during lesson observations to gain a deeper understanding of the extent to which the feedback practices of intermediate phase English Home Language teachers encouraged learners' SRL skills. The lesson observations which lasted for two double periods (1 h) were structured to focus on the qualitative descriptions of the feedback practices and actions of the participants. A few days later the lesson observations were followed by individual, semi-structured interviews.

The aim of the interviews was to gain information about participants' understanding of SRL skills, their perceptions of their feedback practices in their English Home Language classes, and how it encourages SLR skills. Examples of the main interview questions were: What type of feedback do you use in your English Home Language classes? How does the feedback you provide to your English Home Language learners encourage learners to: Set their own learning goals? Stay motivated and believe in their capabilities to learn and speak English as a Home Language? Select the best strategies to improve their learning? Evaluate the success of their learning? Take responsibility for their learning?

The validity of the study is supported by describing the findings in rich detail, with verbatim quotations so that readers can draw their conclusions from the data presented. Reliability was assured by

applying similar procedures to all participants and a systematic approach to data collection consistent with the theoretical framework of feedback and SRL and the research aims. The university at which we are based granted ethical clearance for this study. The education departments and the principals of the five schools also granted permission to conduct this study. Ethical considerations such as informed consent, honesty, objectivity, confidentiality, anonymity, respect for the participants, protection from harm and the right to withdraw, were adhered to in this study (Maree, 2016).

3.4 Data analysis

Our data analysis approach was a hybrid approach which entails a thematic approach using both deductive and inductive data analysis (Proudfoot, 2023). The schools were coded using alphabet letters and participants received a number to protect their identities. For example, SBP5 refers to school B, participant number 5. Verbatim quotes, printed in italics were used to provide a rich description of participants' views.

4 Results

4.1 Discussion of findings

Data from the observations and individual, semi-structured interviews were analysed, interpreted and integrated for the discussion that follows. The findings will be presented along with the discussion since everything is so closely intertwined. Discrepancies were noted in what some participants said in their interviews and what was observed during the lesson observations. These discrepancies will be pointed out in the discussion that follows.

According to Purković and Kovačević (2020) teachers' perceptions are shaped by their attitudes and beliefs, prior general and pedagogic knowledge, life experiences, own education, work context, and culture among others. All of these and more could contribute to participants' perceptions of their feedback practices that encourage SRL skills in English Home Language classes. Therefore, they were firstly asked to explain their understanding of the concept of feedback, their intentions with providing feedback, and the types of feedback they provide in their English Home Language classes. Secondly, they were asked which SRL skills they encourage to improve English Home Language proficiency? From participants' responses, two main themes were created: Theme 1: perceptions of feedback practices that encourage SRL skills in English Home Language classes and Theme 2: perceptions of developed SRL skills to enhance English Home Language competency.

4.2 Theme 1: perceptions of feedback practices that encourage SRL skills in English Home Language classes

One participant (SCP3) explained her intention with feedback: *...I need the learners to learn from their mistakes and the learners to see where they can improve themselves... That is why you need to encourage them to go in that direction so that the learner can work on their own.*

Interview data revealed that participants also intend to develop Cognitive Academic Language Proficiency (CALP) and build English

language skills (cf. Department of Basic Education, 2011, p. 8) with their feedback. Some of their feedback goals include the fostering of reasoning and critical thinking skills to create metacognitive awareness (Manual, 2020). Participant, (SEP1) clarified: *...the learners must be able to communicate confidently and effectively in their Home Language. They must be able to read and give information for enjoyment. They must be able to write different types of texts and for different purposes. They must also be able to use the language to think and reason.* During the lesson observations it was observed, for example, that the following participants (SAP3, SBP2, SBP3, SCP1, SCP3, SEP1, and SEP2) allowed for self-feedback, permitting learners to work independently after receiving teacher feedback. As the learners were working on their activities, the participants provided oral feedback through explanations and discussions. They utilized higher-order questioning, requiring learners to provide reasons and explanations for why they chose a particular answer as correct or incorrect.

Moreover, with their feedback and teaching strategies, they intended to create task value by teaching learners useful writing skills and habits of mind such as persistence, and positive self-efficacy beliefs (Zimmerman and Moylan, 2009). This is how one participant explained: *Completion of tasks comes from interest and interest comes from what they see a lot... many of the texts that they have are oral texts. Texts that are on a compact disc, where there is a narrator that tells the story, they really enjoy that, and then it, it sort of captures their interest, and that interest will then encourage them to complete their tasks* (SAP1).

Participants mainly provide oral feedback at the task and process levels where feedback involves many transmission teaching approach strategies such as acquisition, storing, reproduction, use of knowledge, and changes in performance from previous efforts (Hattie and Timperley, 2007). One participant clarified: *I give written activities after each lesson and assess. I mark their books timeously and the learners do corrections I also observe in the class where the learners communicate and answer questions and then we also do revision often to check on their progress* (SEP1). These perceptions of participants were supported by the lesson observations where it was also noted that many participants favor traditional teaching approaches and positive reinforcement with their oral feedback on task level (Manual, 2020).

Participant SBP1 explained she teaches learners to be persistent on the task level for learners to experience success because of their effort and practice: *It's more of practice, practice on all the way...* (SBP1). Another two participants added: *I will call them, speak to them, and indicate where they have made the errors and thirdly is by positive encouragement* (SDP3) and *...they can see for themselves where their shortcomings are and say I need to address a, b, c and d I need to improve; I need to work a little harder...* (SDP1).

One participant indicated that reflection on the story helps them to comprehend a lot (SBP3). Another participant added that they evaluate whatever they have with them and then redo or look at new ways that they can improve (SEP2). Participants struggled to explain the strategies they apply such as metacognitive questions they can ask to develop reflection, planning, monitoring, and self-evaluation skills to facilitate the improvement of learners' efforts. One participant indicated: *If they made mistakes, they redo it in the form of corrections where the learner self understands and says look, I did this wrong and I did that wrong and I can improve here, and I did not read the question there...* (SCP3). Another participant's response indicated that she believes she allows learners to take ownership and responsibility for

their learning by understanding their shortcomings to bring improvement: *...I teach them that they should take the initiative and say No this is my point of view and maybe this is what I got wrong, and you know that allows them to reflect now on what they have done* (SEP2).

The following theme illustrates the SRL skills participants perceive themselves to encourage, with their teaching and learning strategies as well as with their feedback, to improve English Home Language proficiency. The SRL skills are grouped into sub-themes according to the three phases of [Zimmerman and Moylan's \(2009\)](#) SRL model.

4.3 Theme 2: perceptions of developed SRL skills to enhance English Home Language competency

4.3.1 Sub-theme 2.1: SRL skills fostered before learning tasks

According to participants' perspectives, they encourage the following SRL skills in the forethought phase of [Zimmerman and Moylan's \(2009\)](#) model: goal setting, strategic planning, motivation and self-efficacy beliefs, outcomes expectations, and task value and interest.

4.3.1.1 Goal setting

To encourage goalsetting participants indicated that they provide constructive feedback for learners to aim high, they motivate learners, building their confidence to perform better and they also allow learners to create their rubrics where they write down their own goals: *I encourage the learners to set up a rubric for their group and the group with the best rubric win like a chocolate or whatever. With the rubric game, they set their own goals, and they try to achieve those goals* (SCP1). A rubric communicates expectations and clarifies learning targets, resulting in learner autonomy and assisting them in planning, monitoring, and achieving goals, by encouraging goal setting with rubrics, participants believe they teach learners to be persistent and put effort into their learning to achieve their goals ([Zimmerman, 2000](#)). Moreover, participants revealed that they want learners to envision where they want to be in the future; this relates to outcome expectations and self-motivational beliefs as it builds the learner's own beliefs in their capabilities and encourages them to reach their future dreams ([Zimmerman, 2015](#)). For example, one participant indicated: *...To be good readers, good listeners... whatever that I do with them in class they take it to their hearts and their minds and they can use it in future* (SBP1).

However, during lesson observations, none of the participants displayed feedback to encourage goal setting and goal orientation. It was expected that before they began teaching, participants would state the lesson outcomes as a way of demonstrating goal setting, however, they did not. The learners may have been better able to focus their attention and establish learning objectives related to the skills and information they should have by the end of the lessons with the aid of the lesson outcomes. This might have boosted SRL abilities and English language competency.

4.3.1.2 Strategic planning

A few participants indicated that they perceived themselves to be encouraging learners to be strategic planners through setting up timetables to manage their time and focus when completing homework, studying, and specifically for learning tasks such as

planning their first draft in essay writing. These strategies relate to time management and SRL skills: *...telling them to set themselves a timetable, when to do their homework, when to study to reach the end point where they want to be, the outcome...* (SDP1). Another added: *I teach them to plan their writing when they work on their own and how to edit their essays* (SDP3). Planning and editing of work help learners to refine what they want to say, allowing them to modify and adjust mistakes, and giving directions on how their essays should be structured. Participants did not elaborate on the strategies they exposed learners to enable them to make choices on suitable strategies to reach goals. During the lesson observations, the same two participants (SCP1 and SCP3) assisted learners during the planning phase of their essay writing. It was observed that after the teachers' scaffolding, learners could autonomously continue their planning with their mind maps and start the first drafts of their essays.

4.3.1.3 Motivation and self-efficacy beliefs

By praising and motivating learners and providing tangible reinforcements like stickers and stars to help them feel more capable of achieving their goals, participants believe they are fostering motivation and self-efficacy beliefs: *... when I stamp their books and I say 100% congratulations and I give them a certain kind of comment and a stamp that says wow, excellent, well done it boosts their self-confidence and their self-esteem so much that there are only positives that comes out of it* (SDP1).

Their perceptions about the fostering of motivation and self-efficacy beliefs are supported by their teaching behavior during the lesson observations where learners' efforts were acknowledged for being very good answers or well explained. Participants (SBP3, SCP3, SDP1, SDP3, SEP1, SEP2, and SEP3) praised learners when they provided correct answers. Participant SEP1 provided an opportunity for learners to clap hands if a learner wrote a correct answer on the board teaching learners to acknowledge each other's efforts which builds learners' beliefs in their capabilities to complete tasks successfully, which will sustain their motivation to achieve in English Home Language. High self-efficacy beliefs and motivation develop positive outcome expectations of learning ([Zimmerman, 2015](#)). However, this type of feedback can be regarded as ineffective as participants praised learners on their performance without specifying what made their performances outstanding ([Australian Institute for Teaching and School Leadership, 2015](#)).

4.3.1.4 Outcome expectations

Participants perceive themselves to be encouraging positive outcome expectations by creating awareness of the utility value of English language proficiency in the future. Participants also want learners to be active and conscious thinkers to make a difference in the world: *This results in learners being good readers, listeners, and conscious thinkers, which will help them in the future* (SDP3). However, only a few participants showed this encouragement of positive outcome expectations.

4.3.1.5 Task value and interest

Participants use of technology and pictures to capture learners' interest and develop their attention-focusing skills: *Completion of tasks comes from interest and interest comes from what they see. Many of the texts that they have are oral texts. I use texts that are on a compact disc, where there is a narrator that tells the story, they enjoy that and then, it*

sort of captures their interest, and that interest will then encourage them to complete their tasks (SAP1). Two participants added: ... if you give them the pictures, they can tell you the story about that picture ... (SBP2) said: Show them things visually it helps them a lot to understand the work (SCP1). By using their imagination to conjure up a story around a picture, learners can enhance their cognitive capacities for creative thoughts, which leads to the development of imagery as an SRL skill. Visuals, in the form of posters and reading books in the classroom, can also keep learners interested in tasks (Schunk et al., 2016).

Participants' views of how they encourage task interest and task value were confirmed during the lesson observations. Participant SAP1 made use of practical demonstrations, where learners clap their hands, to break up words into syllables. Participant SBP1 allowed learners to read in groups; participant SCP1 used examples of learners' everyday life situations such as what they do when they come from school to motivate learners to be creative writers. She also read a text to inspire ideas while learners were busy planning their essays. Participant SEP2 used practical examples to keep learners' attention. The participant read a text while learners had to take notes, thereafter, the participant used practical objects, a letter, a knife, a cloth *etcetera*, and learners had to plan their discussion based on the objects the participant presented them with.

Participant SBP1 made use of scaffolding and peer feedback, where the stronger learners assisted the weaker learners with their reading and provided summative feedback by giving a mark for the reading. Participant SEP3 made learners write answers on the board and the rest of the class should say whether it was correct or incorrect and explain why. The strategies are useful to develop SRL skills such as self-questioning, reflection, and metacognitive knowledge. Additionally explaining answers and thoughts through the help and guidance of others can improve learners' English language proficiency slowly moving them away from support and resulting in greater autonomy.

Although participants did not mention these strategies in the interviews it was observed during their lessons. Their strategies are conducive to creating task interest and task value by engaging learners in interesting tasks related to their everyday life situations, essay planning, discussions, practical demonstrations, spelling words, and reading tasks to keep learners motivated (Zimmerman, 2013). Task interest helps to develop and improve SRL skills because if learners have well-prepared teachers, they become interested in learning tasks which makes them persist and work harder (Schunk et al., 2016).

Next, SRL skills enhanced in the volitional phase will be discussed.

4.3.2 Sub-theme 2.2: SRL skills fostered during task completion

In the interviews, participants indicated they believe they encourage the following SRL skills in the volitional phase: the use of different task strategies, imagery, metacognitive self-monitoring, time management skills, and help-seeking skills when providing oral, written, formative, and self-feedback.

4.3.2.1 Task strategies

Participants (SEP1, SCP1, SBP3, SCP1, SCP2, SCP3) indicated that they utilize different task strategies to improve learners' English proficiency through active learning. They mentioned the creation learning games, clarifying aspects of rubrics, engaging in practical

work, use of flash cards, word searches, teaching learners to use dictionaries and writing summaries of what they have read and encouraging library visits with parents to assist learners with reading. One participant explained: *I also create games, learning games just for them to be active enough in class* (SBP3). Another example was: ... *We have word searches on our poems. I sent them to ask their parents to take them to the library to read stories with them and thereafter I let them write their stories or summarise what the story was about...* (SCP3). Participant SDP2 read through a story, gave learners examples of higher-order questions, gave them opportunity to create their own higher-order questions based on the story and thereafter demonstrated how to write a summary of the story. Participant SEP2 encouraged attention focusing and note taking in a reading lesson. She read a story and learners had to take notes on important aspects, which will assist them with discussions in their groups.

4.3.2.2 Imagery

Participant (SBP2) mentioned she developed imagery by using pictures and posters to stimulate learners to create their own stories. Only one participant mentioned it in the interviews and only one participant (SBP3) was observed using imagery as an SRL skill. The participant allowed learners to predict through using pictures what will happen next in a story. This allowed learners to create a picture as to what might happen, to focus their attention, and to keep their interest in the lesson.

4.3.2.3 Metacognitive monitoring skills

Participants indicated they encourage metacognitive self-monitoring by providing learners opportunities to self-assess their performance to become aware of their mistakes. Participant SEP2 clarified: ... *after I give them feedback, they can criticise and evaluate their own work. It also guides them to become conscious, active thinkers so that when they enter the world, they are prepared to think about what they do and make a difference not just go with the flow.* Lesson observations revealed that participants (SAP3, SBP2, SBP3, SCP1, SCP3, SEP1, and SEP2) fostered self-feedback where they allowed learners to autonomously make revisions after they provided feedback. While learners completed their activities, participants supported them with oral feedback through explanations and discussions. They employed higher-order questioning, requiring learners to justify their answers and explain why they were correct or incorrect. Participants provided descriptive feedback using examples to illustrate errors, written feedback through corrections, and peer feedback, where learners assisted each other. However, in most lessons, participants did not provide an opportunity for learners to self-observe and self-record their performances to find possible causes of success or failure.

4.3.2.4 Time management skills

Only a few participants addressed time management skills in their lessons. Through self-feedback, participants (SAP3 and SEP3) gave learners follow-up activities to complete after the oral feedback they provided. Participant SAP3 taught her learners for a double period. She used the first period to provide oral feedback on a written activity and instructed learners to manage their time so that they could complete the activity before the end of the second period. Participant SEP3 gave learners 5 min to underline the subject and predicate in sentences.

By not using feedback to encourage learners to complete class and homework tasks within a specific target time, many participants missed the opportunity to encourage learners to manage their time more effectively and to develop time management skills. For example, participants (SAP1, SDP1, SDP3, and SEP1) provided time in class for learners to complete their corrections, but they did not indicate how long learners had to finish with the corrections. Two other participants (SCP1 and SCP3) gave learners an opportunity to write the planning of their essays without indicating to learners what would be effective time spent on their planning. Likewise, participants (SDP1 and SDP3) provided homework without specifying a due date for completion (Manual, 2020).

4.3.2.5 Help-seeking skills

During the interviews participants (SAP2, SCP1, SDP2) indicated they developed help-seeking skills by encouraging learners to use libraries, dictionaries, the Internet, and peer engagement to improve their understanding of content. One participant indicated: *...they will question it with their peers and the peer will explain to them, they'll come together to complete tasks* (SCP1). The encouragement of help seeking from peers and the teacher for assistance were observed to a limited extent during lesson observations. In a reading lesson, learners engaged in peer feedback where the stronger learners assisted the weaker learners with their reading (SBP1). Another participant added: *... and use what you have available to ... you have your dictionary; you have your textbook, and you have your reader and the internet* (SDP2). Participants (SBP2 and SCP1) used descriptive feedback to prompt learners to seek help from her as the teachers and to ask higher-order questions. Higher-order questions require reasons and explanations, to seek clarity regarding the outline of an essay, and the writing of a dialogue.

SRL skills such as structuring of a favourable learning environment, interest incentives and self-consequences after task completion as well as self-recording were not mentioned in the interviews nor observed during the lesson observations.

In the next section, SRL skills enhanced in the reflection phase will be discussed.

4.3.3 Sub-theme 2.3: SRL skills fostered after task completion

From the interview data, it can be inferred that participants perceive themselves as developing self-evaluation skills in learners. They believe they are teaching learners to build realistic attributions for their successes or failures, to adapt their behavior after failure, and to avoid practicing defensive behavior in response to failure.

4.3.3.1 Opportunity for self-evaluation and self-judgement

During the lesson observations, it was observed that participants (SAP1 and SEP1) provided written feedback through writing corrections on the board and learners completed corrections in their books. Participants (SAP3, 116 SBP1, SCP2, and SEP3) provided self-feedback where learners completed a follow-up activity after they have received feedback in the form of corrections and reflect on their reading mistakes after they received a summative mark. Participants encouraged self-reflection by instructing learners to mark their activities in books (SDP1 and SDP3). Participants (SEP1 and SEP3) incorporated peer feedback in their lessons where they allowed

learners to write answers on the board and the peers had to identify whether the answer is correct or incorrect and explain why.

4.3.3.2 Self-satisfaction

During the observations, participants displayed knowledge of the importance of self-satisfaction after the successful completion of a task and achievement of learning goals. They used praise (SBP3, SCP1, SCP2, SCP3, SDP1, SDP3, SEP1, and SEP2) as positive reinforcement to make learners experience positive feelings toward learning. This is how one participant clarified: *I think important in feedback is also complimenting the learners. I also give them the sticker and acknowledge the good that they have done...* (SAP1). Participants indicated that they see the expressions of self-satisfaction on learners' faces that they understood a task: *You actually see it in many learners where they nod their head, they smile, they so sort of show you they have received it, they have internalized it and this is now how they going to go about it, remedying it and improving ...* (SAP1).

Participants did not express in the interviews how they think they promote self-evaluation skills following a learning task. The development of accurate attributions, refraining from defensive actions, and changing one's behavior after failing were also neither mentioned or demonstrated in the lessons.

5 Discussion of findings

The first theme revealed that participants understand the concept of feedback and have specific intentions with the feedback they give. They perceive feedback mostly as a process to inform learners about their strengths and weaknesses, and to create awareness of mistakes that can result in improved work (Manual, 2020). They provide feedback to the parents regarding learners' progress, to help learners to understand instructions and new knowledge, and build their confidence through developing their reading, writing, and communication competencies (Manual, 2020). Participants perceive their feedback to be focused on the correction of learners' faulty interpretations in written or oral tasks. They indicated that they normally utilize discussions, and repeated explanations in addition to extra time for continuous remedial work and practice, providing feedback throughout the process (Manual, 2020). Feedback on the self-level, which focuses on learners' comprehension of their own progress and performance was also limited in both the interviews and the lesson observations. Only two participants perceive themselves to provide feedback on the regulatory process level, which allows learners to reflect, plan, monitor, self-evaluate, and engage further in a task. While participants understand the fundamentals of the feedback concept their responses showed that they frequently overlook its more expansive goals, which include opportunities that should enable learners to monitor and evaluate their learning, self-feedback that should enhance deeper learning, and feedback that empowers learners to take ownership and responsibility for their learning (Hattie and Timperley, 2007; Panadero et al., 2019).

The feedback provided by participants supports the development of various self-regulated learning (SRL) skills, such as motivation and persistence. Overcoming mistakes and witnessing progress enhances learners' motivation and persistence, teaching them that effort and perseverance can lead to improvement. By communicating with learners about their errors, participants help them learn to effectively

use feedback. This process assists learners in developing the skill of self-assessment, as they learn to recognize and understand their mistakes. This skill is crucial for self-regulated learning, as it helps learners understand and correct their errors. Positive encouragement boosts learners' confidence and self-efficacy beliefs. Additionally, strategic planning skills, adaptation of task strategies, and metacognitive monitoring skills can be developed, as effective remediation requires learners to plan study strategies, allocate time to focus on areas needing improvement, and employ various strategies to better understand the material, such as reviewing notes, seeking help, or using additional resources. Learners also become adept at self-evaluation to identify their errors and areas of weakness, enabling critical evaluation and understanding of what needs improvement. Redoing work or finding new ways to improve fosters strategic thinking and adaptability. Reflection is a part of metacognitive monitoring skills; therefore, the oral feedback provided by participants allows learners to reflect on stories, helping them internalize information and connect it to their prior knowledge.

5.1 SRL skills fostered before learning tasks

The findings of the second theme indicate that participants have a clear understanding of the SRL skills they aim to foster before learning tasks, but there are discrepancies between their intentions and practices. While participants believe they encourage goal setting by using rubrics and envisioning future outcomes, this was not observed during lesson observations. Explicitly stating lesson outcomes could help learners focus their attention and establish learning objectives, thereby enhancing SRL skills and English language competency.

The encouragement of strategic planning through timetables and planning phases in essay writing was noted. However, participants did not elaborate on how they help learners choose suitable strategies to reach their goals. Observations showed that scaffolding during planning phases allowed learners to continue autonomously, indicating a positive impact on SRL skills.

Participants' efforts to praise and motivate learners were observed to boost self-confidence and motivation. However, the feedback was often generic, lacking specificity about what made performances outstanding. More detailed feedback could better support the development of self-efficacy beliefs and motivation.

Encouraging positive outcome expectations was reported by only a few participants. Increasing awareness of the practical benefits of English language proficiency and fostering a mindset of active thinking could further enhance SRL skills.

The use of engaging materials and practical demonstrations was effective in capturing learners' interest and maintaining attention. These strategies are conducive to developing SRL skills by making learning tasks more interesting and relevant to learners' lives.

5.1.1 Sub-theme 2.2: SRL skills fostered during task completion

The findings indicate that while participants recognize the importance of fostering SRL skills during task completion, there are areas where their practices could be improved. The use of diverse task strategies to engage learners in active learning is commendable. Participants' efforts to incorporate games, practical work, and reading

activities help develop learners' English proficiency and SRL skills. However, there is room for more consistent application of these strategies across different lessons and participants.

The use of imagery as a teaching strategy is limited. While it was effective when used, more participants should incorporate imagery to stimulate learners' creativity and attention. Literature supports the use of pictures to increase interest and visualization (Panadero and Alonso-Tapia, 2014).

Encouraging self-assessment and metacognitive self-monitoring is vital for developing SRL skills. While participants provided opportunities for self-assessment, there was a lack of consistent practices for self-observation and self-recording of performances. Implementing these practices could enhance learners' awareness of their learning processes and outcomes.

Addressing time management skills is crucial for developing SRL. Although some participants provided follow-up activities and oral feedback, many missed opportunities to reinforce time management by not specifying time limits or due dates. Clear guidelines and consistent reinforcement of time management strategies would benefit learners.

Encouraging help-seeking from peers and teachers is essential for developing SRL skills (Zimmerman, 2002). Participants' efforts to promote academic help-seeking using external resources like libraries, dictionaries, and the Internet are beneficial. Seeking academic assistance is thought to be a crucial SRL skill that supports learners' learning (Karabenick and Knapp, 1991). The following categories of help-seeking noted by Karabenick and Knapp (1991) were noted in the participants' responses and lesson observations. They urged learners to approach them as teachers with questions and requests for assistance. A meaningful learning process that improves knowledge development and shows an active involvement in learning necessitates asking questions as a means of seeking assistance. Additionally, students were encouraged to ask for informal guidance from their classmates as well as through instrumental activities where they were taught to put in more effort to enhance their performances. Observing more structured peer engagement and higher-order questioning can further enhance these skills.

Overall, while participants are making efforts to foster SRL skills during task completion, there is potential for more consistent and comprehensive application of these strategies. Enhancing imagery use, providing clear time management guidelines, and encouraging structured help-seeking practices can further support the development of SRL skills in learners.

5.1.2 Sub-theme 2.3: SRL skills fostered after task completion

Although participants did not mention how they developed self-evaluation and self-judgment skills in the interviews, the lesson observation revealed that participants incorporated different teaching strategies to encourage learners to self-evaluate and monitor their performance (Panadero and Alonso-Tapia, 2014) against goals or lesson outcomes set by participants (Schunk et al., 2016). The findings suggest that participants are making efforts to develop SRL skills after task completion, but there are areas for improvement. While participants are making strides in fostering SRL skills after task completion, there is a need for more explicit and consistent emphasis on self-evaluation, accurate attributions, and adaptive behaviors following failure. This can be achieved through

professional development and reflective practices that help participants better understand and articulate their teaching strategies.

6 Conclusion

The aim of this study was twofold: first, to investigate participants' perceptions of their feedback practices that promote SRL skills in their English Home Language classes; and second, to examine which SRL skills participants encourage to enhance proficiency in English Home Language. The findings related to the first research question indicate that the participants' feedback practices largely emphasize immediate, corrective feedback aimed at improving task performance and building foundational English language proficiency skills. However, there is a notable gap in using feedback to develop SRL skills. The participating teachers do not consistently use feedback to help learners monitor and evaluate their learning, adapt strategies to correct errors, or take ownership of their learning.

Concerning the second research question the findings indicate that not all sub-processes in Zimmerman and Moylan's (2009) model were mentioned as SRL skills by participants during the individual, semi-structured interviews. However, the findings of the lesson observations indicate that participants encourage the use of SRL skills such as strategic planning, motivation and self-efficacy beliefs, task value and interest, task strategies, imagery, time management, help-seeking, self-evaluation, self-satisfaction, and self-recording. Participants also did not mention the fostering of time management skills through feedback, but during the lesson observations, it was observed that they provided learners with specific time to complete activities. It can be inferred that the context of the lesson observations might have prompted participants to emphasize the fostering of SRL skills more than they would mentioned in the discussion about teaching practices in the interview settings. Another possible reason might be that participants lack a clear comprehension or vocabulary regarding SRL skills and are not consciously aware of or able to express how they integrate the development of SRL skills through feedback. This suggests a disconnect between participants' conceptual understanding of the development of SRL skills through feedback and how they are developing SRL skills when teaching English Home Language.

7 Recommendations

Based on the findings, the following recommendations are made for teaching practice:

The Department of Basic Education should prioritize pedagogical training for English Language teachers. Targeted professional development courses can help to bridge teachers' knowledge gaps in effectively encouraging and developing SRL skills. These professional development courses should focus on helping teachers integrate SRL-promoting feedback practices into their classrooms.

The Department of Basic Education and schools should implement targeted workshops to raise teachers' awareness and understanding of SRL skills, offering opportunities for collaborative learning where teachers can share insights and best practices related to SRL. Workshops should offer practical examples and

demonstrations to help teachers understand how to incorporate SRL principles into their daily instruction.

English Home language teachers should align teaching and feedback practices to foster SRL skills. They should be encouraged to explicitly integrate SRL skills into their teaching and feedback strategies.

A culture of continuous professional development should be fostered, emphasizing the importance of constructivist teaching approaches and staying informed about new concepts and strategies related to SRL.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/supplementary material.

Ethics statement

The studies involving humans were approved by Education Faculty Research Ethics Committee (EduRec). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

JM: Conceptualization, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Methodology. BG: Conceptualization, Supervision, Writing – review & editing, Formal analysis, Investigation. KK: Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Teachers' perceptions of their self-regulated learning practices in elementary school classrooms

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Self-regulated learning (SRL) is associated with adaptable, critical, lifelong thinking skills. Teachers are essential to promoting SRL in learners, yet infrequently teach these learning strategies in classrooms. We addressed three research questions: (1) How do K–5 teachers implement SRL in their teaching?, (2) How is the use of SRL strategies linked to their self-efficacy or confidence in teaching?, and (3) How do teachers differ in their use of SRL depending on school type (public vs. private)? Semi-structured interviews were conducted with 12 primary in-service teachers, sampled equally from one public and one private school, to explore their SRL practices. They frequently utilized SRL in implicit ways. Further themes included setting goals based on student needs, monitoring student progress, and thereby adapting instruction. Teachers were largely confident about incorporating SRL into their instruction. Public school participants relied on time management and tracked student progress in more summative ways than their private school counterparts.

KEYWORDS

self-regulated learning, metacognition, teaching strategies, instructional planning, monitoring, self-reflection, primary grade levels, qualitative interviews

Introduction

Self-regulated learning (SRL) is defined as an “individuals' self-generated cognitions, affects, and behaviors that are systematically oriented toward attainment of their goals” (Schunk and Mullen, 2013, p. 363). Positive learning outcomes associated with SRL include improved academic performance and motivation (e.g., Zimmerman and Bandura, 1994; Cazan, 2013) as well as lifelong learning (e.g., Dent and Koenka, 2016; van Beek et al., 2014). Because SRL is based on a socio-cognitive theoretical framework (Bandura, 2001; Zimmerman, 2013), it has also been shown to have social and behavioral benefits, especially when present in a community of learners engaging in co-regulated or shared-regulation (Hadwin et al., 2017; Quackenbush and Bol, 2020).

The literature supports the effectiveness of metacognitive strategies and SRL. For example, Elhusseini et al. (2022) conducted a quantitative systematic review of the effects of SRL interventions on primary and secondary students' academic achievement. These authors reported positive effects of SRL strategies on reading, writing, and math achievement among primary and secondary students. Dent and Koenka (2016) further revealed small but statistically significant correlations among metacognitive and cognitive processes for children and adolescents. Overall, these metanalytic results varied in strength depending on the grade level, subject area, measures, and particular strategies but were nonetheless significant, pointing to positive results for self-regulatory and metacognitive strategies on academic and social outcomes.

Researchers also tell us that metacognition and self-regulation occur at an early age and can be improved (Roebers et al., 2009; van Loon et al., 2021). In yet another meta-analysis,

SRL, metacognitive, and motivational strategies were shown to be effective among primary school students (Dignath et al., 2008). Based on Muir et al.'s (2023) systematic review, this seems to be true even for preschool children with regards to executive functioning. These results suggest that young children can develop self-regulation and metacognitive skills, although some of this depends on whether the context facilitates SRL application.

One such contextual variable is prior achievement. In an early study, Zimmerman and Pons (1986) demonstrated distinct patterns for the frequency and consistency of SRL strategy use by student achievement level. Higher achieving students were more likely to engage in monitoring, help-seeking, organizing, transforming, and delivering self-consequences when compared to their lower achieving counterparts. More recently, Cleary et al. (2020) reported similar findings. Middle school students reporting strong SRL skills had higher mathematic achievement levels than those reporting poor SRL skills.

Instruction represents another contextual variable influencing students' use of SRL strategies. Teachers play a critical role in supporting student SRL growth (e.g., Kramarski and Michalsky, 2009). Teacher practices of SRL are influenced by their beliefs, attitudes, and prior knowledge of SRL strategies (Karlen et al., 2020). Teachers generally hold positive feelings toward SRL practices, but they do not consistently cultivate and apply these learning strategies (Dignath-van

Ewijk and Van der Werf, 2012). Additionally, while teachers find SRL strategies to be valuable in theory, some teachers believe their students are incapable of these skills (Spruce and Bol, 2015). Teachers would benefit from competently self-regulating their own learning before teaching SRL to others (e.g., Hattie and Yates, 2014). Using Zimmerman's self-regulated learning theory (Zimmerman, 2008) and Kramarski and Heaysman's (2021) "triple SRL-SRT processes" as a framework, we identify the ways primary teachers implement SRL, explore their self-efficacy beliefs in teaching SRL, and investigate differences in SRL use between public and private school teachers.

SRL theoretical frameworks

SRL is comprised of "self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals" (Zimmerman, 2000, p. 14). SRL is set in a socio-cognitive framework, as it requires internal beliefs, cognitions, and metacognitions as well as external influences including feedback and teacher support (Zimmerman, 1989). Zimmerman and Moylan's (2009) cyclical model of SRL recognizes learning strategies that occur pre-performance, during performance, and post-performance of an academic task in a teaching context (see Figure 1). In the forethought

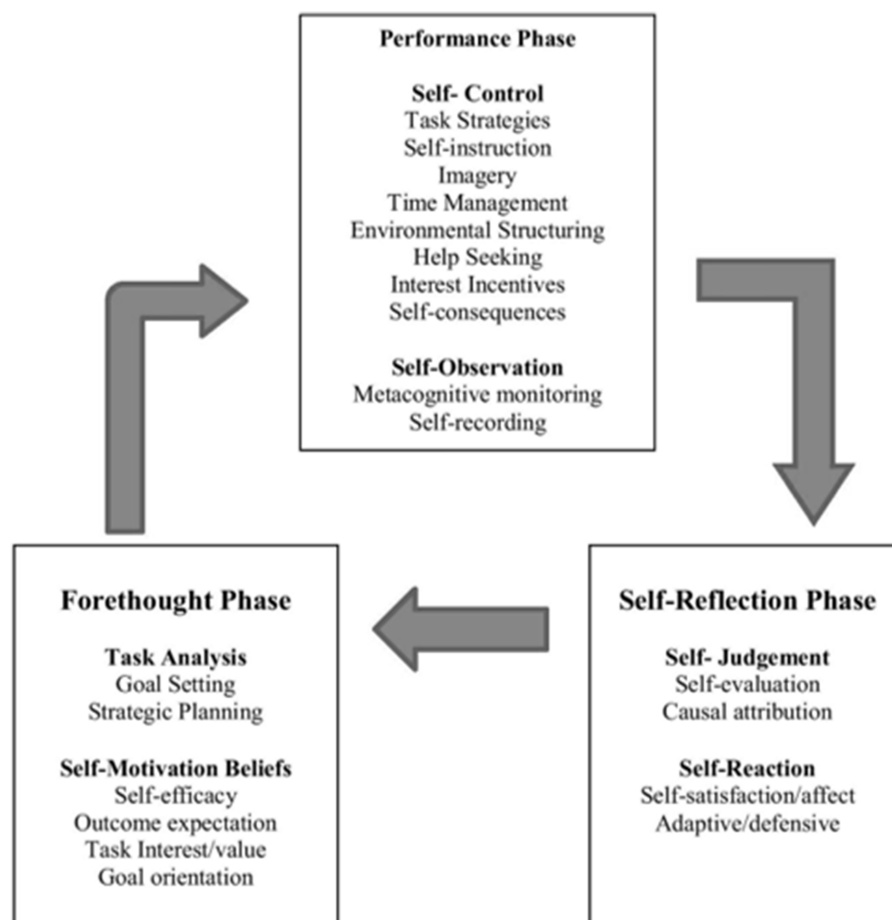


FIGURE 1
Zimmerman and Moylan's (2009) model of self-regulated learning.

phase, learners establish their objectives, evaluate their motivation and capabilities to accomplish the tasks, and devise plans to actively participate in the task at hand. During the performance phase, learners actively participate in the tasks, implementing strategies such as time management, help-seeking, and environmental structuring, monitoring their progress throughout. It is in the last phase, the self-reflection phase, wherein learners critically analyze their performance of a task through self-evaluation, fostering a deeper understanding of their own abilities and areas for improvement.

Kramarski and Heaysman (2021) created a pragmatic framework that aims to connect theory, practice, and research on teachers' SRL. Refining already existing frameworks that distinguish between teacher personal SRL use and SRL instruction for learners, the "triple SRL-SRT processes" was designed, wherein three self-regulation categories are offered: "(1) teachers self-regulate their own learning as learners (SRL); (2) teachers self-regulate their practice as self-regulated teachers (teacher-focused SRT); (3) teachers activate students' SRL as teachers of SRL (student-focused SRT)" (Kramarski and Heaysman, 2021, p. 298). Teachers' beliefs, knowledge, and practices seem intertwined and could affect all three categories of the Triple SRL-SRT framework.

Teachers and SRL

Teacher beliefs and knowledge of SRL influence how teachers integrate SRL in their teaching (Calderhead, 1991; Hoy et al., 2006). Teacher beliefs and knowledge are closely related concepts, often difficult to isolate as they are interwoven (Hoy et al., 2006; Pajares, 1992). Teacher understanding of SRL can be categorized in the following ways: the beliefs and knowledge teachers carry about practicing SRL instruction and their beliefs and knowledge of how to construct an environment conducive to supporting SRL development (Dignath-van Ewijk and Van der Werf, 2012).

Teacher SRL beliefs

Teacher beliefs have been found to have the strongest impact on teacher SRL behavior, due to their affective nature that takes prominence when cognitive reasoning is not successful (Pajares, 1992). Teachers largely believe that SRL strategies should be developed in their students (Perry et al., 2008). However, while teachers find SRL strategies to be valuable in theory, some teachers believe that these skills are not transferable to their own students, due to their perceptions of student capability and other factors (Spruce and Bol, 2015).

Dignath (2016) identified three types of teacher beliefs related to SRL: epistemological beliefs, beliefs on SRL promotion, and self-efficacy beliefs. Epistemological beliefs include beliefs on knowledge, such as learning theories and systems (Schommer-Aikins, 2004; Perry, 1970). Beliefs on SRL promotion include the perceptions of instructional SRL-related pedagogy (Lombaerts et al., 2009). Self-efficacy beliefs regarding teacher SRL are the beliefs a teacher holds on their capability and effectiveness for providing SRL-related instruction (Tschannen-Moran and Woolfolk Hoy, 2001).

Teacher self-efficacy beliefs

Self-efficacy is a prominent component of Bandura's (2001) socio-cognitive theory that describes an individual's belief in their ability to reach a learning goal. Situated in the forethought phase of Zimmerman and Moylan's (2009) model, self-efficacy is categorized as a

self-motivational learning factor that occurs prior to a task or experience. One's self-efficacy beliefs can influence their utilization of SRL in the performance and self-reflection phases, including their monitoring and evaluation skills (Pajares and Usher, 2008).

Teacher self-efficacy is defined as a "teachers' individual beliefs about their own abilities to successfully perform specific teaching and learning tasks within the context of their own classrooms" (Dellinger et al., 2008, p. 751). SRL self-efficacy is one factor that determines the degree of SRL facilitation by teachers, as it directly influences their likelihood for promoting these learning skills in their practice (Dignath, 2016). Teacher perceptions of SRL influence their self-efficacy to apply these learning strategies (Hoy et al., 2006). Unfortunately, while many instructors hold positive beliefs regarding the benefits of SRL, they lack the confidence to pursue SRL-related instruction in the classroom (Perry et al., 2008).

Teacher SRL knowledge

Teachers' beliefs in the usefulness of SRL are widely positive, but their actual working knowledge of these strategies is generally low (Spruce and Bol, 2015). Teacher SRL knowledge is particularly weak in the forethought phase of planning and the self-reflection phase of evaluation (Spruce and Bol, 2015). Novice teachers in particular lack knowledge of how students learn (Askell-Williams et al., 2012) and are less likely to facilitate SRL as a result (Butler and Cartier, 2004). Teachers who have comparable knowledge of SRL may exhibit differing instructional behaviors that vary in effectiveness (Dignath-van Ewijk and Van der Werf, 2012). Teacher knowledge and beliefs about SRL and its effectiveness should logically affect their SRL practices.

Teacher SRL practices

Although educators have many opportunities to develop student SRL strategies in the classroom (de Boer et al., 2018; Azevedo et al., 2008), they infrequently implement these fundamental learning skills (Dignath and Büttner, 2018). There is a misalignment between teacher SRL beliefs, knowledge, and practice (Spruce and Bol, 2015). Teachers often lack the skills to integrate SRL into their practices (Dignath and Büttner, 2018) and fail to consistently cultivate and apply these learning strategies as a result (Dignath-van Ewijk and Van der Werf, 2012). While SRL encompasses cognition, metacognition, affect, motivation, and behavioral processes (Zimmerman, 1990; Schunk and Green, 2018), teachers most commonly promote cognitive learning strategies and rarely incorporate other SRL-related competency development in their instruction (Dignath and Veenman, 2021). When SRL is incorporated into instruction, it tends to be more implicit rather than explicit in nature.

Implicit versus explicit SRL instruction

As noted, SRL is primarily taught implicitly (Kramarski and Michalsky, 2015; Spruce and Bol, 2015) despite the research that students benefit the most from explicit SRL instruction (Kistner et al., 2010; Dignath and Büttner, 2018). Throughout daily classroom instruction, there are myriad opportunities for the explicit teaching of SRL strategies (Azevedo et al., 2008). Explicit teaching of SRL is the direct instruction and modeling of what specifically these strategies are, why they are beneficial, and how and when to utilize them in a learning context (Zimmerman, 2008; Dignath and Veenman, 2021). Explicit instruction of SRL components differs based on their associated SRL phase (Michalsky, 2021). Teachers more often explicitly

teach metacognitive monitoring skills and less frequently focus on strategic planning and evaluation (Quackenbush and Bol, 2020), despite evidence on the effectiveness of less frequently taught SRL components such as task analysis and self-evaluation on academic achievement (Michalsky, 2020). Reflection is the most common SRL strategy used by novice teachers to improve upon their explicit SRL practices (Kohen and Kramarski, 2012; Kramarski and Michalsky, 2010). Some of these SRL practices may be influenced by the type of school in which a teacher is employed. SRL practices may differ in terms of the flexibility or latitude teachers have in their schools. One potentially important difference relates to whether the teachers are employed in private versus public school.

SRL and school type

School climate is a strong indicator of the degree and quality of SRL promotion and application in the classroom (De Smul et al., 2019). Some facets of school climate differ between public and private school types (Lubienski et al., 2008). Private schools generally allow for greater teacher autonomy and flexibility in curriculum, for instance (Miron and Nelson, 2002). A study by Fidan and Öztürk (2015) concluded that attributes such as creativity and intrinsic motivation have been found to be more prevalent in private school teachers. They additionally discovered that private schools are more supportive of innovation and have greater access to resources that enhance innovation. As researchers consider SRL an “innovative practice” (Lombaerts et al., 2009), and given the curricular flexibility and autonomy experienced by private school teachers, it would be interesting to understand the differing ways in which SRL concepts are promoted in private versus public schools.

Overall, when a school's educators share knowledge and perspectives of SRL and are guided by the same framework of SRL and its strategies, they are more likely to implement SRL in their practice (Vandevelde et al., 2012; Peeters et al., 2016). While no previous research has compared SRL development amongst public and private elementary schools, overall, studies have found that private schools receive more administrative support than public schools (Lubienski et al., 2008). When people in leadership positions such as district administrators and principals advocate for SRL use in teacher practice, a school climate is cultivated that supports the utilization of SRL strategies (James and McCormick, 2009). Given these findings, private school teachers are better positioned due to the autonomy and supports they receive to develop SRL skills and strategies. This research study addresses the ways in which SRL is implemented in public and private school environments.

Overview and rationale for present study

Based on Kramarski and Heaysman's (2021) typology of teacher SRL, we focused mostly on how teachers self-regulate their practice as self-regulated teachers. However, we regard the three types of teachers' SRL as intertwined. That is, we would expect that teachers who self-regulate their own learning and instruction would be better equipped to promote SRL among their students. Although we emphasized teachers' practice of SRL, we also explored their knowledge and familiarity as well as their self-efficacy for SRL. The most studied components of Zimmerman and Moylan's (2009) SRL model and those most familiar to teachers were

chosen for our study (Spruce and Bol, 2015). From the forethought phase, the variables of emphasis were goal setting and strategic planning, subcomponents of task analysis. From the performance phase, time management was a subcomponent of interest, as were metacognitive monitoring and self-recording, subcomponents of self-observation. The self-reflection phase was represented with causal attribution and adaptive reaction, subcomponents of self-judgment and self-reaction, respectively. Several components incorporated into the present research were further selected due to the explicit nature of these strategies, such as help-seeking, which could be recognized through social interactions, and time management, which may be more salient due to measuring tools such as clocks and timers. Metacognitive monitoring is another SRL strategy that teachers can understand via feedback, gradebooks, and other student progress evaluation techniques (Halpern, 1998). Teacher self-efficacy for promoting explicit and implicit SRL strategies in classrooms was an additional area of interest. It is important when considering teacher SRL perspectives to understand their confidence in teaching these skills and making connections with teacher knowledge and beliefs of SRL.

Pre-service teachers are often the focus of studies on the effectiveness of SRL interventions (e.g., Glogger-Frey et al., 2018). Professional development at the pre-service level brings awareness of SRL strategies and demonstrates their relevance to instruction and student learning before a teacher enters the workforce, reinforcing the importance of these skills (Vosniadou, 2019). Some researchers specifically select pre-service teacher participants to understand the effectiveness of SRL professional development on novice educators at the beginning of their training (Panadero, 2017). However, pre-service teachers are selected largely because they are a more easily accessible population (Cebesoy, 2013). We address this gap in the literature by exploring the SRL-related teaching practices of in-service teachers. It may be the case that professional development and intervention studies be designed differently for pre-versus in-service teachers. Exploring the practices of in-service teachers via interviews may be an initial step in tailoring professional development.

Aligning with recommendations to enhance teachers' SRL, self-efficacy for teaching, and instructional effectiveness (Spruce and Bol, 2015; Panadero et al., 2017), the present study investigates in-service teachers' use of SRL strategies in K–5 contexts and how it is linked to teaching self-efficacy and instructional effectiveness. The study further seeks to make comparisons between SRL practices of public and private school teachers. Exploring teacher SRL practice and efficacy beliefs will help us construct a picture of how SRL is being utilized in varied educational settings. The following research questions guide this study:

1. How do K–5 teachers implement SRL in their teaching?
2. How is the use of SRL strategies linked to their self-efficacy or confidence in teaching?
3. How do teachers differ in their use of SRL depending on school type (public vs. private)?

Understanding teacher perceptions and SRL practices can be useful in finding ways to utilize effective SRL strategies in the classroom and promote self-efficacy around SRL instruction. The present study contributes to existing literature by targeting in-service teachers and making connections between their beliefs, knowledge, and self-efficacy regarding SRL to their own SRL practices. Additionally, this study is the first we know of to compare SRL practices between public and private school settings.

Method

A qualitative interview study was designed to examine teachers' use of SRL strategies in K–5 contexts. A consultation of qualitative methods texts (e.g., [Muljana and Luo, 2023](#); [Katsantonis and McLellan, 2023](#)) and other published studies in the area of SRL (e.g., [Brady et al., 2024](#); [Russell et al., 2022](#)) point to the legitimacy of using just one qualitative data collection technique, like interviews, in qualitative research. One-on-one structured interviews were conducted with primary school teachers to understand their knowledge and practice of SRL strategies. The interview protocol was drafted to incorporate all phases and selected subcomponents of [Zimmerman and Moylan's \(2009\)](#) model of SRL. The selected components from the broader framework were described earlier and are presented in [Figure 2](#).

Participants

Participants included 12 in-service primary school teachers (K–5). Six participants were employed at a public charter school, and six participants taught at a private school, both located in Southern California. Of the sample, three teachers were male and nine were female. The number of participants in our sample seemed appropriate to achieve in-depth exploration of the phenomenon via a qualitative design ([Moustakas, 1994](#); [Clandinin, 2006](#)).

Years of teaching experience amongst participants ranged from 3 years to 16 years. Our selection criteria required that participants are in-service teachers with at least 3 years of teaching experience at their current school. In the interest of addressing gaps in the research, in-service teachers were the study focus. Similarly, K–5 educators were our sample of interest as elementary level educators are infrequently the population utilized for research in this context ([Xu et al., 2022](#)). Participants were recruited in equal numbers from one private and one public school in southern California, resulting in a homogenous sample.

Purposive sampling was implemented to select participants based on our specific criteria. Purposive sampling is a nonprobability sampling technique commonly used when research does not aim to

generalize results ([Etikan et al., 2016](#)). Qualitative research benefits from purposive sampling due to the rich information collected from individuals targeted based on their experience with the phenomenon of focus ([Patton, 2002](#); [Creswell and Plano Clark, 2011](#)).

Interview protocol

A semi-structured interview protocol (see [Appendix A](#)) was designed by a team of four educational psychology specialists to explore teacher perceptions and knowledge of SRL as it applied to their practice. This constituted expert review and enhanced the content validity of the interview instrument. The protocol design was informed by comprehensive systematic reviews of current literature on SRL that suggest all phases be incorporated into SRL study designs ([Dunlosky and Rawson, 2019](#); [Heikkinen et al., 2023](#)). For the present study, components from the forethought, performance, and self-reflection phases of [Zimmerman and Moylan's \(2009\)](#) model were selected so that each phase was represented in the interviews. A blueprint was designed to guide the development of the interview questions and to further strengthen content validity (see [Table 1](#)). Several rounds of revisions were made as a team and questions deleted to create a parsimonious protocol that featured SRL components relevant to the research questions and commonly understood by teachers. Response burden was also a consideration in drafting the final list of questions. From a total of 15 open-ended interview questions, three questions were associated with the forethought phase, four questions represented the performance phase, and five questions explored self-reflection. Two general questions were additionally included to understand teacher perspectives of SRL as a broader construct and were posed at the beginning of the interview before the description of the SRL model. The interview was piloted with two teachers prior to study commencement, as an additional method for strengthening the trustworthiness of findings. Few changes were incorporated based on responses to the pilot interviews and resulted in minor rewording and estimations of interview length.

Procedure

Upon receiving university IRB and school approval, teachers were informed of the study and asked to participate. Over the course of 8 weeks, 12 teachers were individually interviewed over one session either in person on their school campus or via video conference. Participants were informed that they would be recorded and provided their consent prior to interview commencement. The length of each interview session was approximately 30–40 min in duration. All interviews were recorded using Zoom video conference for future reference and to facilitate transcription.

Data analyses

Data was initially analyzed through a first-cycle *a priori* coding process that took a deductive approach by using pre-defined codes based on the subcomponent SRL targets ([Saldaña and Omasta, 2016](#)). Deductive coding uses an existing theory or framework, (in this case SRL theory), to determine the set of codes that will guide the data

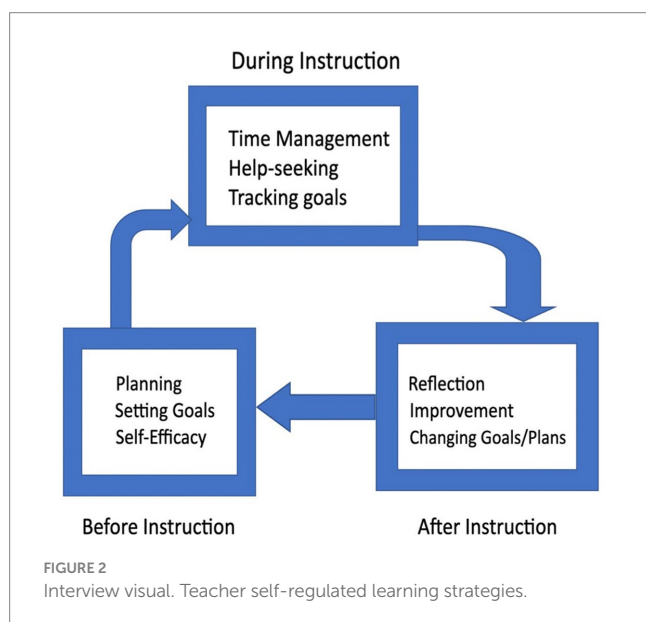


TABLE 1 Blueprint for teacher interviews: items numbers in interview protocol.

	Knowledge	Self-efficacy	SRL practice
General SRL	3, 4		
Forethought/planning		7	
Goal setting			5, 6
Performance		11	
Time management			8
Goal tracking			9
Help-seeking			10
Reflection		16	12
Change, improve			13
Attribution			14, 15

TABLE 2 Inter-rater reliability scores per section and cumulative.

	Agreement	Total	Percentage
General	18	21	86%
Forethought	26	29	90%
Performance	51	57	89%
Reflection	52	62	84%
Overall	147	169	87%

analysis (Bingham and Witkowsky, 2021) (See Appendix B, C for codebook samples). Following the first round of coding, we interpreted the data by adding new codes, utilizing an inductive coding approach to apply meaning to the data, and identifying broad emerging themes and categories (Saldana, 2013; Bingham and Witkowsky, 2021). An iterative process was used to switch between deductive and inductive coding to capture a comprehensive picture of the phenomenon. Iterative coding “involves moving back and forth between concrete bits of data and abstract concepts, between inductive and deductive reasoning, and between description and interpretation” (Merriam, 1998, p. 178). A second-cycle thematic coding process was conducted by grouping topics into categories and labeling a new code to each grouping that illustrated thematic patterns found in the data (Braun and Clarke, 2021). Thematic analysis of data highlights the salient themes present within a phenomenon (Daly et al., 1997). We further examined themes that emerged across categories that informed our interpretation of findings.

The unit of analysis was the topic or idea conveyed and not the number of teachers. For example, a teacher could have described two distinct ideas in response to one question and it would be coded into two categories. Two researchers coded the interview responses independently, using random selection with replacement to check reliability. During this process, two coded transcripts from each school ($n = 4$) were randomly chosen per interview question to confirm the accuracy of their themed codes throughout. The researchers addressed inconsistencies in their interrater agreement levels by consulting one another and offering clarification until a consensus was reached, followed by another round of recoding and another reliability check. Agreement on the number of topics or ideas were included in the calculations. The results of the reliability check were an overall inter-rater reliability score of 0.87 (Table 2).

We calculated separate reliabilities by phase that ranged from 0.84 for Reflection to 0.90 for Forethought.

Results

Our results are organized around the research questions. We begin with teacher SRL practices, move to our findings related to self-efficacy, and then discuss some patterns observed when comparing private versus public school teachers. As previously noted, to understand the degree of awareness each teacher had on the phases and components of SRL, an interview visual (see Figure 2) was shown to each participant prior to the first question. The opening questions were posed in conjunction with the Figure as an advance organizer and way to familiarize participants with language to be used in interviews. In correspondence with the interview visual that outlined salient aspects of SRL, participants were asked about their familiarity with self-regulated learning (Table 3). Many responses reflected teachers’ unfamiliarity with SRL (41%). One educator stated that she is “not super familiar on specifically self-regulated learning.” Another teacher said, “This is the first time I have heard about it.” In contrast, others asserted they had heard of the term and were familiar with SRL or at least some of its more common components, such as time management, reflection, and goal setting (41%). “I have not heard the term self-regulated learning, like the actual term is new but the concept of it is not.” A few responses were categorized as “other” because teachers said they were more familiar with self-regulation as a strategy for controlling one’s own behavior, or they thought that SRL was simply common sense. These findings are in line with prior research that suggests teacher SRL knowledge is limited, particularly prior to SRL training (e.g., Spruce and Bol, 2015).

Teacher SRL practices

Our first research question investigated teacher SRL practices. As an SRL theoretical framework was used to guide the study and design the interview protocol, it seemed appropriate to present the findings as they relate to each of Zimmerman’s (2002) phases. We begin with forethought, or how teachers plan their instruction, especially as it relates to goal-setting (Zimmerman, 2012).

TABLE 3 Teacher responses to general self-regulated learning questions.

Category	N	%	Illustrative quote
How familiar are you with these concepts of self-regulated learning? (n = 17)			
Not familiar with SRL theory	7	0.41	"I have not heard about it before. This is the first time I've heard about it."
Familiar with some SRL concepts	7	0.41	"I'm really familiar with it. I have not heard the term self-regulated learning, like the actual term is new, but the concept of it is not."
Other	3	0.2	Other topics included: SRL as a sensical practice, SRL vs. self-regulation

TABLE 4 Forethought phase: goal setting responses.

Category	N	%	Illustrative quote
How do you use goal setting in your own practice as a teacher? (n = 26)			
Tailored learning goals	7	0.27	"I set different goals in different areas, depending on what is needed at the time."
Structured goals	7	0.27	"I look at the commons or standards, look at the curriculum. I determine the learning concept or objective we are trying to achieve. Then I also look at the students - what their prior knowledge is, what are any gaps or misconceptions in their understanding of that concept or that common core standard. And then I reflect on how I can adjust accordingly."
Socioemotional goals	3	0.11	"For me, my goals are being tracked in the form of the children, and how excited they are to learn, and how proud they are of themselves, and how confident they become, and that's more fulfilling than saying that like by a certain time in a school year, a child should be learning this or at this level."
Individual student goals	5	0.19	"I look at each child individually first, so I see each child and where they may lie within, social-emotionally and then also academically."
Time management goals	3	0.11	"Little goals each day, little goals each week, to hopefully get to the end result of us being successful in them learning something in the classroom."
Other	1	0.04	Topics included self-directed goal setting

Forethought

Teachers were asked to respond to questions related to task analysis in the forethought phase, such as goal setting and planning (see Table 4). Teacher goals often include learning outcomes and milestones used for self-evaluation, “a criterion against which to assess, monitor, and guide cognition” (Pintrich, 2000, p. 457). Teachers generally believe that goal setting is valuable and that it can improve their teaching (Camp, 2017), a belief our teacher participants shared across the board. A study by Hagger and Malmberg (2011) identified the following teacher professional goal categories: personal goals, teaching tasks, goals for students, and impact. When inquiring about how our teachers use goal setting in their practice, salient themes generally fell into the “goals for students” or “teaching tasks” categories, and included structured goals, classroom management goals, time management goals, socioemotional goals, individual student goals, and whole group learning goals. These goals were mostly formulated in the forethought phase, before a learning task begins, although several goals (such as goals centered around improving instruction) were a product of reflection and resulted in adaptations to their practice. One teacher commented, “If something really, truly did not work in that class, I adapt it for the next class, and if it does not work over a couple of classes, I just scrap it completely.”

Of Hagger and Malmberg (2011)’s professionally-related teacher goal areas, we found that our participants largely focused on student goals and goals regarding the impact their own behaviors and practices had on student academic and socioemotional performance. Most of

the participants (27%) stressed the importance of tailoring learning goals to meet the needs of the students. Some of these goals were directed at individual students and others were more collective and broader. One educator stated she used common core standards, expressing, “I determine the learning concept or objective we are trying to achieve.” Another 27 percent relied on structured goals supported by student assessment data and being “more reflective of my own learning goals.” One teacher referenced socioemotional goals, stating that “my goal is also mainly for my students to feel good about themselves as learners.” Regarding relationships with students and their families, a teacher mentioned, “Another goal is to make sure that my families feel that I am supporting them and feel that they are getting an education that is top notch...I want them to like feel like they are getting the best service that they can.”

Widely, our teacher participants focused on student-centered goals, a finding corroborated by Hagger and Malmberg (2011) who found that student performance is a primary goal of teachers. However, several goals focusing on teacher wellness or teaching position were noted. Regarding personal goals cited by Hagger and Malmberg (2011), one teacher mentioned a goal to strike a work-life balance, commenting,

It’s gotten to the point where my kids will be like, can you please close your laptop and come play with us?... If I close my computer at 4 0’ clock, the only person who will suffer is me and my students, because then the teaching’s not intentional.

TABLE 5 Performance phase: time management responses.

Category	N	%	Illustrative quote
How do you manage your time in the classroom? (n = 31)			
Structured schedule	9	0.29	"I also have consistent schedules, so that I know in the mornings we do math, in the middle of the day we do readers, and balance literacy in the afternoons."
Flexibility	6	0.19	"I do not feel the time crunch to get things done and rush the children through the learning because I always know that I have the ability to continue that throughout the week."
Student responsiveness	7	0.23	"I usually start my classes with an activity to kinda ground the class, like a game or you know, maybe a breathing exercise or something to just kind of bring the energy down."
Other	4	0.13	Topics included managing time outside of the classroom
Timers	5	0.16	"I use a lot of timers. I'm very intentional about my time."

TABLE 6 Performance phase: goal tracking responses.

Category	N	%	Illustrative quote
In what ways do you track whether your instructional goals are being met? (n = 23)			
Monitoring student learning	6	0.26	"Keeping notes and reflecting. I think that's super important. And also reading the room. How are the kids doing? Are they getting it? Are they understanding it?"
Formal and informal assessment	8	0.35	"Working in a space where we do not do testing or grades, the assessment has to be all day every day. Really, it's constant, and so that's how I keep track of how close we are getting to our goals."
Student and teacher feedback	3	0.13	"Sometimes I ask the kids for feedback. Also, just seeing emotionally how they are doing."
Monitoring student engagement	4	0.17	"I could sit there and [have them] repeat after me. That's not fun. How can I make this more engaging? So, I think as I go, I keep reflecting on that. How can I continue to make this even more fun and engaging for these kiddos?"
Other	2	0.09	Topics include creating cohesive lessons and reteaching for comprehension

Another teacher mentioned administration-mandated goals that teachers were required to work toward and would be assessed upon.

According to Zimmerman (2012), this planning and goal setting is adaptive and sets the stage for instruction. However, the findings regarding the various types of goals raise the question of whether and how goals align with different purposes. For example, teachers would develop a goal to target individual learning needs and another to enhance socio-emotional development. It may be that goal setting be based on assessments of students in different areas.

Performance

The next questions were grounded in the performance phase of Zimmerman and Moylan's (2009) model, focusing on learning strategies that occur during instruction. We began by asking teachers how they managed their time during instruction (see Table 5). Emerging time management themes included structured schedules, flexibility, and use of timers. Most participants agreed that the key to time management was consistency in the form of daily schedules and time blocks per subject (29%). Other responses reflected use of an advance organizer or some other activity to keep the students on track and manage the classroom (23%). "I usually start my classes with an activity to kind of ground the class." Some participants mentioned the need for flexibility in their schedules to adjust lessons based on student needs (19%). These findings align with a study by Khan et al. (2016) who discovered a positive relationship between teacher time management and classroom performance. One teacher stated, "I approach [instruction] with a certain amount of flexibility. So, I have

my ideal [schedule], but I'm very open to, if this is not working, how do I shift?" Actual timers were also used to monitor time during instruction (16%). Overall, teachers had a positive view on time management and utilized time management strategies in their practice.

When asked how they track whether their instructional goals are being met, teachers offered a wide array of responses (Table 6), such as through formal and informal assessments (35%), by monitoring student learning (26%) and their engagement (17%) during instruction. The following overarching themes were identified: monitoring learning, monitoring engagement, teacher reflection, feedback, and assessment. Regarding assessments, one teacher in the private school group explained they do not do formal student testing, but assessment was "constant and so that is how I keep track of how close we are getting to our goals." Another relied on feedback, particularly from their students (13%). One participant noted, "I find that the feedback from the children is the best way in [tracking instructional goals]. How they are understanding material, how they are working with the material, how they respond to the material."

Simultaneously, student SRL can be developed through teacher feedback, particularly scaffolding feedback that promotes metacognitive strategies, promotes motivation to learn, and enhances self-efficacy for SRL use (Guo and Wei, 2019). Teacher feedback influences how learners monitor, evaluate, and adapt their learning performances (Zheng, 2022). Several teachers spoke about the goals they set for providing student feedback. One teacher said that they "give them that on-demand, on-the-spot feedback and send them back. They'll do it and come back, ideally. Realistically, it does not always happen." She explained that giving immediate feedback was

TABLE 7 Performance phase: help seeking responses.

Category	N	%	Illustrative quote
When you encounter a challenge in your practice, in what ways do you seek help? (n = 27)			
Teachers	9	0.33	"I seek help first from my team because I am lucky to work with incredible educators, so I seek help from them first."
Colleagues	7	0.26	"If I still hit a road bump, or there is something that's stopping us from progressing forward, I'll turn to a colleague for support, for any ideas, and then try that out."
Adapt/solve on own	6	0.22	"I kind of just figure it out... like really just figure out what it is that needs to be done to get over this challenge because that could definitely slow you down."
Text/online resources	3	0.11	"There are some incredible resources online. I try to... dig a little deeper, for the research-based facts and practices."
Other	2	0.07	Topics include seeking help within the community

often a challenge due to the constant flood of distractions or classroom happenings that have to take priority. Another teacher commented,

My own personal teaching goals for my own practice have been related to student assessment and providing student feedback in a much more regular and predictable way to my students, because I feel like that's another way that I can really work with that gap is by providing them feedback much more immediately, and deciding on how to intervene sooner than what I think I've done in the past.

Teacher feedback is essential for student learning, reducing the gap between what students understand and what they seek to achieve (Hattie and Timperley, 2007). Ultimately, our teacher participants set explicit student feedback goals and believed in giving immediate feedback but recognized that there were limitations and challenges in doing so.

In addressing our question on help-seeking, the teachers described where they go for support when encountering a challenge (see Table 7). Emerging themes for teacher help-seeking sources included teacher colleagues, administration, field experts, content resources, and adapt/solve on own. Largely, our participants sought help from other teachers (33%), a finding corroborated by similar research studies on teacher help-seeking (e.g., Tatar, 2009). Our participants also sought help from other colleagues like administrative team members and support staff (26%). "I seek help first from my team because I am lucky to work with incredible educators." Others explained that they prefer to troubleshoot problems on their own and adapt accordingly before seeking the help of others (22%). A smaller percentage of responses focused on using text or on-line resources (11%). "There are some incredible sources on-line. I try to ... dig a little deeper for the research-based facts and practices."

Again, help-seeking is an adaptive learning strategy that promotes goal-oriented behaviors (Ryan et al., 2005). While there is a gap in the research on in-service teacher help-seeking behaviors (e.g., Butler, 2007), we offer a definition of teacher help-seeking based on Ryan and Pintrich's (1998) interpretation, contextually set in educational environments. Teacher help-seeking is a problem-solving behavior through which a teacher seeks external knowledge or support from a competent individual, group, or other resource when faced with an obstacle or challenge. Butler (2007) discovered that teachers hold positive beliefs about the benefits of teacher help-seeking behavior. She further found that teacher perceived help-seeking is positively

associated with mastery goal orientation for teaching. Examining teacher help-seeking behavior from Kramarski and Heaysman's (2021) triple SRL–SRT model, we found that our teacher participants seek help to improve their own learning and teaching but did not purposefully model help-seeking behaviors to their students. This may be due to the lack of knowledge teachers hold on SRL strategies and their benefits on student learning growth (e.g., Spruce and Bol, 2015). It is notable most teachers did not express reluctance to seek help in contrast to students who may be reluctant. Some studies show that students avoid help-seeking to conceal their weaknesses or are disengaged from content and lack motivation to seek help (Marchand and Skinner, 2007). As students are generally unfamiliar with SRL strategies such as help-seeking and are unable to properly utilize them without implicit or explicit teaching (Peeverly et al., 2003), it may be beneficial for teachers to actively model help-seeking behaviors in their classrooms (Bandura, 1972).

Self-reflection

When asked about self-reflection as it relates to their practice, the teacher participants responded that they frequently used this SRL strategy to improve upon their instruction (see Table 8). Teachers self-reflect by collecting data on their practices and evaluating whether their practices coincide with their beliefs (Farrell, 2007). Upon coding the self-reflection items, the following thematic categories were formulated: reflection on instruction, co-reflection, reflection on student progress, and adapting lessons based on reflection. One participant elaborated on the ways she uses reflection after daily instruction.

I like to go through a checklist of things I did to prepare before the lesson, [and reflect on] how the actual lesson went... and then how the children received that information, and just to see if they enjoyed themselves, if they learned the material, if it was an engaging experience.

They acknowledged their reliance on reflection to adapt future lessons and meet the individual and collective needs of students. In addition to reflecting on their own, teachers co-reflect with their students and peers (15%) to understand how lessons are being received and their improvement. "Once I have reflected on a lesson, I'll go back and make a change, then I also introduce that discussion with my students so they can also have that understanding as well." Teacher participants typically self-reflected naturally through their

TABLE 8 Self-reflection phase: instructional reflection responses.

Category	N	%	Illustrative quote
How do you reflect on your instruction after teaching a lesson or a unit? (n = 31 ideas)			
Reflection on instruction	7	0.23	"How can I improve [instruction]? What could I have done differently?"
Student monitoring/assessment/progress	8	0.26	"Through little assessments that we do, I get a pretty solid understanding of where they need help and the pieces that they are missing from years before."
Adapting lessons	6	0.19	"If something really, truly did not work in that class, I adapt it for the next class, and if it does not work over a couple of classes, I just scrap it completely."
Other	4	0.13	Topics include reflecting on student-centered learning and student help-giving.
Co-reflection with students	3	0.10	"I always say, 'Hey guys, how did yesterday's lesson feel to you?'"
Co-reflection with peers	3	0.10	"I have lunch with my grade-level colleagues... and so we'll just talk about it then, like, 'Hey, I'm not understanding how to reteach this in a different way, like they are just not understanding it.'"

TABLE 9 Self-reflection phase: causal attribution responses.

Category	N	%	Illustrative quote
Think about a time when your teaching was successful. To what do you attribute that success? (n = 25)			
Climate	6	0.24	"Success comes in a child feeling a sense of pride and finding a love of learning. So even if they do not master the skill I'm hoping they master, if they came out excited to learn more or proud of themselves, I consider that a win all day every day."
Student relationships	6	0.24	"I always tell everyone that I cannot teach your child until your child feels connected to me, so I always build that connection first, so that they have that trust."
Instructional planning	4	0.16	"Well-crafted lessons that give the right amount of rigor without being too overwhelming, without trying to push down a bunch of information."
Teaching strategies	4	0.16	"I attribute my teaching success to best practices and strong curricula. I think a high-quality curriculum, and high-quality expectation of content knowledge."
Other	3	0.12	Topics include trust-building and teacher interest in content. "They trust me. They know they can say whether it's, if they are not comfortable saying in front of everybody or they know they can come up to me and say, I need more help with this."
Adapting instruction	2	0.08	"If it does not go well, back to the drawing board. But if it works, it works. So, I would say I'm open to change, I'm open to critique, and I'm open to just trying it out to see where it goes."

cognitions. Among the interviews, there was no mention of explicit reflection-generating activity use, such as journaling or recording analysis of their lessons, which have been found to be effective reflection strategies (Jaeger, 2013).

We further delved into reflection by asking teachers to think about a time when their teaching was successful and to what they attributed that success (see Table 9). Two inter-related categories emerged. The first was the attribution of success to careful instructional planning and competence by implementing effective teaching strategies. Others responded that their success could be attributed to climate in a broad sense (24%). One teacher described a climate of student pride and confidence in learning. Other teachers described the import of relationships with her students (24%). "I always tell everyone that I cannot teach your child until your child feels connected to me, so I always have that connection first, so they have that trust." A sense of belonging enhances academic performance and cultivates student wellbeing and engagement (Zimmer-Gembeck et al., 2006; Dweck, 1999). However, teachers often feel constrained by structured schedules and other job-related pressures that impede their ability to strengthen their relationships with students (Allen et al., 2021).

Teacher self-efficacy

Our second research question explored teacher self-efficacy for SRL strategy use (Table 10). Teacher self-efficacy positively relates to effective instructional practices in the classroom (Klassen and Tze, 2014; Zee and Koomen, 2016). We use Tschannen-Moran and Woolfolk Hoy's (2001) teacher self-efficacy model to organize the analysis for a richer understanding of the findings. Their Teacher Sense of Self-Efficacy Scale (TSES) categorizes teacher self-efficacy into three area: efficacy for student engagement, efficacy for classroom management, and efficacy for instructional strategies. Regarding efficacy for instructional practices, teachers generally expressed high confidence for planning quality instruction that promotes student growth (43%). One teacher claimed it was one of her "strengths." Overall, the teachers felt confident in their ability to improve their instruction as it was occurring during the performance phase (26%) (see Table 11). "Altering the ways in which you teach so that it does go successfully is a key component in this teaching world." They largely attribute that confidence to successfully monitoring student progress (18%) and adapting their lessons during instruction (29%). Teachers expressed confidence in adapting instruction to better meet student needs (26%). They described ways they develop

TABLE 10 Forethought phase: self-efficacy responses.

Category	N	%	Illustrative quote
How confident are you in your ability to plan instruction that impacts students' growth? (n = 20)			
High confidence	9	0.43	"I'm very confident in my ability to [plan instruction]. I think it was one of my strengths."
Low confidence	2	0.09	"I'm not feeling super confident at the moment. But I am trying to get more confident by learning a lot really fast, drinking from the fire hose, as they say."
Teaching experience	4	0.19	"I feel like I'm pretty confident, and I feel that confidence comes from the years of practice as opposed to the years of schooling."
Teaching strategies	4	0.19	"I find that I use a variety of different ways of learning to ensure that the kids learn in the best way possible and get to experience the material in a variety of capacities. Like with a degree of experiential education, I want them to learn by doing in a variety of ways."
Other	2	0.09	Topics included growing confidence after goals are reached, confidence after additional schooling

TABLE 11 Performance phase: self-efficacy responses.

Category	N	%	Illustrative quote
How confident are you in your ability to improve instruction as you are teaching? (n = 34)			
Confident	9	0.26	"I feel pretty confident in [my ability to improve instruction]." I think my experiences definitely helped me in building that confidence up, especially working with pre-K kids, you have to be able to adapt."
Adaptive teaching	10	0.29	"Altering the ways in which you teach so that it does go successfully is a key component in this teaching world."
Monitoring student responses	6	0.18	"I have to see that it's not resonating or they give me that look and that nod in their head of like, "huh?." And I'm- "Alright. Let us try it a different way."
Teaching strategies	5	0.15	"I feel confident that I have several tools within my toolbox to shift and improve instruction."
Reflection	3	0.08	"I think that I am a learner, and I can learn to do better, and I can reflect and recognize when the learning did not go well."
Other	1	0.03	Topics include learning how to improve instruction.

their confidence, which included expanding their knowledge on a topic, learning new teaching strategies, and recognizing areas in their practice that could be improved. As was the case with teacher efficacy in planning and performance phases, teachers were largely confident that their instruction improves due to reflection (33%) (see Table 12).

Regarding efficacy for student engagement as viewed through an SRL lens, teachers spoke on their efficacy for monitoring student response and interaction with the material (11%). One teacher said,

I find that when you see that the children aren't understanding it, or when they are going haywire, or when they need a break... altering the ways in which you teach so that it does go successfully is a key component. I think I'm pretty good at it.

Another teacher spoke on their perceived ability to create engaging content and promote student self-efficacy. "My goals are being tracked in the form of the children, and how excited they are to learn, and how proud they are of themselves, and how confident they become."

While efficacy for classroom management was less frequently spoken upon as it related to SRL practices, several teachers did address confidence in their management styles. One participant elaborated on goals they set for themselves, explaining, "my goal, especially last year, was finding better classroom management, and I felt like I got pretty good at that." Overall, few connections were made between classroom management and our target SRL components.

Facets of teacher self-efficacy outside the scope of the Teacher Self-Efficacy Scale included confidence related to years of experience

and use of a variety of active instructional strategies. "Like with a degree of experiential education, I want them to learn by doing in a variety of ways." Two teachers admitted to periodic lack of confidence because they were learning as they went. "But I am trying to get more confident by learning a lot really fast." One of these participants was relatively new to teaching and expected to gain more confidence with experience. Finally, one teacher described growing confidence each year concurrently with their flexibility and adaptation.

School type

Our third research question assessed the differences in SRL use between public and private school type. Although several SRL components were universally used by public school participants and their private school counterparts, there were areas where their SRL teaching strategies differed notably (see Table 13). The latter group attributed their instructional success to the flexibility and autonomy they are granted to set and adjust goals. One teacher reflected on the fluidity of their daily school schedule, commenting,

We set a daily schedule at the beginning of the day, and... I approach it with a certain amount of flexibility. So, I have my ideal one, but I'm very open to, if this is not working, how do I shift?

Another teacher shared a similar autonomy-based strategy for planning their school year, stating,

TABLE 12 Self-reflection phase: self-efficacy responses.

Category	N	%	Illustrative quote
After reflection, how confident are you that you can improve your teaching? (n = 27)			
Confident	9	0.33	"I feel confident because I can make decisions and know these are the decisions I'm gonna make because they are best for my students."
Adapting instruction	7	0.26	"Once I've reflected on [a lesson], I'll go back and make a change, and then I'll also introduce that discussion with my students so that they can also have that understanding as well."
Other	4	0.15	Topics include immediate vs. long term changes and help-seeking.
Reflection	4	0.15	"After I reflect as a whole with the class, and then as I reflect internally by myself, then I feel confident in knowing that I can do it."
Experience	3	0.11	"Every year, I gain a little bit more confidence, and I think it's not just confidence in like, I'm the best teacher in the world. It's confidence in being able to fail. And be flexible and switch."

TABLE 13 Comparison of public versus private school teacher use of SRL strategies.

Teacher participants	Public school teachers	Private school teachers
Goal setting	Ability to set own goals limited by administrative and federal milestones and regulations	Autonomy to set goals
		Flexibility to adjust goals
Time management	Used timers and structured schedules to meet milestones	Able to adapt instruction without time limit restrictions to meet student needs
Tracking student progress	Relied largely on summative assessments of students	Assessed student progress mainly through formative assessment and student feedback

I will look at my grade level milestones, and I track it out for the year. I sit and track it in ways that make sense for me knowing that I'm going to need some flexibility for when [the students] get things quicker than I thought, or when it's taking a little longer than I thought. So, I guess I start in a very macro sense and then week to week I make adjustments from there.

One participant detailed a time when a learning game they planned was not engaging the students and how they had the flexibility to shift to an entirely different activity that was more effective in retaining the attention of the students. The private school participants largely spoke on the ease of adapting instruction without time restrictions to meet student needs. These results align with research finding that private school teachers have greater autonomy in their instruction than their public-school counterparts (e.g., [Miron and Nelson, 2002](#)). Conversely, the public-school teachers were more limited by structures set in place by their administration, district, and federal government. They expressed feeling restricted or constrained by schedules and goals that were set for them. One public school teacher outlined their rigid ELA program structure, lamenting that time constraints mean that they do not always have the latitude to adapt or strengthen a lesson. As a result, they relied on time management more to meet milestones.

Largely, the private school teacher participants more frequently regarded relationship-building as critical to student success. Given that private schools generally offer more autonomy in their schedules and curriculum ([Miron and Nelson, 2002](#)), it makes sense that they would have a greater opportunity for relationship-building without some of the external pressures that exist in public schools. As relationship-building between students and their teachers lead to positive goal outcomes, particularly due to the

increased opportunity to understand and meet individualized needs of students ([Nordengren, 2019](#)), teachers may consider reflecting upon strategies for strengthening relatedness among their students.

An area of greater divergence between school types concerned student feedback. While public school participants tracked student progress in more summative ways, private school teachers were more likely to assess their students using formative assessment methods. Studies have found that while both assessment types are effective, formative assessments were more highly associated with motivation to learn and SRL skills ([Ismail et al., 2022](#)). When asked about how they monitor student progress, a private school participant detailed their formative assessment process:

I find that the feedback from the children is the best way. How they are understanding material, how they are working with the material, how they respond to the material. And then I guess also, I do not want to say tests because we do not really believe in tests, but ways in which you can strategically test them to understand the material and asking them questions and seeing their answers.

Discussion

Research suggests that teacher prior knowledge about SRL influence teachers' instruction ([Spruce and Bol, 2015](#); [Dignath-van Ewijk and Van der Werf, 2012](#)). As such, our initial interview questions sought to gauge these teachers' knowledge or familiarity with SRL. We considered their familiarity important for understanding their classroom practices relates to SRL and their beliefs about SRL in terms of their self-efficacy or confidence. We found just less than half

of teachers stated they were not familiar with SRL theory, and the same percentage of respondents expressed some familiarity with the concepts if not the terminology. Teachers appeared to possess more practical than theoretical knowledge of SRL. Even though they were not able to well-articulate tenets of SRL theory, they were able to provide examples in the context of instructional practice that would suggest some implicit knowledge that guided their practices. The lack of explicit knowledge has been well-documented in the literature (Spruce and Bol, 2015) and would be logically linked to their more implicit rather than explicit SRL practices described during the interviews. These results are supported by observational studies that also show a lack of explicit instruction by teachers (Quackenbush and Bol, 2020; Spruce and Bol, 2015).

The remainder of the interview was devoted to how they implemented their implicit understanding of SRL in practices and their confidence in the effectiveness of these practices. Our continued discussion of our results is organized around our three research questions. We then move to a description of our limitations that lead to implications for research and practice.

Teacher implementation of SRL

Our first research question addressed how K–5 teachers implement SRL in their teaching. The present results offer some insight into how teachers plan their instruction. More specifically, we better understand the myriad goals they employ to plan their instruction. Tailoring and structuring goals were common, suggesting that goal setting may be somewhat formal and differentiated depending on student needs. This kind of goal setting has been recommended by other educators and researchers because they recognize individual differences and assessment in a more formative sense (Tomlinson and Moon, 2014).

Our results also inform how they improve their instruction. They largely turn to their fellow teachers, other colleagues, or text-based resources; however, a smaller number attempt to solve problems on their own. Some of these avenues are similar to student help-seeking behaviors, including a reluctance to ask others for help (Karabenick, 2012). The more adaptive help-seeking behaviors could be explicitly modeled by teachers for their students.

While we know a good deal about time management (Manso-Vázquez et al., 2016), we understand less about how teachers manage their time. Teachers in the present study were concerned about managing their time and even used physical timers. They carefully structured their schedules to cover different subjects at particular times during the day. Others were more flexible in their time management and were responsive to students' needs when considering the pace and readiness for instruction.

There were some patterns detected across phases and components, sometimes blurring the lines between phases. The first was self-regulation interpreted as regulation of emotion or affect. One teacher participant explained that her understanding of SRL is that it is “tied to social emotional learning, to develop self-regulation skills in terms of coping with big emotions.” When initially asked about SRL, some teachers thought we meant self-regulation more generally as it pertained to socioemotional as well as academic characteristics. Again, this could be due the primary grade levels taught by these teachers (K–5). They mentioned this aspect of regulation in the context of goal setting, tracking goal accomplishment, and reflection phases. They

wanted their students to be excited and confident in their learning, viewing it as more or equally important as academic goals. “Success comes in a child feeling a sense of pride and finding a love of learning. So even if they do not master the skill I’m hoping they master, if they came out excited to learn more or proud of themselves, I consider that a win all day every day.” Other patterns noted across phases pertained to monitoring and adjusting instruction to meet the needs of students collectively and individually. Teachers would informally or formally assess their students to set goals and to determine whether instructional goals were realized. Monitoring with adaptations were commonly described for the performance and reflection phases of instruction as well. In the reflection phase, adjustments for improving lessons could occur in collaborative ways with students and peers. Monitoring and adjusting instruction based on formative assessment is a critical metacognitive strategy that could be transferred to students during their own learning (Andrade, 2010; Panadero et al., 2018).

Teacher self-efficacy

Our second research question examined teacher self-efficacy as it related to SRL strategy use. Teachers were confident in their ability to plan for, implement, and reflect on their instruction, and largely attribute that confidence to their cumulative teaching experiences. Salient experiences include adopting an array of effective teaching strategies, monitoring and adapting their instruction, managing their time efficiently, getting feedback from students and colleagues, and reflecting on how their instruction may be improved. This confidence may be both positive and negative. Confidence suggests high self-efficacy in teaching, and teacher perceptions of SRL influence their self-efficacy and quality of SRL instruction (Hoy et al., 2006). However, confidence or self-efficacy does not always equate with competence.

There is a large literature on over-confidence in meta-analytic judgments. Calibration is one such judgment and represents the correspondence between individuals' perceptions of their task performance and actual performance. We have repeatedly found that lower-achieving students are grossly inaccurate and overconfident; whereas higher achieving students are much more accurate and even a bit underconfident (Bol et al., 2016; Foster et al., 2017; Hacker et al., 2000). It may be these teachers are a bit overconfident in their ability to self-regulate their teaching. There has not been much research on teachers' competence, confidence, and SRL, but Dignath (2021) found an interaction between teachers' competence and the success of SRL professional development. Those teachers who had more competent instructional profiles profited more from the professional development than did their less competent counterparts. Whether their confidence also systematically varied awaits empirical confirmation.

While teacher self-efficacy for practicing SRL was high among our participants, explicit instruction of these components embedded within the SRL framework was rather low. One explanation could be that teachers generally are not familiar with SRL concepts, but naturally incorporate aspects of them into their implicit teaching. Some teacher participants were candid in admitting they had not heard of the term SRL but considered aspects of the framework as part of effective instruction. These results point to more implicit rather than explicit use of SRL and how it is communicated to students. Other researchers have observed a similar trend (Michalsky, 2020; Quackenbush and Bol, 2020; Spruce and Bol, 2015). Even though explicit instruction is shown to

be more effective in promoting students' SRL (Kistner et al., 2010), implicit instruction is more common. As noted earlier, teacher efficacy beliefs about SRL may influence to what extent they explicitly implement SRL in their instruction. Because these teachers taught at primary grade levels, they may not think their students capable of understanding SRL explicitly and opted for what they believed was a more developmentally appropriate way to implicitly convey these concepts. However, the literature supports early development of SRL (Dignath et al., 2008; Roebbers et al., 2009; van Loon et al., 2021) and students may be more capable of understanding and using these strategies than teachers believe.

SRL and school type

Our third research question compared teacher SRL practices in differing school types. As in similar studies exploring differences between public and private schools, we also discovered a few themes that distinguished responses between teachers from each school type (Lubienski et al., 2008). Private school teachers had more of their autonomy or flexibility in goal setting. These findings support previous research that private schools generally have greater autonomy in shaping their curriculum (Miron and Nelson, 2002). Additionally, private school teachers were able to adjust their instruction to better meet student needs and used more formative assessment as well as student feedback in measuring progress. In contrast, public school teachers were held to administrative or federal standards in goal setting, were more formal in their time management strategies, and relied heavily on summative assessments of their students. These differences could be not only linked to administrative demands but perhaps the kinds of students enrolled in these courses. Another possible explanation for these differences may be school climate as an indicator of the degree and quality of SRL instructional practices (De Smul et al., 2019). In private schools, teachers also have more flexibility to incorporate SRL in their practice without the pressure of pacing and high-stakes testing (Madaus et al., 2009; Miron and Nelson, 2002).

Limitations

The current study is not without limitations. The first is the rather narrow focus of our interview questions both in terms of SRL components and the type of teachers SRL examined. As described by Kramarski and Heaysman (2021), there are three types of teacher SRL: (1) teachers self-regulate their own learning as learners, (2) teachers self-regulate their practice as self-regulated teachers, and (3) teachers activate students' SRL as teachers of SRL. We primarily focused on the second type-how SRL influenced their teaching practices. However, we also had items about teachers' familiarity with SRL and their confidence or self-efficacy in its effectiveness. The three types of SRL are interwoven. A second limitation is related to social desirability inherent in any self-report measure. Because the interviews were confidential, teachers may have been more candid. Based on our own observations during the interviews, the teachers seemed comfortable and willing to admit what they did and did not know. They also bolstered their responses with examples that would be difficult to fabricate. A third limitation was our reliance on self-selected volunteers, and that their responses may not be generalizable to other teachers. We did purposefully select from a group of volunteers, but nonetheless, they were self-selected into the sampling frame. Another limitation is

that we relied on one data collection method, in-depth interviews. There is precedence for using one data collection technique like qualitative interviews (e.g., Muljana and Luo, 2023; Brady et al., 2024), yet it would be informative to conduct a more ethnographic type of design where we collected data from several sources longitudinally. This was not possible in the schools recruited due to resources and permissions. Although the purpose of qualitative studies typically is not to generalize (e.g., Polit and Beck, 2010; Niaz, 2007), external validity was constrained by having only twelve teachers, six from each type of school in primary grade levels. Even for a qualitative study, it may have been informative to have more teachers from each type of school.

Implications

Our findings have implications for theory, research, and practice. In terms of theoretical and practical implications, different components of Zimmerman and Moylan's (2009) model may be more important given the context for instruction. For example, teachers who have more flexibility may find it more useful to focus on particular types of goals like those that rely on formative assessment results (Traga and MacArthur, 2023). Teachers constrained by district and state guidelines may rely on more summative types of assessments to develop goals. Time management may be more essential when meeting scope and sequence objectives in public schools. There may be more options for help-seeking in larger public schools. Moreover, the theory may emphasize different components within phases depending on the type of teacher self-regulated learning addressed. For example, if the goal is to develop the teachers' own sense of SRL as a learner, the motivational components like self-efficacy and attribution theory may be more important. If the goal is to instill SRL among students, more tangible aspects of the model like goal setting, help-seeking, monitoring and time management might be more readily and obviously applied to teaching practices as a place to begin. Some researchers (Quackenbush and Bol, 2020; Spruce and Bol, 2015) have shown that teachers do tend to use more components in the performance phase of Zimmerman and Moylan's (2009) model.

Implications for practice include professional development on SRL for in-service teachers (Perels et al., 2009; Gillies and Khan, 2009). Much of the literature relies on understanding and providing professional development for pre-service and not in-service teachers (e.g., Kramarski, 2017; Michalsky, 2014; Perry et al., 2008). We assert that professional development in SRL be on-going and not restricted to preservice teachers. The likelihood of teachers applying SRL in their teaching increases as administrators encourage this practice and reward teachers in their evaluations. The focus of professional development might be on how to explicitly incorporate SRL in teaching practices. One form of explicit instruction could be teachers modeling for the students how to engage in SRL strategies (Bandura, 1972). Another might be teachers developing goals with their students, reflecting on whether these goals were realized, and adjusting goals as they return to the planning phase. The later example reinforces the cyclical nature of the model for teachers and students alike.

There are myriad directions for future research. One direction would be to include data such as classroom observations and artifacts from teachers and students to understand how teacher beliefs and knowledge of SRL align with their classroom practices and their skills of activating SRL among their students. As the present study compares teacher SRL in schools serving communities of two distinct

populations, professional development may be tailored depending on school type (public versus private). Exploring the effectiveness of classroom coaching of SRL would be informative, and explicit versus implicit teacher training practices may be another fruitful direction for study. A comparison of teachers' understanding, beliefs, and practices by SRL type would also be informative. Examining these three strands of SRL may enable us to link them to their implicit and explicit SRL practices and hopefully illuminate avenues for making SRL more explicit. While research has been conducted on teacher knowledge, beliefs, and behaviors regarding student SRL, the present study contributes to the literature on teacher perceptions of SRL as it relates to their own practices in primary grades levels.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors without undue reservation.

Ethics statement

The studies involving humans were approved by Institutional Review Board Old Dominion University. The studies were conducted in accordance with the local legislation and institutional requirements. The ethics committee/institutional review board waived the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin because we recorded it before each interview.

Author contributions

SG-M: Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Resources, Validation, Writing

– original draft, Writing – review & editing. LB: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Validation, Writing – original draft, Writing – review & editing. CH: Project administration, Writing – original draft.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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Variations in online self-regulated learning abilities among Chinese K-12 teachers across different regions and levels

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Introduction: Online self-regulated learning (OSRL) is crucial for online learners' success and lifelong learning. This study investigated the OSRL characteristics of K-12 teachers in China, who embody the dual roles of learners and educators. It also analyzed the differences in OSRL abilities across different genders, education stages, and school locations, and examined the correlation between education qualifications, years of service, and OSRL abilities.

Methods: A self-report measure was used to assess K-12 teachers' OSRL, with data collected from 1,443 K-12 teachers (394 males and 1,049 females) in northeastern China. Descriptive statistical analysis was utilized to explore the characteristics of their OSRL. Independent *t*-tests and ANOVA were employed to investigate differences in OSRL among different genders, regions, and educational stages. Correlation analysis was conducted to examine the relationships between education qualifications, years of service, and OSRL among K-12 teachers.

Results: The data analysis revealed that K-12 teachers scored the lowest in Online Learning Self-Efficacy (OLSE), followed by Online Learning Management Strategies (OLMS), and then Online Learning Resource Management (OLRM). Notably, urban K-12 teachers exhibited higher OLSE abilities than their rural counterparts, while high school teachers scored higher in OLSE and OLMS compared to primary school teachers. Furthermore, a positive correlation was observed between education qualifications and K-12 teachers' OLSE, whereas a negative correlation was identified between years of service and K-12 teachers' OLSE.

Conclusion: The findings reveal an uneven development across various dimensions of online self-regulated learning among K-12 teachers, necessitating support for the advancement of OLSE, OLMS, and OLRM. Particular attention should be given to the OLSE of teachers with longer teaching years and rural teachers. Encouraging K-12 teachers with lower education qualifications to pursue further education is also recommended. This study provides evidence and a novel perspective for teacher educators to develop online professional development programs, which is significant for optimizing online learning experiences and enhancing educational outcomes.

KEYWORDS

online self-regulated learning, K-12 teacher, educational stages, regions, education qualifications, years of service

1 Introduction

With the rapid advancement of information technology, online learning has gained considerable traction and has found extensive applications in the field of education (Xu and Xu, 2020). In primary and secondary schools, online learning has evolved into a pivotal tool for reshaping traditional classroom teaching. Through the integration of blended learning, it aims to optimize the efficiency and effectiveness of conventional school education, thereby enhancing students' overall learning satisfaction. Particularly during the COVID-19 pandemic, this trend has experienced significant momentum, with numerous primary and secondary schools requiring teachers to possess the capability to conduct online teaching and seamlessly transition to online instruction as needed (Johnson et al., 2023).

Concurrently, to adapt to the digital transformation of education, K-12 teacher professional development programs need to align with the requirements of online teaching, thereby enhancing teacher competencies. These programs strive to bolster teachers' proficiency in both online instruction and learning methodologies through the execution of online learning initiatives. Additionally, K-12 teachers can leverage fragmented time to participate in online professional development activities while engaged in online learning. This practice significantly mitigates conflicts stemming from concurrent work and academic commitments. In recent years, online learning has become a common form of professional development for K-12 teachers in China.

However, in the online learning environment, a temporal and spatial gap exists between instructors and students, resulting in a dearth of in-person communication and engagement. Online learning relies on both asynchronous and synchronous interaction within a virtual environment (Serdyukov, 2020). Compared to traditional classroom instruction, online learning necessitates a higher degree of learner autonomy (Yu, 2023). It requires learners to demonstrate elevated levels of online self-regulated learning (OSRL) abilities (Broadbent and Poon, 2015), thereby implying a heightened engagement in managing their learning processes, encompassing the establishment of learning objectives, monitoring progress, and adjusting learning strategies accordingly.

In K-12 online education, research has highlighted the importance of utilizing various technologies and methods to enhance students' OSRL abilities (Johnson et al., 2023). However, numerous research findings indicate that students often lack robust OSRL abilities, exhibit deficiencies in pertinent OSRL knowledge, and struggle to effectively employ learning strategies (Broadbent and Poon, 2015; Kuo et al., 2020; Archambault et al., 2022). To enhance students' OSRL abilities and optimize the efficacy of online instruction, K-12 teachers must undergo transformation, acquiring robust OSRL proficiencies and adeptness in implementing online SRL strategies (Peeters et al., 2014; Sáez-Delgado et al., 2022).

K-12 teachers play a crucial role in supporting the development of students' self-regulating learning ability in many aspects (Dignath and Veenman, 2021; Perry et al., 2020; Sang et al., 2023). An apt Chinese proverb underscores the imperative preparedness of educators: "If you want to give the students a glass of water, the teacher should have a bucket of water." This proverb accentuates the essentiality for teachers to possess robust OSRL abilities to effectively nurture students' OSRL proficiencies and guide their learning pathways within educational settings (Kramarski and

Heaysman, 2021). Empirical investigations corroborate that students can transition into adept online self-regulated learners under the expert guidance of K-12 teachers (Karlen et al., 2023; Heirweg et al., 2020).

Existing research indicates that while K-12 teachers, as adult learners, possess some degree of OSRL ability, their proficiency in OSRL does not meet expected levels, particularly when confronted with different online learning environments (Karlen et al., 2023). K-12 teachers exhibit disparities in two primary aspects: First, there is considerable variation in OSRL abilities among different K-12 teachers (Liu et al., 2021). Second, individual K-12 teachers demonstrate varying levels of proficiency across different components of OSRL (Alqurashi, 2016; Ogodo et al., 2021). Scholars advocate for a targeted focus on the disparities in OSRL abilities among K-12 teachers, with the aim of continuously enhancing their abilities in this area (Broadbent and Poon, 2015; Chen and Bonner, 2020).

In light of this, the OSRL abilities of K-12 teachers are indispensable. They must possess ample OSRL skills to effectively foster the growth of students' OSRL abilities (Karlen et al., 2023; Sáez-Delgado et al., 2022; Vosniadou et al., 2020). This study aims to investigate the characteristics of OSRL abilities among K-12 teachers, analyzes the differences in OSRL abilities across different genders, educational stages, and school locations, and examines the correlation between education qualifications, years of service, and OSRL abilities.

2 Literature review

Self-regulated learning (SRL) refers to learners who are metacognitively, motivationally, and strategically engaged in learning (Winne, 2005). Online self-regulated learning (OSRL), conceptually, refers to the ability to autonomously manage one's learning process by establishing objectives, tracking progress, and employing tactics aimed at improving learning outcomes within an online setting (Zimmerman, 2000; Winne, 2019). The OSRL ability is a critical factor in achieving good online learning performance for learners and is regarded as a key competency for adults to achieve lifelong learning (Broadbent and Poon, 2015).

Teachers with strong OSRL abilities are better equipped to efficiently manage online learning tasks, which in turn promotes their professional growth. Moreover, these abilities enable teachers to gain a deeper understanding of students' OSRL experiences, allowing them to more effectively identify and address students' learning needs and barriers, and to implement more targeted instructional interventions (Karlen et al., 2023). K-12 Teacher's OSRL ability not only impacts their own teaching performance but also has a profound effect on students' online learning experiences and outcomes (Xu et al., 2023).

While it is theoretically assumed that teachers, as adult learners, should possess strong OSRL skills, existing research reveals significant variability in this ability. Bylieva et al. (2021) found that teachers often struggle with time management, leading to incomplete tasks and decreased engagement. Dabbagh and Kitsantas (2013) further noted that maintaining motivation is particularly challenging for teachers in online learning environments lacking immediate feedback or peer interaction. Additionally, Greene et al. (2014) highlighted that teachers frequently experience cognitive overload when navigating new technological platforms and integrating complex content, which undermines their ability to effectively SRL abilities.

Moreover, OSRL abilities are influenced by individual characteristics, educational levels, and regional differences. Most studies suggest that females tend to perform better in OSRL, especially in traditional learning environments. Research by Wang et al. (2013) indicates that females are more adept at employing metacognitive strategies, setting learning goals, and managing time, possibly due to their stronger sense of academic responsibility and self-discipline. However, gender differences are not consistent across all cultural contexts. Aydoğmuş and Ibrahim (2022), for example, found no significant gender differences in OSRL in studies conducted in the U.S. and Turkey, highlighting the need for further investigation into these discrepancies.

The impact of individuals' academic backgrounds and teaching experiences on their OSRL abilities also requires further exploration to uncover underlying mechanisms. Existing research suggests that teachers with higher academic qualifications generally possess stronger metacognitive skills and strategic behaviors, which enable them to more effectively self-monitor and adjust in complex online learning environments (Loeng, 2020). Additionally, extensive teaching experience allows teachers to accumulate diverse learning strategies, enhancing their ability to reflect and assess their own learning, thereby better addressing the challenges posed by online learning (Zimmerman, 2000).

Regional disparities also influence teachers' OSRL abilities. Huh and Reigeluth (2018) found that rural teachers often have lower OSRL abilities compared to their urban counterparts, mainly due to their limited familiarity with digital tools and lack of access to technical support and training opportunities. Manner and Rodriguez (2012) further noted that rural teachers, due to fewer professional development opportunities, exhibit lower motivation and engagement in online learning, and often lack the necessary guidance and feedback, which undermines their OSRL abilities. Investigating these regional differences is essential for understanding the challenges teachers face in diverse educational environments and for improving support systems aimed at enhancing their OSRL abilities.

Therefore, research on K-12 teachers' OSRL should employ appropriate measurement tools to assess their abilities and examine differences across regions, teacher categories, and educational levels. These insights are crucial for improving teachers' learning outcomes and effectively advancing targeted professional development efforts.

Through a review of the literature, in measuring learners' online self-regulated learning abilities, the analysis of self-assessment and reflection plays a major role, with questionnaires or surveys being the primary methods of data collection (Basilotta-Gómez-Pablos et al., 2022; Rovers et al., 2019). Pintrich et al. (1993) developed the Motivated Strategies for Learning Questionnaire (MSLQ), which has gained widespread usage. This instrument comprises four constructs: learning motivation (e.g., intrinsic and extrinsic goal orientation, self-efficacy), cognitive strategies (e.g., rehearsal, elaboration), metacognitive strategies (e.g., planning, monitoring), and resource management strategies (e.g., help-seeking, time management). Weinstein et al. (2002) introduced the Learning and Study Strategies Inventory (LASSI), which encompasses dimensions such as attitudes, motivation, time management, test strategies, and academic resources. Barnard et al. (2009) devised the Online Self-Regulated Learning Questionnaire, focusing on six dimensions: goal-setting, task strategies, time management, environmental structuring, help-seeking, and self-evaluation. Although each scale has its structure and items, in general aspects, some coincidences

underline the importance of motivation, self-efficacy, and learning strategies.

Existing research has indicated that Online Learning Motivation (OLM) constitutes a crucial component of OSRL abilities (Deci and Ryan, 2000; Pintrich, 2003). Learners with strong motivation are better equipped to regulate their online learning processes effectively. Some researchers have initiated investigations into the influence of gender on online learning motivation (Liu et al., 2021). However, the current findings remain inconclusive, with inconsistent effects of gender on OLM observed across learners of different ages (Ajlouni et al., 2022; Yukselturk and Bulut, 2009; Yu and Deng, 2022). It is necessary to further explore whether there are differences in OLM among K-12 teachers of different genders.

Online Learning Self-Efficacy (OLSE) is defined as a learner's confidence to complete online learning tasks and achieve favorable outcomes in online learning (Pampaka et al., 2018). Learners with high OLSE are more likely to exert the necessary effort to overcome obstacles in online learning (Mushtaque et al., 2022; Calaguas and Consunji, 2022). The OLSE is a significant predictor that can enhance academic success (Taipjutorus et al., 2012; Zimmerman and Kulikowich, 2016). Some studies have shown that OLSE can facilitate learners' academic performance by fostering their OSRL abilities (Dignath and Veenman, 2021; Karlen et al., 2020; De Smul et al., 2018; Usher and Pajares, 2008).

Some researchers believe the online learning experience of learners can influence their OLSE (Peechapol et al., 2018). The simplicity and user-friendliness of the online learning platform, along with learners' digital literacy, can influence their OLSE (Yeşilyurt et al., 2016). A certain level of computer proficiency and confidence in online communication methods can influence learners' OLSE (Xu et al., 2023). Therefore, researchers suggest that there are differences in OLSE among learners (Shen et al., 2013; Alqurashi, 2016; Wang et al., 2013). Researchers can investigate the characteristics of learners in depth to explore the nuances of their OLSE, thereby enabling targeted interventions aimed at enhancing learners' sense of OLSE (Peechapol et al., 2018).

With the increasing prevalence of online education across higher education and K-12 settings, the adept utilization of effective SRL strategies in online environments is paramount for academic success. The necessity for online learners to exhibit traits of self-direction, independence, and autonomy has been emphasized (Schunk and Zimmerman, 2011). Researchers have increasingly explored the characteristics of learners' online self-regulated learning from the perspectives of online learning motivation, self-efficacy, and learning strategies (Barnard et al., 2009; Pintrich, 2004). Existing research serves as an important reference for this study in exploring the OSRL abilities of K-12 teachers.

Previous research has predominantly focused on SRL abilities of students within traditional face-to-face classroom environments, often neglecting adult learners, particularly K-12 teachers. This oversight is significant, as teachers play a crucial role in fostering SRL abilities among their students. Additionally, findings related to online OSRL have not always been consistent, underscoring the pressing need for further investigation in this area. Understanding K-12 teachers' OSRL abilities is essential for the development of effective professional development programs and the enhancement of instructional practices. The following research questions guided our investigation:

Q1. How do K-12 teachers perceive their abilities in OSRL?

Q2. Is there a difference in the perception of the OSRL abilities among K-12 teachers of different genders, educational stages (primary school, middle school, high school), and regions (urban, rural)?

Q3. Is there a correlation between the education qualifications, years of service, and the OSRL abilities of K-12 teachers?

3 Materials and methods

3.1 Procedure

The study was approved by the Science and Technology Ethics Committee of Changchun Normal University. All participants provided voluntary consent to participate. Prior to the start of the survey, participants were fully informed of the study's objectives and explicitly informed of their right to withdraw at any time. Additionally, participants were assured that their identities would remain confidential and that all collected data would be anonymized.

Respondents utilized the Questionnaire Star software for questionnaire completion. Before responding, all participants provided informed consent. They were informed that "submitting the questionnaire" would be considered as giving consent. Overall, participants spent about 8 min to complete the electronic questionnaire.

3.2 Instruments

According to the literature review, researchers generally consider online self-regulated learning to encompass motivation, self-efficacy, and learning strategies. Among these, learning strategies primarily focus on cognitive learning strategies, metacognitive learning strategies, and resource management learning strategies. Therefore, this survey's sub-dimension items were derived from published sources, translated into Chinese, and subsequently refined. The questionnaire utilized in this study comprised two sections. The first segment elicited participants' demographic details, including gender, education qualifications, schooling stages, school location, and years of service. The second segment encompassed items gauging each sub-dimension of OSRL. Responses for all items were recorded on a 7-point Likert-type scale, ranging from 1 denoting "strongly disagree" to 7 indicating "strongly agree."

To ensure the validity and reliability of the OSRL questionnaire, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted using SPSS 26 and AMOS 26, respectively. The EFA identified five distinct five-factor OSRL instruments, that is OLM (6 items), OLSE (7 items), OLCS (10 items), OLMS (13 items), and OLRM (7 items). The reliability (alpha) coefficients for the five factors ranged from 0.91 to 0.97. The Composite Reliability (CR) values ranged from 0.90 to 0.96. Additionally, the variables exhibited a Kaiser-Meyer-Olkin (KMO) measure of 0.966. The CFA results also supported the five-factor structure and high model fit indices (CMIN/DF = 2.57, RESEA = 0.07, TLI = 0.93, CFI = 0.94). These results signify a robust fit of the proposed model to the observed data, providing strong support for the questionnaire's reliability and validity. The details of each scale are as follows, and further information can be found in [Appendix A](#):

- 1 Online Learning Motivation (OLM) scale: evaluating K-12 teachers' motivation in the context of online learning,

encompassing both intrinsic and extrinsic motivations (Pintrich et al., 1993). In this study, the OLM scale obtained Cronbach's alpha values of 0.91.

- 2 Online Learning Self-Efficacy (OLSE) scale: assessing K-12 teachers' confidence in navigating online learning platforms and engaging in online learning interactions (Shen et al., 2013). In this study, the OLSE scale obtained Cronbach's alpha values of 0.95.
- 3 Online Learning Cognitive Strategies (OLCS) scale: exploring K-12 teachers' cognitive approaches to online learning, such as paraphrasing, organization, and in-depth processing of learning material (Pintrich et al., 1993). In this study, OLCS obtained Cronbach's alpha values of 0.96.
- 4 Online Learning Metacognitive Strategies (OLMS) scale: measuring K-12 teachers' predominant use of strategies that involve the establishment of online learning objectives, self-planning throughout the learning process, self-monitoring, and metacognitive management techniques (Pintrich et al., 1993; Barnard et al., 2009). In this study, the OLMS scale obtained Cronbach's alpha values of 0.97.
- 5 Online Learning Resource Management Strategies (OLRM) scale: assessing K-12 teachers' focus on resource management tactics related to online learning time allocation, effort management, and seeking assistance when encountering learning challenges (Pintrich et al., 1993; Barnard et al., 2009). In this study, the OLRM scale obtained Cronbach's alpha values of 0.97.

3.3 Participants

A hybrid approach combining stratified sampling and random sampling was adopted to recruit 500 teachers from primary, middle, and high schools in Northeast China, respectively. Incomplete responses and questionnaires with a response time of less than 3 min were excluded. Ultimately, 1,443 valid responses were collected, yielding a valid data rate of 96.2%. Among the 1,443 K12 teachers, 498 were primary school teachers, 496 were middle school teachers, and 449 were high school teachers. The demographic distribution included 72.7% female ($n = 1,049$) and 27.3% male ($n = 394$). In terms of location, 59.4% were urban teachers ($n = 858$), while 40.6% were rural teachers ($n = 585$). Regarding education qualifications, 10.1% held an associate degree ($n = 146$), 81.5% held a bachelor's degree ($n = 1,176$), and 8.4% held a graduate degree ($n = 121$). Teaching experience was diverse, with 9.7% having 0–5 years, 11.4% having 5–10 years, 8.1% having 11–15 years, 8.1% having 16–20 years, 24.3% having 11–15 years, 21.3% having 16–20 years, 32.7% having 21–25 years, and 13.8% having more than 25 years of teaching experience.

3.4 Statistical analysis

The collected data followed a normal distribution, and a series of analyses were conducted using SPSS 26 software. Firstly, independent samples t-tests were conducted using SPSS 26.0 to examine the OSRL abilities of K12 teachers across different demographic categories, including gender and region. Subsequently, ANOVA was employed to investigate differences in OSRL abilities among primary, middle, and

high school teachers. A significance level of $p < 0.05$ was considered statistically significant. Lastly, Pearson correlation analysis was undertaken to explore the relationships between K12 teachers' OSRL abilities and their education qualifications as well as years of service.

4 Results

4.1 K-12 teachers' responses on the OSRL

To address our first research question, we conducted a descriptive statistical analysis on the collected valid data about various dimensions of OSRL among K-12 teachers, as reported in Table 1. Among the five dimensions, OLSE exhibited the lowest level of personal perception ($M = 4.02$, $SD = 0.87$), followed by OLMS ($M = 4.11$, $SD = 0.63$). The mean of OLRM ($M = 4.28$, $SD = 0.68$) was slightly higher than that of OLMS. Conversely, OLM ($M = 4.73$, $SD = 1.40$) and OLCS ($M = 4.68$, $SD = 1.04$) exhibited the highest and second-highest mean levels of personal perception, respectively.

4.2 The comparisons of K-12 teachers' OSRL by gender, region, educational stage

To address research question 2, independent samples t-tests were employed to analyze the differences in OSRL levels among K-12 teachers of different genders (male = 1, female = 2) and regions (urban = 1, rural area = 2). Additionally, ANOVA was used to analyze differences in OSRL among K-12 teachers across various educational stages (primary school teachers = 1, middle school teachers = 2, high school teachers = 3). The findings showed no notable distinction in OSRL dimensions between male and female K-12 teachers. However, a notable finding emerged from the independent samples t-test, revealing a significant difference in OLSE between urban and rural K-12 teachers, as depicted in Table 2. The mean scores of OLSE for urban K-12 teachers ($M = 4.12$) were higher than those of rural K-12 teachers ($M = 3.86$).

The results of the variance analysis of OSRL for K12 teachers are shown in Table 3. We found the OLSE and OLM of high school teachers were higher than that of primary school teachers ($F = 6.50$, $p < 0.05$, $F = 3.90$, $p < 0.05$), but there were no significant differences between high school teachers and middle school teachers. On the other hand, the high school teachers have higher OLSE and OLM. High school teachers are more willing to participate in online learning, and they are confident in the functionality of the platform, online communication, technology integration, and the ability to complete online learning tasks very well.

TABLE 1 Descriptive analysis of K-12 teachers' OSRL.

Variables	N	Mean	SD	Range
OLSE	1,443	4.02	0.87	1.00–7.00
OLM	1,443	4.73	1.40	1.00–7.00
OLCS	1,443	4.68	1.04	1.00–7.00
OLMS	1,443	4.11	0.63	1.00–7.00
OLRM	1,443	4.28	0.68	1.00–7.00

SD, standard deviation.

4.3 Correlations between K-12 teachers' education qualifications/years of service and OSRL

To address research question 3, we conducted an analysis examining the correlation between education qualifications and years of service with OSRL among K-12 teachers. Among the respondents, 10.1% held an associate degree ($n = 146$), 81.5% held a bachelor's degree ($n = 1,176$), and 8.4% held a graduate degree ($n = 121$). To elucidate the relationship between education qualifications and OSRL among K-12 teachers, separate Pearson correlation analyses were performed. The correlations between education qualifications and OSRL among K-12 teachers are outlined in Table 4. Results showed a positive correlation between education qualifications and OLSE (correlation coefficient = 0.129, $p < 0.01$), while no significant correlation was observed with the other four dimensions. In essence, these findings suggest that as education qualifications advance, K-12 teachers exhibit heightened self-efficacy and confidence in online learning endeavors.

The years of service among K-12 teachers were categorized into six groups: 0–5 years, 6–10 years, 11–15 years, 16–20 years, 20–25 years, and more than 25 years. To facilitate analysis, the years of service were converted into virtual continuous variables, represented by the corresponding numerical values: 1, 2, 3, 4, 5, and 6, respectively. Table 5 displays the correlations between years of service and OSRL among K-12 teachers. Results revealed a significant negative correlation between years of service and OLSE (correlation coefficient = -0.126 , $p < 0.01$), with no significant correlation observed with other dimensions. This finding suggests that K-12 teachers with longer teaching experience tend to be older and may possess weaker network operation skills compared to younger teachers, which could impact their confidence in online learning to some extent.

5 Discussion

5.1 Low dimensions of K-12 teachers' perception of OSRL

The results of this study indicate that the mean scores of K-12 teachers' OSRL across dimensions range between 4 and 5 on a seven-point scale. Among the five scales of the OSRL survey, they scored relatively lower on the OLSE, OLMS, and OLRM compared to others. According to the relevant research on teachers' OLSE, researchers proposed that teachers' OLSE is changeable and can be developed through teacher training (Michalsky, 2021; Karlen et al., 2023). To potentially augment K-12 teachers' OLSE, teacher educators can implement a range of strategic approaches. Initially, teacher educators should consider continuously integrating various online professional development plans tailored to K-12 educational professionals based on the characteristics and evolving trends of K-12 teachers' OSRL. This deliberate incorporation ensures a sustained exposure of K-12 teachers to technology-enhanced learning modalities across the duration of the program (Liu et al., 2021; Basaran and Yalman, 2020). Subsequently, teacher educators can proffer targeted support mechanisms for K-12 teachers engaged in online learning endeavors. These mechanisms encompass the facilitation of online learning partnerships, the management of online learning materials, the provision of timely

TABLE 2 Comparisons of K-12 teachers' scores of OSRL between different regions.

Variables	Region	N	Mean	SD	T	p
OLSE	Urban(1)	858	4.1235	0.86732	5.804	0.000**
	Rural(2)	585	3.8570	0.83994	5.840	0.000**
OLM	Urban(1)	858	4.7122	1.41790	−0.606	0.545
	Rural(2)	585	4.7579	1.39356	−0.608	0.544
OLCS	Urban(1)	858	4.6946	1.04728	0.657	0.512
	Rural(2)	585	4.6581	1.02271	0.660	0.510
OLMS	Urban(1)	858	4.0959	0.62613	−1.276	0.202
	Rural(2)	585	4.1392	0.64436	−1.269	0.205
OLRM	Urban(1)	858	4.2823	0.66801	0.192	0.848
	Rural(2)	585	4.2753	0.69648	0.190	0.849

* $p < 0.05$; ** $p < 0.01$.

feedback on learning progress, and the mitigation of the apprehension and uncertainty inherent in K-12 teachers' online learning experiences arising from the technological milieu. By perpetually bolstering K-12 teachers' confidence in online learning and refining their self-efficacy in this domain, teacher educators can cultivate a more proficient cadre of practitioners adept at leveraging digital platforms for learning and teaching.

Besides OLSE, the OLMS and OLRM of K-12 teachers are relatively low. The OLMS refers to K-12 teachers' self-planning, self-monitoring, and management and regulation of online goal setting, and learning process. This aligns with certain findings derived from prior research. Existing research has found that adults can monitor and reflect on their strategy usage. However, there is still a lack of metacognitive knowledge, especially in online learning environments (Anthonysamy et al., 2020). Some researchers support that the utilization of OLMS among adults is still relatively limited (Hashemyolia et al., 2015; Moreno-Marcos et al., 2019). A wealth of research indicates that OLMS is a crucial dimension of learners' OSRL abilities, significantly impacting online learning performance (Shen and Liu, 2011; Cho and Heron, 2015; Goradia and Bugarcic, 2017; Dumford and Miller, 2018).

The OLRM primarily involves the strategic scheduling of online learning time, effective effort management, and seeking assistance when facing challenges. Observed differences in the application of OLRM strategies have been noted across traditional and online learning settings (Broadbent and Poon, 2015). The effectiveness of resource administration strategies may differ between traditional and online settings. Learners transitioning from traditional to online environments may encounter unfamiliar challenges, potentially requiring adjustments in their approach to resource management strategies. For example, when learners encounter learning difficulties in a traditional setting, they can easily seek help from teachers and peers. However, in an online learning context, interactions between teachers and learners, as well as among learners themselves, occur asynchronously in terms of time and space. Learners seeking help from teachers and peers may not receive feedback as promptly. Moreover, some learners may not know how to utilize online tools to seek assistance (Broadbent, 2017; Anthonysamy et al., 2020).

Therefore, K-12 teachers can be supported through targeted interventions in online professional development programs to

promote the development of OLMS and OLRM. Educational administration departments should establish avenues for K-12 teachers to enhance their knowledge, skills, and practical experience, enabling them to effectively acquire and refine OLMS (Anthonysamy et al., 2021; Kasalak and Dağyar, 2020). Additionally, we recommend that online learning platforms integrate intelligent feedback systems and real-time assessment tools, while visually presenting K-12 teachers' learning paths and role models to encourage reflection on their online learning and timely adjustments to their learning pace. Support teachers can provide scaffolding for K-12 teachers engaged in online learning, such as learning plan prompts, reflection frameworks, and personalized learning path recommendations, to continuously enhance their OLMS. Moreover, teacher educators should focus on improving K-12 teachers' OLRM by utilizing intelligent agents, recommending learning partners, offering time management tools, and providing regular learning reminder emails to strengthen their OLRM abilities.

5.2 Comparison of K-12 teachers' OSRL by gender, region, stage

The findings of this study indicate that gender does not significantly influence the OSRL abilities of K-12 teachers. The previous research findings regarding whether gender affects learners' SRL have been inconsistent. Some studies have found no gender disparities in SRL among US or Turkish samples (Aydoğmuş and Ibrahim, 2022; Liu, 2017). Existing literature examination reveals a consistent trend where past studies on students frequently indicate that females exhibit higher levels of self-regulated learning abilities than males, especially in traditional learning environments (Wang et al., 2022; Zheng et al., 2022). Furthermore, K-12 teachers have been exposed to pedagogical training and instructional methodology throughout their professional development, a distinction that sets them apart from students (De Smul et al., 2018). The variability in research conclusions can primarily be ascribed to differences in study populations and their respective educational environments, encompassing both online and traditional learning settings (Cheng et al., 2023).

The results of the differential analysis suggest that there are disparities in OLSE between urban and rural K-12 teachers, with urban teachers demonstrating higher levels compared to their rural counterparts. In alignment with the viewpoints of existing research, some studies suggest that due to remote geographical locations and inadequate hardware facilities, rural K-12 teachers exhibit relatively lower levels of OLSE. This is reflected in their lack of confidence in utilizing technology for both learning and teaching purposes (Kellerer et al., 2014; Ogodo et al., 2021). Some researchers believe the online learning experience of learners can influence their OLSE (Moos and Azevedo, 2009; Peechapol et al., 2018). Meanwhile, the simplicity and user-friendliness of the online learning platform, along with learners' digital literacy, can influence their OLSE (Prior et al., 2016; Tsai et al., 2011; Yeşilyurt et al., 2016). Additionally, students' digital literacy also impacts K-12 teachers' OLSE in rural areas, where online interactions rely on digital tools. Teachers must not only possess strong digital skills but also address disparities in student proficiency (Xu et al., 2023). In rural regions, limited access to devices and technology often leads to lower student digital literacy, which may undermine teachers'

TABLE 3 Comparisons of K-12 teachers' scores of OSRL among three educational stages.

Variables	Primary school teachers (N = 498) (M, S.D.)	Middle school teachers (N = 496) (M, S.D.)	High school teachers (N = 449) (M, S.D.)	F(ANOVA) Scheffe Test	
OLSE	(3.93,0.859)	(4.00,0.801)	(4.13,0.930)	6.498*	(3) > (1)
OLM	(4.62,1.308)	(4.71,1.390)	(4.87,1.520)	3.917*	(3) > (1)
OLCS	(4.64,0.991)	(4.63,1.020)	(4.67,1.037)	3.487	
OLMS	(4.12,0.629)	(4.09,0.576)	(4.13,0.698)	0.603	
OLRM	(4.32,0.663)	(4.23,0.644)	(4.30,0.732)	2.392	

* $p < 0.05$; ** $p < 0.01$.

confidence in delivering effective online instruction (Kellerer et al., 2014).

Therefore, the measures are required to enhance K-12 teachers' OLSE, with a particular emphasis on rural K-12 teachers. This involves improving hardware facilities in rural schools and implementing online learning support strategies to aid rural K-12 teachers in boosting their OLSE.

Data analysis indicates that high school teachers demonstrate significantly higher levels of OLSE and OLM compared to their counterparts in primary education. Self-reports from high school teachers suggest a prevalent perception that their professional responsibilities are demanding, often necessitating extended hours on campus each day. They perceive online learning as offering flexible scheduling, which minimally disrupts their routine teaching duties. Furthermore, in high schools, there is a relatively higher proportion of young teachers with advanced education qualifications, combined with their proficient use of information technology, which notably contributes to the cultivation of their self-efficacy and motivation towards online learning.

On the other hand, in primary school settings, the developmental stage of students may require the adoption of hands-on and personalized teaching methods. Overcoming challenges associated with young students, coupled with limitations on the use of computer devices in the classroom to protect children's visual health, typically restricting teachers' use of technology to no more than 20 min. Consequently, these limitations on accessing and applying online resources may impact the self-efficacy and motivation of primary school teachers in online learning.

5.3 K-12 teachers' OSRL in relation to education qualifications and years of service

The correlation results of this study indicate that the teachers' education qualifications are positively correlated with OLSE. That is, K-12 teachers with higher qualifications tended to perceive themselves as having higher levels of OLSE. In this study, survey data demonstrates that among the 121 teachers with graduate degrees, 109 are high school teachers, accounting for as much as 90%. This reciprocal validation reinforces the conclusion drawn from our study, suggesting that high school teachers demonstrate a high level of OLSE. Moreover, this conclusion is also consistent with previous research. Prior studies have shown that K-12 teachers with advanced education qualifications

tend to exhibit higher levels of OLSE and are perceived as more proficient in effectively integrating technology into teaching and learning practices (Liang et al., 2013; Lee et al., 2020; Peechapol et al., 2018).

Results showed a negative association between K-12 teachers' years of service and OLSE, suggesting that teachers with more teaching experience in K-12 settings tend to exhibit lower levels of personal confidence in OSRL. This finding aligns with prior research, which has similarly observed a negative relationship between technology-related self-efficacy and either years of service or age (Lin et al., 2018; Cardullo et al., 2021). Concurrently, K-12 teachers with longer years of teaching experience typically correspond to older individuals. These teachers have amassed substantial teaching experience and refined pedagogical techniques. However, their receptivity to emerging technologies diminishes, and they encounter greater challenges in adapting to new tools, environments, and online resources (Pham et al., 2023).

In future online teacher professional development programs, we anticipate a focused emphasis on the K-12 teachers with long years of teaching experience, particularly those situated in rural areas, to furnish them with timely online learning support and assistance. This proactive approach aims to mitigate the challenge of inadequate online self-regulated learning abilities stemming from diminished online learning efficacy.

6 Conclusion

This study validated a survey aimed at assessing K-12 teachers' OSRL abilities. The obtained five-factor structure indicates the survey's validity and reliability in profiling K-12 teachers' OSRL. Additionally, survey findings revealed that K-12 teachers' perceptions of OLSE score the lowest, followed by OLMS, and then OLRM. OLSE emerges as a critical factor influencing K-12 teachers' OSRL abilities. Urban K-12 teachers demonstrate higher OLSE abilities compared to rural counterparts, while high school teachers exhibit higher OLSE and OLM scores compared to primary school teachers. Moreover, there is a positive correlation between education qualifications and K-12 teachers' OLSE, while there is a negative correlation between years of service and K-12 teachers' OLSE. This study further discusses the aforementioned findings and offers insights and recommendations. Our research provides evidence and novel perspectives for conducting targeted online professional development programs tailored to K-12 teachers' needs.

TABLE 4 The correlation between the subscales of the OSRL survey and K-12 teachers' education qualifications.

	OLSE	OLM	OLCS	OLMS	OLRM
Degree	0.129**	0.016	0.005	0.044	0.030

* $p < 0.05$; ** $p < 0.01$.

TABLE 5 The correlation between subscales of the OSRL survey and years of service among K-12 teachers.

	OLSE	OLM	OLCS	OLMS	OLRM
Years of service	-0.126**	0.044	0.001	0.015	0.019

* $p < 0.05$; ** $p < 0.01$.

7 Limitations and future research

It is acknowledged that this study has limitations. First, the samples from Northeast China were primarily selected to explore K-12 teachers' OSRL abilities. While this region possesses rich cultural and social backgrounds that offer valuable insights for research, relying solely on samples from this region does pose certain limitations. There are significant differences in economic development, cultural customs, social structure, and other aspects between Northeast China and other regions, which may limit the applicability of research conclusions in other regions. In the future, the geographical scope of the samples should be broadened. During sample selection, the geographic distribution of samples should be expanded to cover as many different regions in China as possible. Furthermore, when conditions permit, the number of samples should be increased as much as possible to strengthen the statistical power of the study. This can be achieved by broadening the survey scope, extending the survey duration, or adopting more efficient data collection methods.

Second, it is a potential limitation that mainly self-reporting instruments were used to assess K-12 teachers' OSRL. While surveys are an effective means of data collection, they may not fully capture the complexity and multifaceted nature of the research question. Future studies should consider incorporating a variety of research methods. For instance, cross-sectional research can capture sample characteristics at different points in time, offering a broader understanding of the factors influencing the development of online self-regulated learning abilities among K-12 teachers and generating more comprehensive data.

This study has discovered that OSRL abilities are crucial for the professional development of K-12 teachers and contribute to their ability to cultivate students' OSRL skills in teaching practice. Investigating the OSRL abilities of K-12 teachers not only expands the research scope of self-regulated learning but also provides essential evidence for enhancing the OSRL proficiency of K-12 teachers. In turn, this can assist teacher educators in designing effective online teaching support to enable K-12 teachers with diverse backgrounds to develop their OSRL abilities. In-depth research in this area will help fill existing gaps in academic literature, promote the professional development of teachers within online teaching environments, and offer stronger support for students' academic achievements.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Science and Technology Ethics Committee of Changchun Normal University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

YZ: Conceptualization, Data curation, Investigation, Writing – original draft. YL: Data curation, Investigation, Writing – original draft, Writing – review & editing. ZS: Supervision, Writing – review & editing. QJ: Conceptualization, Formal analysis, Methodology, Writing – review & editing. SZ: Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2024.1463287/full#supplementary-material>

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Fostering self-regulated learning using synchronous or asynchronous digital learning environments: a latent profile analysis of pre-service teachers' individual differences

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Self-regulated learning (SRL) is positively associated with improved learning achievements during all educational phases. Despite playing an important role in conveying SRL strategies to their students, pre-service often lack knowledge about SRL and imparting it. Therefore, addressing SRL and teaching SRL strategies to students seems relevant to pre-service teacher training. The present study aims to analyze pre-service teachers' SRL profiles in asynchronous and synchronous digital learning environments and compares their influence on training effectiveness. As part of a pre-post design, a total of $N = 141$ pre-service teachers participated in the study, and questionnaires on SRL strategy use and an SRL knowledge test were used. A latent profile analysis indicated a three-class solution (low, moderate, high SRL), revealing significant differences regarding SRL strategy use but not for SRL knowledge. These findings enable a person-centered approach to develop digital learning environments and provide insight into specific learner behavior.

KEYWORDS

digital learning environment, self-regulated learning, teacher education, synchronous learning, asynchronous learning

1 Introduction

Digital learning environments are platforms or applications providing learning material that enable students to study course contents remotely, often on their terms, with or without direct monitoring by the teacher (Arguel et al., 2017; Kümmel et al., 2020). Current research suggests that digital learning environments can positively impact learning (Clark et al., 2016) by, e.g., motivating learners (Chang et al., 2017). They also offer the advantage of reaching many people at the same time. Digital learning environments are particularly suitable for teaching interdisciplinary skills on which students can work regardless of time and location (Broadbent et al., 2020). One of these interdisciplinary skills is self-regulated learning (SRL), the ability to plan and regulate thoughts, feelings, and actions during the learning process, to achieve previously set learning goals (Zimmerman, 2000). SRL comprises cognitive, motivational, and metacognitive components (Boekaerts, 1999): Cognitive components include conceptual and strategic knowledge and the ability to apply appropriate learning strategies. Motivational components include activities to initiate and sustain learning.

Metacognitive components comprise planning, self-monitoring, and reflection on one's own learning process (Boekaerts, 1999).

On the one hand, SRL is a competency that can be fostered directly or indirectly. Direct promotion of SRL often includes the impartation of specific SRL strategies and knowledge via training programs led by trained teachers. In this case, the learners are aware that they are explicitly learning SRL strategies. Indirect promotion is often unconscious and can occur, for example, by providing a learning environment that provides the possibility for SRL but does not instruct the use of SRL strategies explicitly (Dignath and Veenman, 2021). On the other hand, SRL is an essential prerequisite for successful learning in digital environments (Broadbent and Poon, 2015) where learners often work independently. Since they often have limited interaction with lecturers, learners must use SRL strategies to determine with which learning materials to engage, and when (Broadbent et al., 2021; Kizilcec et al., 2017). Research has shown that students who possess self-regulation skills are more likely to succeed in digital learning environments and complete tasks without interruption compared to those who lack these skills (Alhazbi and Hasan, 2021; Cho and Shen, 2013; Lee and Choi, 2011). It has been observed that SRL positively affects learning in all educational domains (Dent and Koenka, 2016) which is why SRL should be fostered as early as possible. Pre-service teachers are particularly relevant to supporting their students' SRL, but they require skills to promote the construct among students. They often lack knowledge about teaching SRL strategies (Gloger-Frey et al., 2018). Therefore, promoting SRL among pre-service teachers as early as possible is crucial, to develop the necessary skills to teach their students explicit learning strategies and serve as a model for their implementation in the classroom (Peeters et al., 2014).

Digital learning environments are an ideal platform for providing pre-service teachers with SRL strategies in an adaptable way. Designing effective digital learning environments requires considering students' individual needs for successful learning. A person-centered approach seems suitable to fulfill this requirement because individual learning profiles can be analyzed and provide a basis for future learning environments. Hence, this research aims to examine individual SRL characteristics of pre-service teachers in two digital learning environments—asynchronous e-learning and synchronous online seminar—and to compare the effectiveness of the training regarding the acquisition of SRL strategies and SRL knowledge.

2 Theoretical background

2.1 Self-regulated learning

SRL is “a process whereby learners activate and sustain cognitions, affects, and behaviors that are systematically oriented towards the attainment of personal goals” (Zimmerman, 2011, p. 1). SRL is a proactive process that demands a high level of SRL strategy use (Zimmerman, 2008). Furthermore, it is a general interdisciplinary competency that supports students in planning, implementing, and reflecting on their learning processes and functions across various disciplines (Bembenutty, 2011). Models for describing SRL distinguish between component and process models. SRL contains cognitive, metacognitive, and motivational components that component models entail (e.g., Boekaerts, 1999). In contrast to component models that focus on constituent parts of SRL, Zimmerman's (2000) social cognitive

model of SRL depicts it as a cyclical process, dividing the learning process into different phases that represent the central components of self-regulation. Due to the consideration of SRL's different components as well as its circularity, Zimmerman's (2000) model is the most popular model for intervention studies and also the basis for the intervention in the present study, and the following section describes it further.

2.1.1 Social cognitive model of SRL

Zimmerman (2000) divides the learning process into three phases: forethought, performance, and self-reflection. These involve cognitive, metacognitive, and motivational components. The cyclical character of SRL is due to the phases occurring sequentially and previous learning processes impact prospective strategy use.

The “forethought phase” represents the first phase of the learning process. Initially, learners set goals, plan their behavior, and choose adequate learning strategies (metacognitive component) that seem beneficial for reaching the desired goals. Moreover, learners must motivate themselves to start the learning process. One important motivational component is self-efficacy, the self-belief that one can master the requirements to solve the task (Bandura, 2006), which often determines the ability to self-motivate (motivational component). If self-efficacy for a specific task is at a high level, starting the task is highly probable.

The “performance phase” refers to the actual learning activity. Cognitive strategies, such as repeating and organizing, particularly help to consolidate acquired knowledge by integrating new information into existing cognitive structures (cognitive component). In this phase, motivational strategies play an important role in maintaining the learning process. Learning can only continue if learners can motivate themselves sufficiently (Alhazbi and Hasan, 2021), have enough volitional strategies to protect themselves from distractions and focus their attention (Dörrenbächer and Perels, 2015; Valenzuela et al., 2020; motivational component). Throughout the whole learning process, learners must self-control their actions to adapt their strategy use if necessary. Self-observation is one essential metacognitive strategy that enables learners to adjust their learning behavior in case of a discrepancy between their goals and the current state (De Bruin and van Gog, 2012). By monitoring the learning process, learners identify the learning strategies that have proved less effective and consequently merit dismissal (metacognitive component).

In the following “self-reflection phase,” learners undertake a self-evaluation by contrasting forethought phase goals with the achieved results (metacognitive component). This comparison entails a selection of productive strategies for prospective learning and a refusal of strategies that did not prove successful and/or an adaptation of goals because the initial goals turned out to be unrealistic (Zimmerman, 2000). For this reason, learners must be able to evaluate their achievements, which closely links to causal attribution (Brun et al., 2021). In terms of self-regulated learning, an internal variable attribution would be the most suitable because it promotes learners' perception of responsibility and controllability. Different options exist for a self-reaction of the learning results. Self-satisfaction with one's own abilities has turned out to be beneficial for learners, resulting in increased self-efficacy. All in all, the successful accomplishment and positive evaluation of a task consolidate the learner's self-motivational beliefs and outcome expectations, causing positive emotions (motivational component)—for example, pride—to impact the choice of strategies in the proximate forethought phase (Zimmerman, 2000).

2.1.2 Pre-service teachers' SRL

Pre-service teachers' self-regulation ability and the use of different SRL strategies should be examined separately. The ability to self-regulate requires declarative knowledge of SRL, defined as "facts, figures, rules, relations" (Cooke et al., 2000, p. 153) about SRL as well as procedural knowledge of SRL ("procedures, sequences and actions required for task performance," Cooke et al., 2000, p. 153). Given that procedural knowledge is difficult to operationalize, this study is focused on declarative knowledge of SRL. However, declarative knowledge of SRL and the use of SRL strategies should be differentiated, since knowledge of SRL strategies does not imply their use (Dörrenbächer-Ulrich et al., 2021; Foerst et al., 2017).

Regarding declarative SRL knowledge, research indicates that pre-service teachers' declarative knowledge of SRL strategies is often fragmented (Lawson et al., 2019) and disorganized (Ohst et al., 2015). Furthermore, some pre-service teachers demonstrate bad-quality metacognitive strategy knowledge (Glogger-Frey et al., 2018), leading to ineffective teaching of SRL strategies. Accordingly, they seldom use SRL strategies spontaneously (Engelmann et al., 2021), or use those that are less effective (Fryer and Vermunt, 2018). Consistent with these findings, Lawson et al. (2019) suggested that pre-service teachers may not be aware of the effectiveness of their SRL strategies and, thus, do not use them or may interrupt their strategy use too early.

Regarding SRL strategy use, successful learners utilize effective learning strategies to achieve their goals (Perry et al., 2018), using not more but more varied SRL strategies than less successful learners (Nandagopal and Ericsson, 2012). Increased strategy use results in deeper information processing and more effective learning. In a study with 366 pre-service teachers, Vosniadou et al. (2021) found a positive relationship between cognitive and metacognitive strategies and academic achievement. Furthermore, there is evidence that pre-service teachers use few SRL strategies to manage their learning (De Bruin and van Merriënboer, 2017).

Pre-service teachers play a crucial role in supporting their students' SRL, but they need to possess the skills necessary to promote this construct among their students. As teachers, they can aid students' SRL development in various ways, including creating challenging assignments, granting independence in decision-making, or providing opportunities for self-evaluation (Dignath and Veenman, 2021). Pre-service teachers not only impart knowledge directly to their students but also serve as role models who use SRL strategies themselves (Peeters et al., 2014). This makes them essential for helping students acquire declarative SRL knowledge and learn how to use SRL strategies effectively. According to Buzza and Allinotte (2013), pre-service teachers who possess good SRL skills are more likely to understand the concepts related to promoting SRL. In addition, Gordon et al. (2007) showed that teachers who have good SRL skills are more likely to create a classroom environment that supports their students' SRL by encouraging mastery-oriented learning. Therefore, promoting SRL among pre-service teachers is crucial for developing their teaching skills and modeling SRL to their students as early as possible.

2.2 Digital learning environments

Digital learning environments provide different formats for conveying knowledge. Their lack of physical encounters magnifies the important role of communication. Learning can involve distinguishing

between synchronous and asynchronous communication. The real-time interaction of the instructor with the learners characterizes synchronous communication (Alhazbi and Hasan, 2021; Amiti, 2020; Shahabadi and Uplane, 2015). Synchronous technologies, e.g., video conference or live chat, enable carrying out this purpose (Giesbers et al., 2014; Watts, 2016), facilitating online instruction and learner-oriented interaction (Shahabadi and Uplane, 2015). Conversely, asynchronous communication occurs independent of time, enabling non-simultaneous participation of the instructor and the learners (Amiti, 2020). The instructor prepares educational material, and communication occurs via asynchronous technologies, such as discussion boards, email, or assessments (Alhazbi and Hasan, 2021; Reese, 2015; Watts, 2016). Both communication methods offer advantages that the next section discusses.

2.2.1 Synchronous digital learning environments

In synchronous digital learning environments, a direct interaction between instructor, learner, and peers occurs. This causes a feeling of collaboration and increases the information flow in the team (Hrastinski et al., 2010). The learners feel less isolated from the instructor and their peers (Amiti, 2020; Francescucci and Rohani, 2019), leading to increased individual participation and more intense interaction (Hrastinski, 2008). This allows for instant feedback among learners and teachers, which may leave less time for reflection but does allow for direct correction of misconceptions (Giesbers et al., 2014). In her literature review, Watts (2016) summarized 24 papers and concluded that synchronous online interactions positively impacted students' engagement in an online learning environment, due to instant feedback and interaction. Despite high-level social interaction in synchronous learning environments, introverted students may participate more because they feel comfortable and less stressed, due to the spatial distance (Amiti, 2020). Communication in synchronous learning environments is faster and more convenient than in asynchronous digital learning environments. A study by Oztok et al. (2013) examined both synchronous chats and asynchronous forums, with 222 university students from a Canadian university. The research found that synchronous messages tend to be shorter, contain more social language, and are easier to read than asynchronous messages. Synchronous learning is well-suited for group projects since synchronous tools offer a high level of media richness that facilitates a deeper learning process (Rockinson-Szapkiw and Wendt, 2015). Additionally, synchronous communication is suitable for socializing, organizing activities, and discussing less complex tasks (Duncan et al., 2012).

2.2.2 Asynchronous digital learning environments

In asynchronous learning environments, learning is time-independent, which benefits students with different learning paces and strategies (Kim et al., 2018; So, 2016). Students must manage their learning but can work at their own pace (Broadbent and Poon, 2015). Asynchronous communication leads to increased engagement with the learning material (Alhazbi and Hasan, 2021; Watts, 2016) because learners have more time available for interacting with, processing, and reflecting on the learning content (Lucas et al., 2014). For example, the ability to pause video lectures reduces cognitive load and leads to deeper processing of the material, due to increased time on task (Nieuwoudt, 2020). Asynchronous messages in a digital learning space use more academic language and are longer than private synchronous

messages, providing increased opportunities for peer interaction due to more reflective content (Oztok et al., 2013). More time spent on writing longer messages encourages reflection as well as the presentation of complex issues (Hrastinski et al., 2010). Researchers suggest using asynchronous interactions for group work, particularly when complex content requires reflection before posting (Griffiths and Graham, 2010; Watts, 2016). A study by Hrastinski (2008) examined the learning outcomes of Swedish and Argentinian students in two synchronous and two asynchronous learning environments. The researcher conducted the study over four weeks and focused on the topic of knowledge management. The study found that asynchronous learning environments led to increased cognitive participation. When students have time to reflect on a problem and construct their response instead of giving a spontaneous answer, they can engage in critical thinking and produce better-quality responses, resulting in higher cognitive achievement than synchronous learning produces (Ogbonna et al., 2019). Given that asynchronous learning involves less personal interaction with peers and does not require spontaneous reactions, this type of communication could especially suit introverted or shy learners (Amiti, 2020).

To summarize, both synchronous and asynchronous learning environments can promote learning but require different learning strategies (Shahabadi and Uplane, 2015) and the ability to self-regulate the learning process.

2.3 Self-regulated learning in digital learning environments

SRL plays an important role when it comes to learning in synchronous or asynchronous digital environments and can be seen twofold: On the one hand, SRL is an essential prerequisite for successful learning in digital learning environments, on the other hand, relevant research indicates that SRL is a fosterable skill in university students (Theobald, 2021). The next chapters provide an overview of SRL double role for learning in digital learning environments.

2.3.1 SRL as a prerequisite for learning in digital environments

Learning in digital learning environments differs from learning in analog settings because the self-contained work on online assignments requires students to plan, monitor, and evaluate their learning process. Time management, critical thinking, metacognitive strategies, and other self-regulating learning processes have proved particularly effective in enhancing learning outcomes in those environments (Broadbent and Poon, 2015), making SRL essential for successful online learning. Due to the high degree of autonomy in digital learning environments, learners must independently plan, engage with, and reflect on learning material while staying motivated (Barnard-Brak et al., 2010; Broadbent and Poon, 2015). Current research findings highlight the importance of using SRL strategy in digital learning environments. Highly self-regulated learners have a greater task completion rate (Ainscough et al., 2019) and achieve better results in digital learning environments than their less self-regulated peers (Ning and Downing, 2015). Therefore, SRL is a crucial factor and represents an important prerequisite for successful learning in those environments. Due to the context-bound nature of SRL, individual differences in motivation and learning strategy

use can arise between online and traditional learners (Meijs et al., 2019), calling for more differentiated view on individual learners, for example by using a person-centered approach. Developing a research approach toward a person-centered examination of SRL has occurred by analyzing subgroups of persons with different SRL profiles, to gain insight into different behaviors during learning (Broadbent and Fuller-Tyszkiewicz, 2018). This approach involves cluster or latent profile analysis (LPA) to categorize learners into definite subgroups.

2.3.2 SRL as improvable competence for learning in digital environments

Given the positive correlation between SRL and online academic performance (Cheng et al., 2023), its development among students as early as possible is essential. Teaching pre-service teachers how to teach SRL strategies to their students in the classroom can achieve this. While digital learning environments generally demand SRL, they also provide an opportunity to promote SRL knowledge and SRL strategy use (Zheng, 2016). This is possible through a direct approach, by explicitly presenting learners with specific SRL strategies, or indirectly, by using digital learning environments that require learners to use SRL strategies but that do not encompass explicit training (Dignath and Veenman, 2021).

E-learning environments, as a type of digital learning environment, are “instruction that is delivered via a digital device that is intended to promote learning” (Clark and Mayer, 2016, p. 7), suitable for both direct and indirect promotion of SRL. However, research indicates that the implementation of SRL training can achieve higher-level academic achievement and an increase in student SRL strategy use (Kramarski and Michalsky, 2010). Even if the implementation of most SRL training occurs in analog learning environments, evidence for the promotion of SRL in digital learning environments is growing. The most common SRL training approach is the direct conveyance of SRL strategies.

Two direct SRL e-learning trainings for students were conducted by van der Beek et al. (2020) and Bellhäuser et al. (2016), strengthening the findings that SRL is promotable via e-learning and classroom seminars are comparably effective in promoting SRL. The presented studies obtained promising results in terms of course performance, knowledge of SRL, and its use, implying the promotability of SRL within direct e-learning environments. However, the studies largely neglect the student teachers target group, despite their important role as multipliers of SRL knowledge and strategy use. Alkhasawneh and Alqahtani (2019) provided direct SRL training to $n = 70$ education students from Saudi Arabia. They implemented an e-learning course, with SRL strategies for the experimental group and without SRL strategies for the control group. In comparison to the control group, the findings indicated an increase of SRL and course performance in the experimental group. Dörrenbächer-Ulrich et al. (2019) used e-learning training to directly promote SRL among $n = 57$ pre-service teachers and revealed an increase of SRL traits, especially in the motivational subscale, as well as increased SRL knowledge in the experimental condition.

2.4 Individual differences in SRL

The SRL person-centered approach to detect individual differences is relatively new, resulting in only a few studies on the topic and

ambiguous findings (Ainscough et al., 2019). For instance, researchers have found different numbers of SRL profiles among university students but only a few studies exist that focus on pre-service teachers as a target group:

A two-profile solution with competent and less competent self-regulated learners was revealed by Huang et al. (2021) with $n = 68$ pre-service teachers from an educational college in the United States, who were using an intelligent web browser to design technology lessons. The findings showed that competent learners were superior regarding the quality of designing good lessons.

A three-profile solution was found most often in the current literature for university students (Ainscough et al., 2019; Esnaashari et al., 2023; Lin et al., 2021). The profiles included students using many SRL strategies, referred to as a high SRL profile, students using a medium number of SRL strategies (medium SRL profile), and students using few SRL strategies (low SRL profile). For preservice teachers, a three-profile solution could be confirmed by Heikkilä et al. (2012) and Muwonge et al. (2020).

A four-profile solution was indicated for university students from Great Britain (Araka et al., 2022), Germany (Dörrenbächer and Perels, 2016), and the United States (Schwam et al., 2020). At one end of the range were “exemplary” students as well as “good self-regulators” and students with the profile “poor self-regulators” on the other end. Students with average SRL scores were located in the middle of the range. Unlike Araka et al. (2022), Schwam et al. (2020), and Dörrenbächer and Perels (2016) found an SRL profile that they labeled “conflicting SRL.” These students showed high scores on some subscales (e.g., self-efficacy) but low scores on other subscales (e.g., time-planning) related to SRL.

A five-profile solution was found by Barnard-Brak et al. (2010) in a sample of $n = 279$ university students in the USA. The analyses revealed that the minimal self-regulators had the lowest GPAs, and competent self-regulators had the highest.

The presented findings illustrate different numbers of profiles, based on SRL for university students and pre-service teachers, making a specific decision on the exact number of profiles difficult. The examination of SRL profiles offers insight into learners’ prerequisites, enabling a categorization of SRL competencies. This offers the possibility of promoting a lack of competencies for students with low SRL profiles or adapting learning environments to students with already high-level SRL skills. Furthermore, the SRL profiles provide a more differentiated view of students learning. For example, there could be students who are very motivated but lack the use of metacognitive strategies which could not be revealed in generalized SRL measures.

2.5 The present study

The aforementioned findings show that SRL is a prerequisite for learning in digital environments and, simultaneously, a competency that can be improved in digital learning environments. However, knowledge about learners’ individual differences in SRL is still sparse and studies analyzing students’ SRL profiles provide different numbers of profiles and neglect the special target group of pre-service teachers, raising the need for further investigation. Moreover, the examination of SRL’s promotability due to individual preferences in synchronous and asynchronous learning environments needs further research.

Therefore, the present study examines the following three research questions:

1. Are there different SRL profiles for pre-service teachers and if so, how many?
2. How does an SRL training affect pre-service teachers with different SRL profiles?
3. What are the differences between synchronous and asynchronous learning environments regarding the effectiveness of SRL training for the different SRL profiles?

To examine the research questions, SRL profiles are deduced, based on the participants’ SRL scores divided into cognitive, metacognitive, and motivational SRL components. In the second step, the training effectiveness, represented by increased SRL knowledge and strategy use, is investigated, based on the profiles. Finally, the study examines the influence of the different communication styles (synchronous, asynchronous) on the training effectiveness, depending on the SRL profile.

3 Materials and methods

3.1 Sample

The study involved $N = 145$ pre-service teachers from a university in southwestern Germany. Four participants were excluded from the final sample, due to numerous missing values in the pretest, leaving a total of $n = 141$ participants. The participants were between 20 and 49 years old, with an average age of $M = 24.24$ years ($SD = 4.50$). On average, the participating students were in their seventh semester of studies ($SD = 2.09$). Most participants identified as female ($n = 102$), $n = 37$ identified as male, and one participant reported a diverse gender identity. One person did not provide gender identity information.

3.2 Procedure

The study was conducted following the Declaration of Helsinki, no institutional approval was necessary by local law. We conducted a quasi-experimental study using a pre-post design with two different training conditions—asynchronous e-learning and a synchronous online seminar. Time (pretest and posttest) was measured as a within-subject factor, while training condition was measured as a between-subject factor. We selected the two groups from preexisting compulsory courses in educational science. Each course ($n = 11$) was randomly assigned to one of the two training conditions, though a randomized assignment of single participants was not possible. Thus, we assigned six courses to the asynchronous e-learning condition ($n = 90$), and five courses to the synchronous online seminar condition ($n = 51$). At the start of each course session, a digital online survey was conducted to collect pretest measurements and, after 6 weeks we conducted posttest measurements. Both questionnaires took about 15–20 min to complete, and participation was voluntary and unpaid. All participants confirmed their participation by informed consent, and their data was anonymized using individualized codes. During the six-week period between the measurements, the participants in

the two conditions gained knowledge about SRL and the use of SRL strategies. The participants in the asynchronous e-learning condition received knowledge through an online platform, while the participants in the synchronous online seminar condition received theoretical input and exercises during weekly online classroom sessions led by a course teacher. The content was identical in both conditions; the only difference was the learning environment in which it was presented.

3.3 Intervention

The SRL training intervention occupied a period of 6 weeks in two learning environments, namely, asynchronous e-learning and a synchronous online seminar. Zimmerman (2000) SRL model provided the basis for the training content and materials. Their positive impact on SRL had been evaluated in an analog training program (anonymous authors). To ensure the attribution of the effects to the different learning environments, the same learning content was used in both conditions. Thus, all learning environments covered the whole SRL process with forethought, performance, and reflection phases. Specific SRL strategies became six modules in the e-learning environment and six online sessions in the synchronous online seminar. More detailed information appears in Table 1.

3.3.1 Synchronous online seminar

A trained instructor led the weekly synchronous online seminar using *MS Teams*. Each session had an equivalent structure and aimed at improving one specific SRL strategy at a time. The forethought phase covered sessions one to three. In session one, Zimmerman (2000) SRL model, its phases, and the topic “goal setting” were introduced to the students. The instructor provided theoretical input on goal definition, the SMART method (Doran, 1981), and goal orientation. After receiving the theoretical content, students completed digital worksheets referring to the presented theoretical input by working on their own or in groups. All worksheets were in PDF format and could be filled out digitally. For example, one of the exercises involved using the SMART method (Doran, 1981) to set goals. The second session covered the topic “time management” and provided such strategies as the ALPEN method (Seiwert, 2006) for organizing all the tasks of the day in five steps: Write down tasks, estimate their length, plan buffer time, make decisions, and follow-up on goal achievement. During this session, participants analyzed their daily behaviors and created a personalized weekly schedule based on their findings. The main topic of session three was “self-efficacy and self-motivation.” Participants learned about procrastination and

self-efficacy. They acquired knowledge about different self-motivation strategies, such as creating the feeling of success or finding a personal benefit in doing required work. Participants utilized worksheets to rate their preferred self-motivation techniques. Additionally, they ran a personal self-experiment to observe the physical effects of self-efficacy on their own bodies.

The performance phase occupied sessions four and five. In session four, the topic was “stress and concentration.” Participants were taught about the SORK Model (Kanfer and Saslow, 1969), which explains how stress develops. Strategies to reduce stress were discussed, including progressive muscle relaxation and cognitive reframing. The session further covered activities to improve concentration. Worksheets guided participants in relaxation and concentration exercises, on their own or with a partner. During session five, which focused on learning strategies, the instructor presented the method of Loci and the technique of mind-mapping. Participants had the chance to practice these strategies through various exercises and worksheets provided during the session.

The reflection phase was the subject in session six, focusing on “self-reflection and causal attribution.” The theoretical content included information about causal attribution theory, along with the benefits and disadvantages of self-reflection. In this session, worksheets were used to explore participants’ own attributional patterns and reference norm orientation.

3.3.2 Asynchronous e-learning environment

The e-learning environment was implemented as a digital online course via the learning platform Moodle, with the experimenter enrolling participants. The course comprised six modules presented in blocks, and participants had a six-week period in which to complete it. It was possible to finish the course faster. The modules were structured in a fixed order, with access to the subsequent module only granted after completion of the exercises in the previous module. The content was similar to that of the synchronous online seminar condition, to enable comparability. All theoretical content appeared as digital text in different chapters. All worksheets were also provided in fillable PDF format and, upon completion, uploaded on Moodle to finish the exercise.

To summarize, both learning environments used the same learning material but differed in the presence of a course teacher (yes/no) and the communication style (seminar = synchronous, e-learning = asynchronous) for learning.

3.4 Measurement instruments

To comprise all relevant information for predicting student profiles, the self-reported use of SRL strategies was assessed. To examine the impact on the training gains, we also assessed participants’ declarative SRL knowledge.

The self-reported use of SRL strategies was measured with the SRL questionnaire by Dörrenbächer and Perels (2016) containing 56 items and covering all three phases (forethought, performance, reflection) of Zimmerman’s SRL model (2000). Thus, the instrument covered the complete cyclic SRL process. The questionnaire provided an overall score as well as subscale scores for the different components of SRL, examining cognitive, metacognitive, and motivational SRL strategies, produced using a four-point Likert scale (1 = “totally disagree,” 4 = “totally agree”). As Table 2 shows, a high level of reliability for the overall scale as well as the motivational and metacognitive component,

TABLE 1 Overview of the training topics and their classification into different SRL phases and components.

SRL phase	Topic	Component
Forethought	Goal setting	Metacognitive
	Time management	Metacognitive
	Self-efficacy and self-motivation	Motivational
Performance	Stress and concentration	Motivational
	Learning strategies	Cognitive
Reflection	Self-reflection and causal attribution	Metacognitive / Motivational

and acceptable reliability for the cognitive component was achieved in the current sample.

To determine whether participants experienced an increase in declarative SRL knowledge, a knowledge test consisting of 10 open-ended questions, answerable with the course content, was used. For example, the questions covered Zimmerman’s SRL model structure: “Between which three phases does Zimmerman (2000) differentiate in his model of self-regulation?” or causal attribution theory: “Name dimensions which can apply to causal attribution.” A total of 28 points was possible, and a research assistant coded all answers, using a standard sample solution to determine the score for each answer.

3.5 Data analysis

To prepare the following calculations, the data set was checked for outliers, resulting in the exclusion of three persons from the analyses, due to repetitive and implausible answer patterns. Thus, the analyses used a final sample of $n = 138$ participants.

(1) To address the first research question, an LPA (Vermunt and Magdison, 2004) was conducted with MPlus 8.8 (Muthén and Muthén, 2017), to identify an ideal number of profiles based on the scores of the questionnaire’s SRL component subscales. The aim of the LPA was to classify pre-service teachers with similar cognitive, metacognitive, and motivational strategies into homogeneous groups that differ maximally from each other. Following the approach by Ferguson et al. (2020), various models, including different numbers of classes were compared regarding their model fit. The number of classes was examined exploratorily by comparing models until the model with $k + 1$ classes did not lead to a significant improvement of the model fit. The LPA was conducted with the Robust Maximum Likelihood Estimator and the Full Information Maximum Likelihood algorithm, to deal with missing data. To avoid local maxima, we used 100 solutions for stage optimization, 2,000 random starts, and 20 iterations. The fit of the competing models was determined by using adequate statistical fit indices, namely, the Bayesian Information Criterion (BIC), the Akaike Information Criterion (AIC), and the Lo–Mendell–Rubin Test (LMRT), together with entropy (E) as an indicator for classification accuracy (Marsh et al., 2009). Lower values of the BIC and AIC represent a better model fit. The LMRT compares the current model with a $k-1$ class model. A significant p -value indicates a better fit than the model with $k-1$ classes. Entropy should be above the threshold of 0.80 to ensure a satisfactory classification of persons into different groups (Asparouhov and Muthén, 2014). In

addition, we considered the theoretical congruity and the number of assigned participants to each profile. Representative profiles can only be classified if more than 5% of the sample falls into them (Masyn, 2013). The classifications were transferred to IBM SPSS (version 28.0.1). Next, we validated the profiles by examining differences in SRL in the pretest, which were (as expected, due to the LPA) statistically significant.

(2) and (3): To investigate the second and third research questions, ANOVAs with post-hoc comparisons were used to analyze possible differences regarding the training gains for SRL strategy use and declarative SRL knowledge in the different learning environments.

4 Results

Descriptive results and correlations regarding all relevant variables appear in Table 3. Our findings indicate moderate-to-strong correlations among the SRL subscales but no correlation between SRL strategy use and declarative SRL knowledge.

4.1 Research question 1: pre-service teachers’ SRL profiles

The results of the LPA support a three-class solution. For the two-class solution, the entropy was above the threshold of 0.80, and it showed the highest AIC value, compared to the other models. The four-class solution showed a slight increase in the BIC and a decrease in the AIC, compared to the three-class solution. Both models had the same classification accuracy, but the LMRT p -value was significant for the three-class solution and not for the four-class solution. The five-class and six-class solutions showed slightly lower AIC values but higher BIC values than the three-class solution. The p -value was not significant for both models, indicating that the three-class solution showed the best fit to the data. The fit indices for all estimated models appear in Table 4.

Profile 1 included seven participants (5%), forming the smallest profile group of participants with low values on all SRL components. Therefore, we labeled the group “low SRL.” Profile 2 comprised 51 participants (37%), and we labeled it “high SRL” because this second group demonstrated high values on all three SRL components. Finally, most of the participants (58%) were assigned to Profile 3, showing moderate values in the motivational component and low values in the cognitive and metacognitive components. Profile 3 scored much

TABLE 2 Overview of the instruments used and their reliability.

Scale	Number of items	Example	Reliability (Cronbach’s α)
SRL strategy use (overall)	56	“During learning for the course, I pay attention to a schedule.”	0.93
SRL, cognitive component	6	“During learning for the course, I collect information from different sources.”	0.61
SRL, motivational component	27	“Even if the course is difficult, I know that I can pass.”	0.82
SRL, metacognitive component	23	“During learning for the course, I reflect on whether my actions are reasonable.”	0.92
Declarative SRL knowledge	10	“Between which three phases does Zimmerman (2000) differentiate in his model of self-regulation?”	-

SRL = self-regulated learning.

TABLE 3 Correlations, means, and standard deviations of the examined variables for the pretest.

		1	2	3	4	5
SRL questionnaire	1. Overall	–	0.70**	0.91**	0.59**	0.11
	2. Cognitive		–	0.59**	0.34**	0.03
	3. Metacognitive			–	0.45**	0.14
	4. Motivational				–	0.10
SRL knowledge test	5. Declarative SRL knowledge					–
M		2.85	2.58	2.85	3.02	5.20
SD		0.32	0.45	0.43	0.32	5.36

** = $p < 0.001$, M = mean, SD = standard deviation, range questionnaire 0–4, range knowledge test 0–28.

TABLE 4 Fit indices for all estimated models.

Classes	df	BIC	AIC	Entropy	LMRT (p -value)
2	10	340.05	310.78	0.73	<0.001
3	14	320.49	279.51	0.84	<0.001
4	18	326.41	273.72	0.84	0.108
5	22	338.76	274.36	0.87	0.368
6	26	351.80	275.70	0.86	0.816

df, Degrees of freedom; BIC, Bayesian Information Criterion; AIC, Akaike Information Criterion; LMRT, Lo–Mendell–Rubin Test.

TABLE 5 Characteristics of the three SRL profiles and the validation results.

	Low SRL ($n = 7$) M (SD)	Moderate SRL ($n = 80$) M (SD)	High SRL ($n = 51$) M (SD)	$F(2,135)$
Cognitive component	1.80 (0.30)	2.40 (0.30)	2.98 (0.30)	101.15**
Metacognitive component	1.97 (0.28)	2.70 (0.28)	3.22 (0.28)	94.30**
Motivational component	2.40 (0.22)	2.82 (0.22)	3.14 (0.22)	61.09**

Standard deviations are in brackets, n = sample size, ** $p < 0.001$.

higher on all components than Profile 1, so we labeled it “moderate SRL.” Table 5 displays the descriptive statistics for the three profiles regarding the examined SRL components. To validate the profiles, isolated univariate ANOVAs were conducted with each SRL component as a dependent variable and the profiles as an independent variable. As expected, due to the LPA, the findings indicated significant differences between all three profiles regarding all SRL components, with all Scheffé p -values <0.001. There were no significant differences between the profiles regarding declarative SRL knowledge before the intervention ($F(2,135) = 2.26$, $p = 0.109$, $\eta^2 = 0.03$).

To facilitate the interpretation of the findings, we converted the means into z -scores. This standardization enables a comparison of relative divergences between the profiles, in which z -scores larger than 0.5 and smaller than -0.5 are interpreted as extreme values (Liu et al., 2014). A profile plot based on the z -scores appears in Figure 1.

4.2 Research question 2 and 3: differential training effects regarding self-reported SRL strategy use and declarative SRL knowledge

To explore whether there are differences in SRL profiles in relation to self-reported use of SRL strategies and SRL knowledge after the

intervention and to examine whether the learning environment influences learning performance, we conducted two 2 (pretest-posttest)*2(e-learning-online seminar)*3 (profiles) ANOVAs. The profiles and training conditions (asynchronous e-learning, synchronous online seminar) were used as between-subjects factors, time (pretest/posttest) was used as a within-subjects factor, while the SRL strategy use and the SRL knowledge separately were the dependent variables. Table 6 shows the means and standard deviations.

For SRL strategy use, results indicate a significant interaction of time*profile, $F(2,112) = 5.35$, $p = 0.006$, $\eta^2 = 0.10$, hinting at different training gains depending on the profile. Scheffé post-hoc comparisons revealed significant differences between all profiles ($p < 0.001$). There was no significant interaction of time*condition, $F(1,112) = 0.02$, $p = 0.896$, and no three-way interaction of time*condition*profile, $F(2,112) = 0.13$, $p = 0.883$. Figure 2 visualizes the change in self-reported SRL strategy use means after the intervention.

To further analyze the training gains of the different profiles, we conducted Wilcoxon-tests, with the profile as independent variable and the SRL strategy use as the dependent variable. The histograms of difference scores were visually inspected and showed a symmetrical distribution of values for all three profiles, confirming the requirements for the test. For the low SRL profile, $z = 2.03$, $p = 0.043$, and the moderate SRL profile, $z = -3.09$, $p = 0.002$, the SRL strategy use increased significantly. For the high SRL profile, $z = -0.15$,

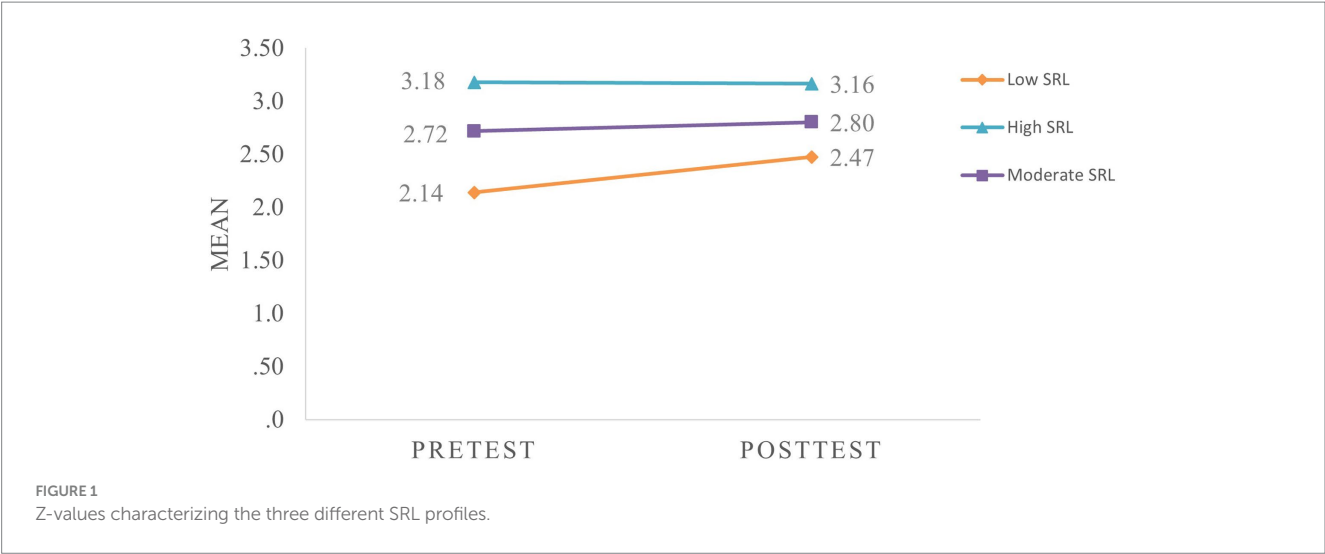
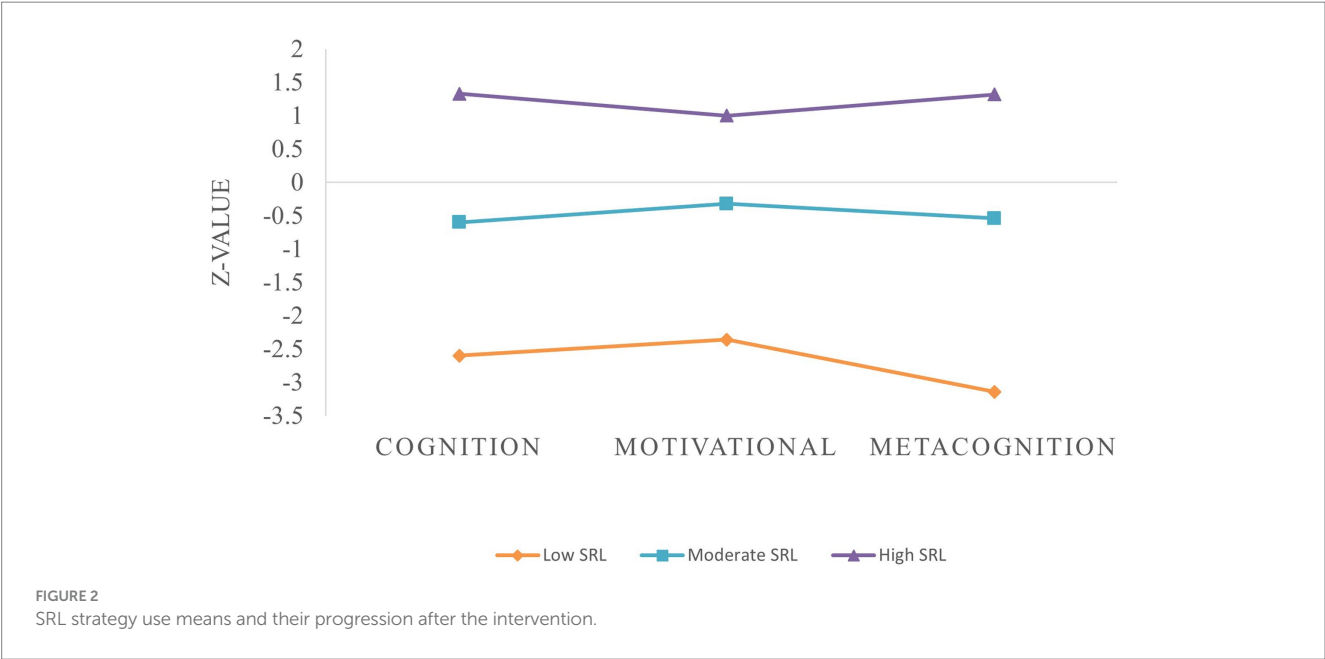


TABLE 6 Descriptive statistics for SRL strategy use and the declarative SRL knowledge.

		SRL strategy use				Declarative SRL knowledge			
		E-learning		Online seminar		E-learning		Online seminar	
Profile	<i>n</i>	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Low	5	2.10 (0.14)	2.43 (0.34)	2.25 (0.05)	2.60 (0.04)	1.40 (2.61)	11.00 (10.05)	3.00 (1.41)	8.00 (11.31)
High	26	3.19 (0.17)	3.17 (0.27)	3.16 (0.22)	3.15 (0.24)	6.21 (5.48)	16.84 (5.11)	5.75 (6.32)	12.78 (9.95)
Moderate	50	2.74 (0.15)	2.84 (0.29)	2.66 (0.15)	2.71 (0.29)	4.31 (4.50)	15.72 (7.62)	5.37 (6.40)	11.66 (8.72)

Means are shown, standard deviations are in brackets. Range SRL Strategy Use 1–4, Range Declarative SRL Knowledge Test 0–28.



$p = 0.882$, there was no significant increase in strategy use after the intervention.

For the declarative SRL knowledge, results reveal a significant main effect of time ($F(1,112) = 62.78, p < 0.001, \eta^2 = 0.36$). No significant time*profile interaction was found ($F(2,112) = 0.14, p = 0.869, \eta^2 = 0.00$), indicating a similar training effect independent of the profile. All profiles increased their declarative SRL knowledge statistically significant after the intervention. [Figure 3](#) visualizes the change in declarative SRL knowledge means. The results also indicate a significant interaction of time*condition, $F(1,112) = 4.46, p = 0.037$,

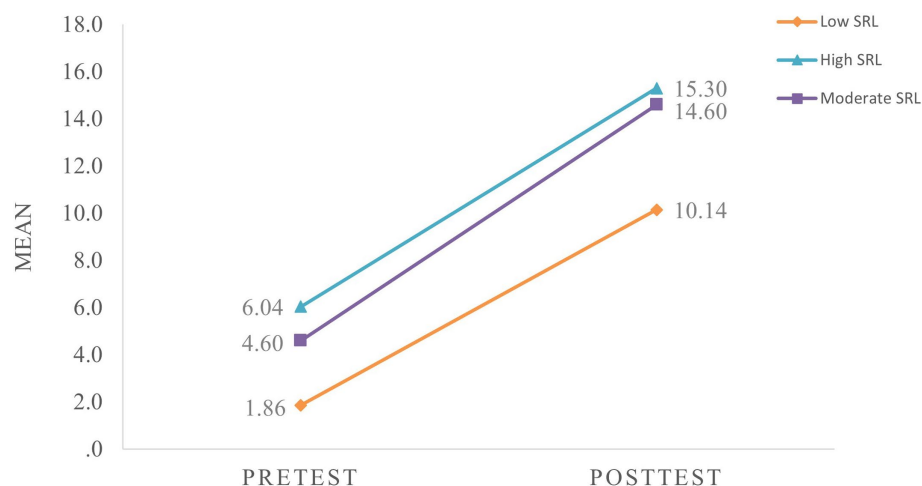


FIGURE 3

Declarative SRL knowledge means and their progression after the intervention.

$\eta^2 = 0.04$, hinting at different training gains depending on the condition. The e-learning condition increased their declarative knowledge more than the seminar condition. There was no significant three-way interaction of time*condition*profile, $F(2, 112) = 0.15$, $p = 0.864$, $\eta^2 = 0.00$.

5 Discussion

The aim of the present study was to examine how the individual SRL characteristics of pre-service teachers influence the effectiveness of two digital learning environments—an asynchronous e-learning environment and a synchronous online seminar—by applying a person-oriented approach. Furthermore, we compared the two different communication styles (synchronous and asynchronous) regarding self-reported SRL strategy use and SRL knowledge.

5.1 Pre-service teachers' SRL profiles

The first research question examined the number of different SRL profiles of pre-service teachers. The results indicate a three-class solution, revealing a low, a moderate, and a high SRL profile. This is in accordance with the findings by Ainscough et al. (2019), Chen et al. (2023), Esnaashari et al. (2023), and Muwonge et al. (2020), who also revealed a three-profile solution for SRL with low, moderate, and high specifications. In our sample, the low-profile group was the smallest group. Most persons were categorized into the moderate profile. For both the moderate-and the low-profile groups, the motivational component is particularly emphasized, but the profiles differ most regarding the cognitive and metacognitive components. This is in accordance with the findings by Veenman et al. (2006) and Hirt et al. (2021), revealing that persons with low SRL also use fewer cognitive strategies, and persons with high SRL use more cognitive and metacognitive strategies. It must be mentioned that our sample included significantly more female than male participants, reflecting the current gender distribution in teacher education (Katsarova,

2020). Although females and males only marginally differ in their SRL (Virtanen and Nevgi, 2010), this could have influenced the distribution of the profiles. Because of a small advantage of females regarding SRL strategies, the number of high and medium profiles could be slightly overestimated due to the smaller number of males in the sample. The findings strengthen the need for SRL training for pre-service teachers because more than 60% of the participants were categorized with a low or medium SRL profile, revealing room for improvement.

5.2 Differential training effects regarding self-reported SRL strategy use and declarative SRL knowledge

The second research question investigated whether an SRL training has a different effect on pre-service teachers with different SRL profiles. The results indicate a significant (self-reported) increase in SRL strategy use for the low and moderate profiles after the training, but not for the high SRL profile. Thus, the training seems to be especially effective for persons included in the low profile; they made the highest gains in SRL strategy use, leading to an approximation of the moderate profile in terms of a compensation effect. This is in line with Esnaashari et al. (2023) who conducted a 12-week blended learning course which led to an increase in SRL strategy use among university students with a low SRL profile. The students categorized with a low SRL profile had similar levels of SRL strategy use as those with average SRL profiles after the course. In contrast to the present study, Dörrenbächer and Perels (2016) found that moderate SRL profile students benefited more from an eight-week training intervention than low or high-profile students, demonstrating a compensation effect as well for students with a moderate SRL profile.

All profiles increased their declarative SRL knowledge significantly after the intervention, whereupon the low profile achieved scores far below the moderate-and high-profile groups. Despite a strong knowledge increase in all groups, persons in the low-profile group still scored less than half of the possible points in the declarative knowledge

test (35%) whereas the moderate-and high-profile groups reached 50% correct answers. This result confirms the training's effectiveness but also reveals that the participants could not use the whole training content to increase their declarative SRL knowledge. One reason for this could have been the training duration. The six weeks could have been too short for the dense amount of knowledge we presented to participants. This is in line with the meta-analysis by [Chen \(2022\)](#), who strengthens the assumption that students need appropriate time to master self-regulation skills, especially when the interventions are conducted in the field.

Another reason could be the fit of the questions and training content. Information provided in the training could have answered all questions; however, the sheer amount of the information could have prevented processing it deeply enough. According to the theory of multimedia learning by [Mayer \(2005\)](#), this could have led to a high cognitive load during learning. In future learning environments, important information should be highlighted visually.

The participants' motivation to participate and their interest in the topic could also be a cause for the results. Students with motivated SRL profiles tend to have higher academic achievement and study intentions compared to students with non-motivated SRL profiles ([Broadbent and Fuller-Tyszkiewicz, 2018](#)). The study was carried out in different compulsory elective courses, which may have caused low motivation and interest in some participants, restricting maximum training gains.

Interestingly, the declarative SRL knowledge did not correlate with the self-reported SRL scales, suggesting a discrepancy between SRL knowledge and self-reported SRL strategy use ([Dörrenbächer-Ulrich et al., 2021](#)). In our sample, high-level SRL knowledge does not imply high-level use of SRL. It could be possible that persons with high-level SRL knowledge also use many SRL strategies but are unaware of using them and, therefore, cannot report it on a questionnaire.

5.3 Differences regarding asynchronous and synchronous learning environments

Our third research question referred to the differences between synchronous and asynchronous learning environments regarding SRL training. For SRL strategy use, there was no significant time*condition interaction, indicating no differences between asynchronous and synchronous learning environments regarding SRL strategy use after the training. The participants in both conditions increased their strategy use, indicating that both communication types are sufficient to support SRL strategy training and that in our sample, SRL strategy use does not depend on whether a course teacher is present.

Concerning declarative SRL knowledge, the results indicated a significant time*condition interaction. In our sample, participants in the asynchronous e-learning condition showed higher training gains than students in the seminar condition, independent of the participants' respective profiles. One cause for this could be that the students had more time to reflect on the material in the asynchronous e-learning environment, which led to more interaction with the material and, hence, deeper processing of information than in the synchronous seminar condition ([Lucas et al., 2014](#)). Regarding SRL knowledge acquisition, the communication style seems to play a significant role. Given that SRL knowledge is a comprehensive and

complex topic, the results suggest asynchronous environments as more adequate for teaching this topic. The automated feedback in the asynchronous e-learning environment seems sufficient to increase declarative SRL knowledge in our sample without actively involving a course teacher. This could be caused by the complexity of the learning content and the profile distribution. In our sample, the participants were able to cope with the information and exercises provided successfully, indicating a reasonable difficulty in the tasks. Because only seven persons were categorized in the low SRL profile, the SRL skills in the sample were high enough to learn without a course teacher. For future studies, it would be interesting to investigate whether a course teacher has a positive effect when applying a more complex task.

5.4 Limitations

Although the study expands previous knowledge on individual learner characteristics of pre-service teachers and their impact on SRL training using differing digital learning environments, there are several limitations that need to be addressed.

One limiting factor is the e-learning environment. Although the students had 6 weeks to complete the e-learning course, faster completion was possible. Some students may have finished the course early; some learners procrastinated and binge-learned the entire content within the last days of the available time. The assessment only registered course completion, not how much time the participants spent in the course to completion. Furthermore, a task was considered completed if the corresponding material was uploaded to Moodle. The assignments were checked visually for reasonable sentences and paragraphs, to prevent cheating on the completion, but the content was not checked for adequacy. This leaves the possibility that learners may have worked on the tasks superficially. Another limiting factor was methodological issues. The sample size is rather small for conducting an LPA. [Spurk et al. \(2020\)](#) recommended at least 500 participants for an accurate categorization in the LPA—difficult to realize—and called for further investigations with a larger sample. Moreover, the gender distribution in the sample causes a limitation of the study. There are significantly more female than male participants, because teaching is still a predominantly female working area with 72% female teachers in the EU ([Katsarova, 2020](#)). In future samples a balanced number of females and males would be desirable. Furthermore, the reliability of the cognitive subscale of SRL is questionable and could have led to unreliable measurement ([van Griethuijsen et al., 2015](#)). Moreover, the present findings are based on self-report data. It cannot be ruled out that the participants provided untrue answers due to social desirability. Another limitation is the small number of subjects in Profile 1 (low SRL), which may not be representative of the whole population of pre-service teachers, limiting the generalizability of the findings. Due to the small group size, an incidental finding of this profile cannot be ruled out. Moreover, the current study relies on quasi-randomized data of participants from different courses at the same university with different course teachers. This nested data structure may have impacted the findings and could be analyzed using multi-level model analysis. The different course teachers worked with the same course material but without a calibration with each other which could have caused an instructor

bias. It must be mentioned critically that the current approach only includes profiles that represent different levels of SRL rather than a continuous spectrum, neglecting other specifications of SRL.

5.5 Implications

The presented results illustrate implications for practical application and research. Pre-service teachers are crucial in modeling strategy use in the classroom for their future students (Peeters et al., 2014). In order to effectively teach students about using SRL strategies, pre-service teachers first need to develop their own SRL skills (Karlen et al., 2023). To achieve this, they could undergo adaptive SRL training during their studies. This training should be tailored to the individual needs of the learners based on their SRL profile and provide adaptive learning content. Based on our findings, asynchronous learning environments are suitable for declarative SRL knowledge improvement and for SRL strategy use, both, synchronous and asynchronous learning environments are adequate. Concerning this matter, either pure asynchronous learning environments or a combination of asynchronous and synchronous learning parts (Giesbers et al., 2014; Amiti, 2020) seem reasonable, to promote SRL strategy use and declarative SRL knowledge simultaneously. A combined use would ensure optimal exploitation of the advantages of both communication types. One way of implementing this is to impart declarative SRL knowledge to pre-service teachers as early as possible in their studies by means of an asynchronous e-learning training environment. Subsequently, the application of SRL strategies can be encouraged through, for example, a synchronous practical seminar that requires SRL strategy use in the classroom. This approach may also help to reduce the discrepancy between SRL knowledge and SRL strategy use. In the course of this approach, pre-service teachers should also be made aware that SRL can enhance students' academic success and that they can facilitate their students' future learning endeavors.

For future studies, we recommend a longer training period, to enable an increase of SRL strategy use or a reduction of training content. In addition, utilizing Moodle as a training platform enables the generation of log and process data. This can provide a more comprehensive understanding of SRL by offering multiple measurement points, which allows for the detection of profile changes throughout the intervention. Our study contributed to the examination of different SRL profiles of pre-service teachers and their impact on different digital learning environments. Because pre-service teachers are important multipliers in the classroom but are often neglected as a target group, we call for more studies regarding pre-service teacher SRL training in different learning environments to develop ideal learning opportunities for future teachers.

6 Conclusion

The findings of the present study underline the importance of a person-centered approach regarding digital learning environments, to fulfill pre-service teachers' individual needs. The results indicate that SRL training for pre-service teachers with different SRL profiles is effective in general, especially for declarative SRL knowledge, but

needs further adaptation to support students with already high-level SRL skills.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical approval was not required for the studies involving humans because the study was conducted following the Declaration of Helsinki, no institutional approval was necessary by local law. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

NB: Conceptualization, Data curation, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing. MB: Supervision, Writing – original draft, Writing – review & editing. LD-U: Resources, Supervision, Writing – original draft, Writing – review & editing. FP: Funding acquisition, Project administration, Supervision, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Fostering learning engagement: the impact of different interpersonal relationships from the perspective of positive youth development

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Learning engagement is a crucial factor affecting the quality of learning and holds significant value in promoting student development and enhancing teaching quality. By using time-lagged data from four schools and considering intentional self-regulation, this study integrates three types of relationships (parent–child, teacher–student, and peer relationships) into the same research framework to examine their impacts on learning engagement and the underlying mechanisms among high school students. The findings reveal that parent–child, teacher–student, and peer relationships all significantly positively affect high school students' learning engagement. Intentional self-regulation plays a partial mediation effect between parent–child relationship and learning engagement, teacher–student relationship and learning engagement, along with peer relationship and learning engagement. The unique effect of peer relationship on learning engagement is significantly greater than that of teacher–student relationship but is not significantly greater than that of parent–child relationship. To better create a supportive synergy for enhancing students' learning engagement, it is suggested that families and schools provide consistent learning support within their capabilities.

KEYWORDS

learning engagement, parent–child relationship, teacher–student relationship, peer relationship, intentional self-regulation

1 Introduction

In recent years, education has been a strategic priority in our country. With the progressive implementation of basic education curriculum reform, quality education has achieved remarkable results, yet there is still a gap in the requirement of “cultivating people through virtue.” Therefore, based on a series of supportive research, it is proposed to develop students' core competencies from a top-level design perspective. Under the overall framework of core literacy, learning to learn is the most important core literacy (Lin, 2016). Enhancing students' learning literacy level and effectively addressing the difficulties faced by educational development are critical factors in improving students' learning engagement (Jia et al., 2018).

The focus of researchers has shifted towards positive psychological qualities, such as learning engagement, with the rise of positive psychology (D'Mello et al., 2017). Learning engagement refers to the sustained state of vigor, dedication, and absorption that students maintain when facing learning-related activities and contexts (Schaufeli et al., 2002). Concretely speaking, vigor implies students' energetic engagement in learning, characterized

by high levels of energy and mental resilience, encompassing a willingness to devote effort to their studies and the ability to persist in the face of challenges; Dedication means to an individual's enthusiastic and proud commitment to learning, characterized by a pioneering spirit; Absorption refers to an individual's complete focus on learning and their willingness to dedicate significant amounts of time to it (Carmona-Halty et al., 2019). Studies showed students' academic achievements, academic exhaustion, and dropout intentions might be predicted by students' learning engagement (Xiang et al., 2022; Bernardo et al., 2022; Wu et al., 2020). In addition, recent findings have shown that the state of learning engagement among Chinese students is concerning, with issues such as low learning efficiency and significant declines in engagement (Qiao et al., 2021). Hence, it is critical to enhance students' level of learning engagement. Exploring the factors that influence learning engagement is essential not only for achieving better academic results but also for effectively supporting the development and improvement of adolescents' learning abilities and preventing the risk of dropout.

2 Literature review

2.1 Interpersonal relationships and learning engagement

The environment in which an individual is situated plays a crucial role in influencing their learning engagement. According to Benson (2003), relationships across various contexts are significant determinants of learning engagement among children and adolescents. Interpersonal relationship is the direct psychological relationship formed by interaction and function between people. Good interpersonal relationships can improve individual health level and is the key factor to maintain the normal development of individual psychology. In contrast, disharmonious interpersonal relationship can trap individuals in self-doubt and self-denial, leading to a loss of motivation for learning and life goals (Zhang et al., 2020). Existing research has found that better interpersonal relationship, which brings more external social support, often lead to advancements in individual learning strategies. This not only facilitates improvements in student academic performance but also mitigates the impact of low self-regulated learning on individual psychological health (Davis and Humphrey, 2012).

Social support includes affirmations, approvals, and acceptance from multiple environments, such as family and school, allowing adolescents to experience a warm and caring atmosphere in healthy interpersonal relationship (Benson, 2002). The core ideas of positive youth development (PYD) emphasize relationship, viewing positive development as the result of intentional and meaningful relationship among adolescents (Benson, 2007). Moreover, the PYD perspective discovers adolescents from the viewpoint of "strengths and potentials," highlighting the importance of the interplay between individuals and their surroundings in fostering positive development (Lerner et al., 2014). The ideal state of learning activities is to engage in meaningful learning with enthusiasm and positivity under the support of interpersonal relationship, thereby experiencing the realization of personal potential and self-worth (Yan et al., 2018).

Schools and families are the primary places and contexts for adolescent development. The teacher-student, peer, and parent-child

relationships formed within these two major contexts are the main social relationship for children and adolescents (Zhao et al., 2021). Previous studies on the relation between interpersonal relationships and learning engagement either approached interpersonal relationship as a whole without differentiating between parent-child, teacher-student, and peer relationships (Collie et al., 2016) or focused on one of these relationship to investigate its influence on student learning engagement. These studies also found that all three types of interpersonal relationship can independently affect learning engagement (Shao and Kang, 2022; Thornberg et al., 2020; Sedláček and Šedová, 2020). However, due to research limitations, previous research has not integrated parent-child, teacher-student, and peer relationships into the same research system to compare their effects on learning engagement. Comparing their impacts within the same research system is crucial for enhancing student learning engagement levels. As a result, the research hypotheses are as follows:

H1: Parent-child relationship can positively predict the high school student's learning engagement.

H2: Teacher-student relationship can positively predict the high school student's learning engagement.

H3: Peer relationship can positively predict the high school student's learning engagement.

2.2 Intentional self-regulation as a mediator

Even in similar environments, individual development can vary (Dang et al., 2016). As research has progressed, scholars within the domain of positive youth development have found that good situational resources may activate positive developmental trajectories in adolescents, however, there might exist indirect pathways in these processes (Benson and Pittman, 2012). The relational development systems theory suggests that the interactions between the individual and his or her environments are the fundamental unit of human development, with intentional self-regulation being a key way individuals contribute to this interaction (Lerner et al., 2005). Previous research has classified self-regulation into organismic self-regulation and intentional self-regulation on the basis of the degree of conscious involvement. Gestsdóttir and Lerner (2008) further noted that during adolescence, intentional self-regulation under individual consciousness control matures and begins to become a significant factor.

Intentional self-regulation is the process by which individuals achieve positive self-development goals, mainly through selection, optimization, and compensation behaviors, aiming to optimally match situational demands, resources, and individual objectives (Gestsdóttir and Lerner, 2008). Research has demonstrated clearly that intentional self-regulation plays a significant role in the accurate prediction of academic performance and is the critical factor (Stefánsson et al., 2018) in burnout learning (Schunk and Ertmer, 2000), career aspirations (Napolitano et al., 2020), academic well-being (Chang et al., 2020) among middle school students. Additionally, the research has revealed that affirmation and support, companionship, and closeness from parents, peers, and teachers have a significant positive

impact on the intentional self-regulation levels of middle school students (Zhou et al., 2021). Intentional self-regulation serves as a bridge between individuals and their environments, playing a crucial role in the adaptation process involving environmental variables (Lerner, 2006). Based on these research, the following research hypotheses are proposed:

H4: Intentional self-regulation would mediate the relation between parent-child relationship and learning engagement.

H5: Intentional self-regulation would mediate the relation between teacher-student relationship and learning engagement.

H6: Intentional self-regulation would mediate the relation between peer relationship and learning engagement.

Moreover, Considering the potential interactions among parent-child, teacher-student, and peer relationships, their effects on learning engagement may overlap if all three types of interpersonal relationships are included in the same structural equation model. Parent-child, teacher-student, and peer relationships may also have unique effects on learning engagement in addition to overlapping effects. The unique effect refers to the remaining predictive effect in a structural equation model that includes parent-child, teacher-student, and peer relationships, along with learning engagement, beyond the overlapping effects. Scholars generally believe that if the remaining predictive effect of an independent variable is not zero, then this variable has a unique effect on the dependent variable (McMahon et al., 2003). Thus, in the same model, the size of the unique effects can be compared to determine the influence of the three different interpersonal relationship on learning engagement. At this stage, direct comparisons of the unique effects of parent-child, teacher-student, and peer relationships on learning engagement are scarce, but research on the impact of home and school relationship on positive learning behaviors can provide references for this study. Research has found that as students age, their attachment to parents gradually decreases while their interactions with classmates increase, and simultaneously parent-child support decreases while peer support increases. The effect on learning engagement also changes, showing a state where peer support exceeds parent-child support on influencing learning engagement during this middle school stage (Zhuang et al., 2016). On the basis of the above studies, when comparing the unique effects of parent-child, teacher-student, and peer relationships on learning engagement, the present research attempts to consider the mediation effect of intentional self-regulation. Hence, this following research hypothesis is proposed:

H7: Considering the mediation effect of intentional self-regulation, the unique effect of peer relationship on learning engagement is significantly greater than that of parent-child or teacher-student relationships among high school students.

2.3 The present study

High school is a crucial stage that bridges earlier and later phases of school education, and it is a key period for developing and nurturing the literacy of “learning to learn” among students. High

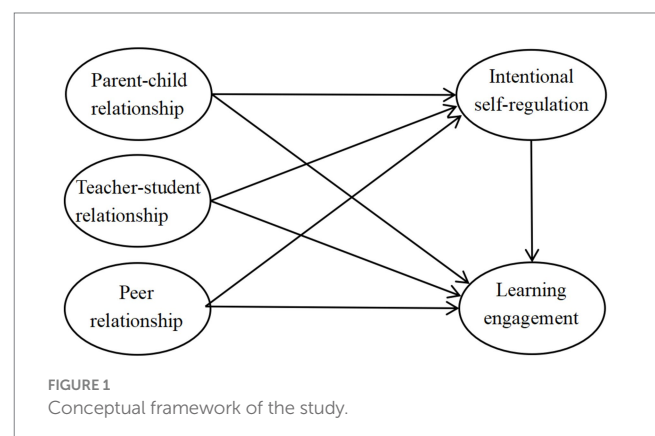
school students face a wide range of subjects, greater difficulty in knowledge, and the immense pressure of college entrance exams. They need to concentrate their efforts on learning activities, and experiencing meaning and value in their studies (Liu, 2016). Therefore, exploring the impact and mechanisms of parent-child, teacher-student, along with peer relationships on high school students’ learning engagement is of significant practical importance for enhancing the core literacy levels of high school students and further improving the learning support system for high school students.

Moreover, although prior studies have mainly concentrated on the relation between one type of interpersonal relationships and learning engagement, less was understood about the relation between multiple types of interpersonal relationships and learning engagement, along with the roles of intentional self-regulation among them. Grounded in the aforementioned theories and empirical studies, the current research aims to explore the influence of parent-child, teacher-student, and peer relationships on learning engagement and their mechanisms among high school students. Integrating research hypotheses 1–7 forms a mediation model. Figure 1 shows the study’s hypothesis framework as follows:

3 Method

3.1 Participants

This study utilized a multi-stage stratified cluster sampling method, with the sample selection process divided into three stages: district division (2 out of 6 districts), school selection (4 schools), and class selection (12 classes). In 4 middle schools across central provinces of China, a sample of 600 survey were administered to students in grades 10–12 across 12 classes, with 540 valid questionnaires retrieved. After excluding questionnaires with incorrect answers to lie detection questions, patterned responses, or missing answers, the effective response rate was 90.00%. Demographic characteristics included age, gender (coded as male = 1; female = 2), grade (10th = 1; 11th = 2; 12th = 3), and living area (1 = urban; 2 = rural). The sample consisted of individuals aged 15 to 18 years, with a mean age of 16.56 ± 0.90 . There were 279 males (51.67%) and 261 females (48.33%). By grade, there were 181 students in 10th grade (33.52%), 184 in 11th grade (34.07%), and 175 in 12th grade (32.41%).



Among them, 283 students (52.41%) were from urban areas and 257 students (47.59%) were from rural areas. Sample size estimation was performed using G*power 3.1 software (Faul et al., 2007), with $\alpha = 0.05$, effect size $r = 0.20$, and aiming for 80% statistical power, at least 193 participants were required. The sample size used in this study met this requirement.

3.2 Measures

3.2.1 Parent-child relationship

The middle school student's parent-child relationship questionnaire designed by Wu et al. (2011) was employed. It consists of 26 items across four dimensions: understanding and communication (10 items, $\alpha = 0.919$), harshness and interference (7 items, $\alpha = 0.903$), fondness and respect (5 items, $\alpha = 0.897$), and growth and tolerance (4 items, $\alpha = 0.847$). Sample item is "When I talk, my parents listen patiently and attentively." These dimensions encompass the cognitive, emotional, and behavioral facets of the parent-child relationship. Scoring is conducted using a 5-point Likert scale that extends from "1 = strongly disagree" to "5 = strongly agree." Higher average scores across all items indicate better parent-child relationship status. In the current study, Cronbach's alpha for this scale was 0.925.

3.2.2 Teacher-student relationship

The Teacher-Student Relationship Scale developed by Zhang (2003) was adopted. This scale was created by referencing Pianta's (1994) questionnaire and conducting interviews with teachers and students. It has 22 items and four dimensions: conflict (9 items, $\alpha = 0.921$), attachment (5 items, $\alpha = 0.875$), intimacy (4 items, $\alpha = 0.848$), and avoidance (4 items, $\alpha = 0.891$). Sample item is "I care about my teachers very much." Scoring is conducted using a 5-point Likert scale, which progresses from "1 = strongly disagree" to "5 = strongly agree." Higher average scores across all items represent a higher level of teacher-student relationship status. In the present study, Cronbach's alpha for the scale was 0.931.

3.2.3 Peer relationship

The Peer Relationship Scale for Children and Adolescents, designed by Guo (2003) and applicable to students aged 7–18, was used. This scale includes dimensions of friendship (5 items, $\alpha = 0.839$), peer rejection (10 items, $\alpha = 0.907$), and peer acceptance (7 items, $\alpha = 0.878$). The scale comprises 22 items (e.g., "I focus on how other students see me.") rated on a 4-point Likert scale ranging from "1 = strongly disagree" to "4 = strongly agree." Items 11, 12, 15, 17, 19, 20, and 21 are scored negatively, while the remaining items are scored positively. Greater scores suggest a poorer peer relationship. In the present study, the Cronbach's alpha for this scale was 0.922.

3.2.4 Intentional self-regulation

The Selection, Optimization, and Compensation (SOC) Scale by Huang (2021) was adopted. This scale was designed by referencing Gestsdóttir and Lerner's (2007) questionnaire. The scale comprises 17 items (e.g., "I always pursue goals one after the other."). It includes three dimensions with 6 items for selection ($\alpha = 0.881$), 5 items for optimization ($\alpha = 0.921$), and 6 items for compensation ($\alpha = 0.922$). The study utilized a 5-point Likert scale (1 = "very disagree," 5 = "very agree"). Higher average scores across all items represent a higher level

of intentional self-regulation. In this study, the Cronbach's alpha coefficient for this scale was 0.935.

3.2.5 Learning engagement

The Learning Engagement Scale, initially created by Schaufeli et al. (2002) and later updated by Fang et al. (2008), was utilized in this study. The scale comprises 17 items categorized into three dimensions: vigor (6 items, $\alpha = 0.878$), dedication (5 items, $\alpha = 0.938$), and absorption (6 items, $\alpha = 0.952$). Sample item is "I feel energetic when I study." The study utilized 7-point Likert scale, with 1 meaning "never" and 7 meaning "always." Higher average scores indicate greater learning engagement. In the current study, the Cronbach's alpha coefficient for this scale was 0.942.

3.2.6 Covariates

In this study, age, gender, grade, and the number of siblings were controlled as covariates; this information was collected during the first data collection to prevent interference with the outcome variables. Previous research has shown that variables such as age, gender, grade, and the number of siblings are related to students' learning engagement (e.g., Falbo, 2019; Santos et al., 2021; Zhong et al., 2023). Therefore, these demographic variables cannot be ignored when studying learning engagement among high school students (Liu et al., 2020).

3.3 Procedure

Research data was collected through self-administered questionnaires. Participant data were collected through an online survey, with teachers sending links to the informed consent form and survey questionnaire to class discussion groups. The aim of the research was introduced in the online questionnaire, and respondents could only submit their questionnaires after completing all items, minimizing the likelihood of accidentally skipping items. A participant could only submit one response. Given the potential for response bias in self-reported questionnaires, the anonymity and voluntary of the survey were disclosed to respondents. They were advised about the survey details and encouraged to answer all items truthfully, with assurances that the results would be kept confidential. Data were collected at two different times: demographic information and the three types of interpersonal relationship in Time 1, and intentional self-regulation and learning engagement in Time 2 (1 month later).

3.4 Data analytical plan

The statistical analysis of the data obtained would be performed using SPSS 25.0 and AMOS 24.0. To identify potential multivariate outliers, the Mahalanobis distance squared (MD^2) method would be used (p_1 and $p_2 < 0.001$), and no outliers were removed. The suitability of the data for factor analysis would be assessed using the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity. A KMO value of over 0.50 and Bartlett's test significance of less than 0.01 (Hadia et al., 2016) would be required. As Hair et al. (2010) state, VIF values ranging from 1 to 5 represent multicollinearity that can be ignored. The Harman's single factor test would be employed to appraise the common method bias (CMB). The CMB did not exist

when a single factor with a small contribution was less than 50% only (Schwarz et al., 2017). The confirmatory factor analysis (CFA) for the latent variable loadings, concurrent validity as well as composite reliability were also considered. Pearson's product-moment correlation test would be used to determine the relationship between these variables. Similarly, the structural equation model would be used to assess and adjust the model's fitness and for the hypothesis test.

4 Results

4.1 Preliminary analyses

In this study, confirmatory factor analysis (CFA) was employed to examine the factor loading, convergent validity (CV) and component reliability (CR) of the five variables. The average variance extracted (AVE) values varied from 0.506 to 0.601 whereas CR varied from 0.803 to 0.819 and the factor load of the five latent variables ranged between 0.580 and 0.867, as Table 1 illustrates. The indicators have all been calculated the values recommended by Hair et al. (2019), implying that the five latent variable measuring methods enjoy good validity and reliability. As well, the square roots of the AVE values for each of the five latent variables were greater than the correlation coefficients between the variables, suggesting good discriminant validity among the five latent variables, according to the discriminant validity analysis of the five latent variables using AVE.

Moreover, the means, standard deviations, and Pearson correlations of the main variables are presented in Supplementary Table S1. The results showed that the mean score for peer relationship ($M = 2.194$, $SD = 0.560$) was slightly below the midpoint of the scale, while parent-child relationship ($M = 3.110$, $SD = 0.601$), teacher-student relationship ($M = 3.099$, $SD = 0.673$), and intentional self-regulation ($M = 3.050$, $SD = 0.751$) showed medium level. In contrast, learning engagement ($M = 4.606$, $SD = 1.111$) was higher. Pearson correlations were used to analyze the relationship between each variable. Learning engagement among high school students can positively correlate with all three types of interpersonal relationships. Intentional self-regulation can significantly correlate with all three types of interpersonal relationships among high school students. And learning engagement was associated with intentional self-regulation among high school students. The correlation coefficients between each of the five variables were all less

than 0.700, suggesting a good linear relationship between the five variables without multicollinearity issues, suitable for further analysis.

4.2 Direct effects of interpersonal relationship on learning engagement

Without considering intentional self-regulation, a model was constructed including parent-child, teacher-student, and peer relationships, along with learning engagement simultaneously to test H1, H2, and H3. Following the three-indicator presentation strategy recommended by Hair et al. (2010), the model fit was evaluated using the root mean square error of approximation (RMSEA), the Tucker-Lewis Index (TLI), and the standardized chi-square test. A model is considered to have a good fit if the RMSEA is less than 0.08, the TLI is above 0.90, and the standardized chi-square is less than 5 (Brown, 2006; Hair et al., 2010). The model accounted for the influence of gender and number of siblings. These control variables did not have a significant impact on interpersonal relationships and learning engagement. The fit indices indicate a good fit of the model to the data ($\chi^2/df = 2.941$, $RMSEA = 0.060$, $TLI = 0.903$), allowing further investigation of the relationship between latent variables to test the hypotheses.

The standardized regression coefficient of parent-child relationship on learning engagement ($\beta = 0.258$, $p < 0.001$) was positive and significantly different from zero, indicating that parent-child relationship can directly positively predict learning engagement, supporting H1. The standardized regression coefficient of teacher-student relationship on learning engagement ($\beta = 0.277$, $p < 0.001$) was positive and significantly different from zero, indicating that teacher-student relationship can directly positively predict learning engagement, supporting H2. The standardized regression coefficient of peer relationship on learning engagement ($\beta = 0.270$, $p < 0.001$) was positive and significantly different from zero, indicating that peer relationship can directly positively predict learning engagement, supporting H3 (see Figure 2).

4.3 Testing for mediation effects

Considering intentional self-regulation as a the mediating variable and simultaneously examining the direct effects of parent-child,

TABLE 1 Confirmatory factor analysis.

Variables	Confirmatory factor analysis			Discriminative validity				
	Factor loading	CR	AVE	PCR	TSR	PR	ISR	LE
Parent-child relationship	0.721 ~ 0.799	0.803	0.506	0.711				
Teacher-student relationship	0.701 ~ 0.807	0.819	0.531	0.383**	0.729			
Peer relationship	0.678 ~ 0.769	0.806	0.585	0.415**	0.431**	0.765		
Intentional self-regulation	0.580 ~ 0.854	0.817	0.601	0.494**	0.421**	0.521**	0.775	
Learning engagement	0.725 ~ 0.867	0.813	0.592	0.420**	0.434**	0.454**	0.480**	0.769

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; bold values indicate the discriminant validity of the constructs. The same below.

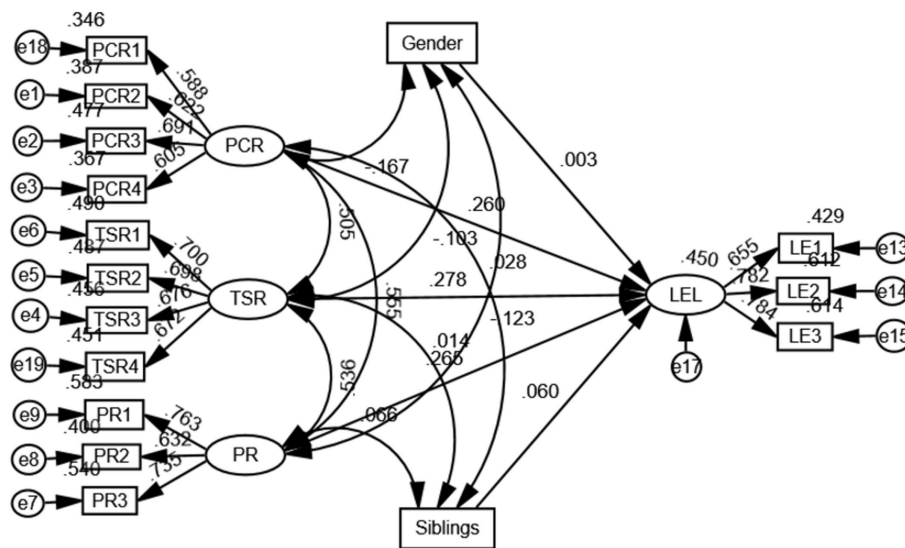


FIGURE 2

The direct effect model of interpersonal relationship on learning engagement.

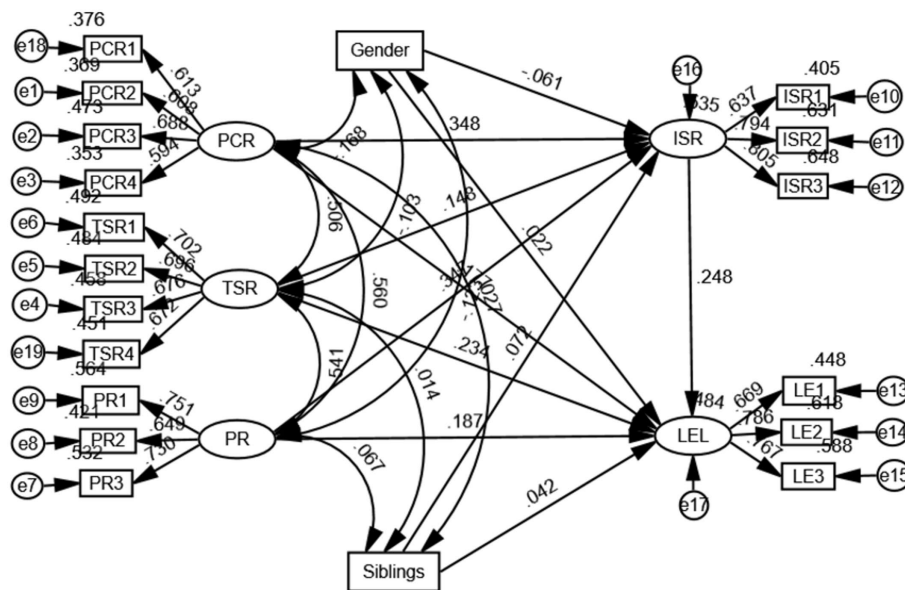


FIGURE 3

The impact model of interpersonal relationship and intentional self-regulation on learning engagement.

teacher-student, and peer relationships on learning engagement, hypotheses H1-H7 were tested. The model controlled for the impacts of gender and the number of siblings, which did not demonstrate significance for intentional self-regulation and learning engagement. The fit indices suggest that the model fits the data well ($\chi^2/df = 2.834$, RMSEA = 0.058, TLI = 0.903). In Figure 3, the standardized regression coefficient of parent-child relationship on learning engagement ($\beta = 0.177$, $p < 0.05$) was significantly different from zero, indicating that parent-child relationship can directly positively predict learning engagement, supporting H1. The standardized regression coefficient of teacher-student relationship on learning engagement ($\beta = 0.234$, $p < 0.05$) was significantly different from zero, indicating that

teacher-student relationship can directly positively predict learning engagement, supporting H2. The standardized regression coefficient of peer relationship on learning engagement ($\beta = 0.187$, $p < 0.05$) was significantly different from zero, indicating that peer relationship can directly positively predict learning engagement, supporting H3.

To examine interpersonal relationships if indirectly affect learning engagement through intentional self-regulation. As shown in Table 2, the standardized regression coefficient of parent-child relationship on intentional self-regulation ($\beta = 0.348$, $p < 0.05$) is significant difference from zero, along with the standardized regression coefficient of intentional self-regulation on learning engagement ($\beta = 0.248$, $p < 0.05$) was also significantly different from zero. The mediation

TABLE 2 Structure path coefficient.

Path			Std. estimate	Estimate	S.E.	C.R.	P
Intentional self-regulation	←	Parent-child relationship	0.348	0.359	0.076	4.719	***
Intentional self-regulation	←	Teacher-student relationship	0.148	0.131	0.054	2.419	0.016
Intentional self-regulation	←	Peer relationship	0.347	0.351	0.073	4.819	***
Learning engagement	←	Parent-child relationship	0.177	0.278	0.119	2.341	0.019
Learning engagement	←	Teacher-student relationship	0.234	0.315	0.085	3.694	***
Learning engagement	←	Peer relationship	0.187	0.289	0.115	2.501	0.012
Learning engagement	←	Intentional self-regulation	0.248	0.378	0.122	3.103	0.002

effect of intentional self-regulation was tested using Bootstrap resampling with 5,000 iterations. The bias-corrected (BC) 95% confidence interval is [0.028, 0.178], not containing zero, suggesting that intentional self-regulation mediates the effect, supporting H4. parent-child relationship have an indirect effect on learning engagement through intentional self-regulation, with a mediation effect of 0.086 (0.348*0.248).

Secondly, the standardized regression coefficient of teacher-student relationship on intentional self-regulation ($\beta = 0.148, p < 0.01$) was significantly different from zero. The mediation effect of intentional self-regulation was tested using Bootstrap resampling with 5,000 iterations. The bias-corrected (BC) 95% confidence interval is [0.011, 0.069], not containing zero, implying that intentional self-regulation mediates the effect, supporting H5. Teacher-student relationship has an indirect impact on learning engagement via intentional self-regulation, with a mediation effect of 0.037 (0.148*0.248).

Lastly, the standardized regression coefficient of peer relationship on intentional self-regulation ($\beta = 0.347, p < 0.01$) was significantly different from zero. The mediation effect of intentional self-regulation was tested using Bootstrap resampling with 5,000 iterations. The bias-corrected (BC) 95% confidence interval is [0.025, 0.158], not containing zero, meaning that intentional self-regulation mediates the effect, supporting H6. Peer relationship have an indirect effect on learning engagement through intentional self-regulation, with a mediation effect of 0.086 (0.347*0.248).

As seen Table 3, the unique impact of parent-child relationship on learning engagement is the sum of its direct and indirect effects, totaling 0.263 (0.177 + 0.086 = 0.263). Teacher-student relationship has a unique effect on learning engagement, which is equal to the sum of their direct and indirect effects, totaling 0.271 (0.232 + 0.037 = 0.271). Peer relationship has a unique effect on learning engagement, which is equal to sum of their direct and indirect effects, totaling 0.273 (0.187 + 0.086 = 0.273). Among the point estimates, peer relationship have the largest unique effect on learning engagement. Using Bootstrap resampling with 5,000 iterations, the differences in these unique effects were tested for significance. The results, with bias-corrected 95% confidence intervals of [−0.059, 0.069], which includes zero, indicate that the unique effect of parent-child relationship on

learning engagement is not significantly less than that of peer relationship. The bias-corrected 95% confidence intervals of [−0.158, −0.006], which do not include zero, indicate that the unique effect of teacher-student relationship on learning engagement is significantly less than that of peer relationship. Thus, H7 is partially supported.

5 Discussion

From the perspective of family and school environments, the present research aimed to examine the impact of interpersonal relationships on learning engagement and the role of intentional self-regulation among high school students. The results indicate that parent-child, teacher-student, and peer relationships could significantly positively predict adolescents' learning engagement. The direct predictive effect remained significant when intentional self-regulation was introduced as a mediator. Parent-child, teacher-student, and peer relationships could indirectly affect high school students' learning engagement through intentional self-regulation.

5.1 Interpersonal relationships and learning engagement

The development of adolescent can be influenced by their relationship with significant others (Laird et al., 2018; Peterson et al., 2013). When they receive recognition and support from significant others, adolescent are more able to achieve a higher feelings of self-worth; when trust and support from significant others are lacking, psychological and behavioral problems may arise (Ryan and Deci, 2017). This study found that these three types of interpersonal relationships positively predicted learning engagement in different ways, echoing the positive youth development (PYD) theory. This theory considers good interpersonal relationships is a key factor for the healthy growth of teenagers, highlighting the significance of supportive interpersonal relationship in stimulating motivation and engagement in learning during adolescence (Lerner et al., 2014).

Parent-child relationship, by providing emotional support and a stable learning environment, lay the foundation for high school

students' learning engagement (Wang and Sheikh-Khalil, 2014). However, parents' expectations and interventions may also increase students' sense of pressure, especially during the academically demanding high school years (Kulakow et al., 2021). On the other hand, parents may have limited mastery of high school course content, which may not suffice to meet students' needs in academic learning (Gonzalez-DeHass et al., 2005). Therefore, parent-child support should balance expectations and encouragement to avoid negatively impacting students' learning engagement. Further findings indicated that the positive impact of teacher-student relationship highlighted the importance of teachers in motivating students, providing academic guidance, and emotional support (Lee et al., 2023). A caring and supportive teaching environment can significantly enhance students' learning engagement and academic achievement. Good teacher-student relationship can promote high school students' cognitive engagement, enhancing their interest and participation in learning. Nonetheless, the unequal distribution of educational resources may limit the opportunity for all students to engage in high-quality teacher-student interactions (Ansong et al., 2017). Meanwhile, peer relationships play a critical part in the socialization process of students, where support and positive modeling behaviors from peers can stimulate students' interest and participation in learning (Wang and Eccles, 2012). However, negative interactions among peers, such as exclusion, bullying, and pressure, may lead to students' avoidance behaviors toward learning, thus affecting their learning engagement (Gonida and Cortina, 2014).

Overall, these three types of interpersonal relationship collectively shape the learning environment and psychological state of high school students, having an indispensable impact on their learning engagement. These findings not only provide educators with diversified strategies to promote students' learning engagement but also offer a new perspective on how adolescents develop and grow within different interpersonal relationship, especially in the context of current educational challenges (educational policy and environmental changes) and promoting comprehensive student development.

5.2 The mediating role of intentional self-regulation

Both the positive adolescent outlook on development and the system theory of relationship development point out that the influence of context on development outcome may be generated through individual self-system and individual behavior (Tian et al., 2015). In this study, intentional self-regulation plays a mediating role between interpersonal relationships and learning engagement of high school students. This study confirmed H4-H6. Based on relational development systems theory, the findings of this study highlight the complexity of individual-environment interactions and the central role of self-regulation in this process (Lerner et al., 2005). Individual development is achieved through dynamic interactions with the surrounding environment, where intentional self-regulation serves as a key mediator, enabling individuals to actively shape their own developmental trajectories (Lerner et al., 2014). Intentional self-regulation is a crucial aspect of adolescent development. Adolescents who can regulate their thoughts, emotions, and behaviors are more likely to succeed academically, have better relationships with peers and adults, and enjoy better mental health (Gestsdóttir and Lerner, 2007). Research has proved that although parental expectations can increase academic pressure, students can

effectively balance these expectations with their own learning motivation through intentional self-regulation strategies (Stefánsson et al., 2018). These strategies include setting personal goals, optimizing resource use, and making behavioral adjustments, all of which enhance learning engagement. Positive teacher-student relationship provide essential emotional support and academic guidance, enabling students to more effectively utilize self-regulation strategies and thereby enhancing their learning engagement (Davis and Humphrey, 2012). Besides, with peer support and pressure, high school students can optimize their match with the environment through intentional self-regulation, maintaining or enhancing their engagement in learning (Zhou et al., 2021).

Furthermore, the findings indicate that with the mediating role of intentional self-regulation, the impact of peer relationships on learning engagement is significantly larger than that of teacher-student relationships. This outcome supports the findings of the study of Yu et al. (2023), who also determined that peer support becomes more important for keeping students in touch with the learning engagement as they age. This may be because during high school, students increasingly look for independence and autonomy, with peer influence and support becoming especially crucial during this learning phase (Zhuang et al., 2016). In spite of the unique effect of peer relationships on learning engagement is somewhat significant, the roles of parent-child and teacher-student relationships remain crucial factors that cannot be overlooked. These relationships provide different forms of support and resources that have a significant impact on both student motivation and emotional development. Therefore, strategies to promote student engagement in learning should take into account multiple interpersonal relationships and how these relationships can be optimized and adjusted through intentional self-regulation.

5.3 Implications

This study offers a new perspective for enhancing high school students' learning engagement, with significant theoretical and practical implications. Theoretically, the present research contributes empirical evidence for positive youth development theory in the setting of high school students' learning engagement, contributing to the existing literature. This study emphasizes the agency and regulatory abilities of individuals in their developmental process. Understanding how interpersonal relationship resources are optimized and utilized through self-regulation strategies. Secondly, by analyzing the unique effects of three types of interpersonal relationships on learning engagement, the current research provides a more detailed perspective to understand the influence of various types of interpersonal relationship on adolescent learning.

Practically, these findings are of significant importance to parents, school teachers, and policymakers. Firstly, confirming the central role of intentional self-regulation in promoting learning engagement means that schools and families should take measures to help adolescents develop and improve their self-regulation abilities. Secondly, given the significant impact of peer relationship on learning engagement during high school, schools should encourage the establishment of a positive and healthy peer culture. Additionally, as parents support their children's learning, they should realize that the influence of peers increases as children grow, and therefore, need to adjust their support methods appropriately, offering necessary guidance and assistance while encouraging their children to think and

TABLE 3 Results for the conditional indirect effect model.

		Effect coefficient	Boot SE	Bootstrap 95% CI		P	Percentage of effect
				LLCI	ULCI		
Indirect effect	Parent–child relationship	0.086	0.038	0.028	0.178	0.012	32.700%
	Teacher–student relationship	0.037	0.016	0.011	0.069	0.019	13.653%
	Peer relationship	0.086	0.038	0.025	0.158	0.024	31.502%
Direct effect	Parent–child relationship	0.177	0.091	0.005	0.371	0.047	—
	Teacher–student relationship	0.234	0.066	0.086	0.365	0.015	—
	Peer relationship	0.187	0.085	0.028	0.379	0.011	—
Total effect	Parent–child relationship	0.263	0.079	0.124	0.423	0.004	—
	Teacher–student relationship	0.271	0.068	0.109	0.394	0.018	—
	Peer relationship	0.273	0.08	0.138	0.454	0.007	—
	Ind _(PCR→LE) Vs. Ind _(TRS→LE)	0.049	0.036	0.001	0.142	0.029	—
	Ind _(PCR→LE) Vs. Ind _(PR→LE)	0.000	0.031	−0.059	0.069	0.906	—
	Ind _(TRS→LE) Vs. Ind _(PR→LE)	−0.049	0.036	−0.158	−0.006	0.026	—

Dependent variable: learning engagement; Mediator: intentional self-regulation.

solve problems independently. Lastly, education policymakers should consider the importance of interpersonal relationship in learning engagement, support schools in implementing student-centered teaching methods, promote positive interactions between teachers students, and peers, and through school-family cooperation, establish a comprehensive supporting learning climate for students.

5.4 Limitations and future directions

Despite the impacts mentioned above, this study still has some limitations. Firstly, this study only focused on self-reported surveys, which may have biases. To optimize this situation, subsequent research could consider integrating other research methods. Secondly, this study only explored the effect of intentional self-regulation in the process of how three kinds of interpersonal relationships affect learning engagement among high school students. In future research, more mediating variables will be considered in the model to reveal the complex process of how three types of interpersonal relationships affect learning engagement among adolescent. Lastly, the impact of three types of interpersonal relationships on student learning engagement varies at different learning stages. Limited by the scope of this study, it did not compare the effects of three kinds of interpersonal relationships at different learning stages. In future research, the influence of three kinds of interpersonal relationships on student learning engagement will be compared at different learning stages to clarify the important changes in interpersonal relationship in student learning growth.

6 Conclusion

In summary, the present research investigated the relation between parent–child, teacher–student, and peer relationships and high school students’ learning engagement from the perspective of positive youth development. All three types of interpersonal relationships had significant positive predictive impacts on learning engagement among high school students. Mediation analysis showed that intentional self-regulation could be an explanatory factor for the improvement of learning engagement by three types of interpersonal relationships among high school students. Additionally, considering the mediation effect of intentional self-regulation, the effect of peer relationship on learning engagement was significantly greater than that of teacher–student relationship among high school students.

Data availability statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics statement

The studies involving humans were approved by Academic Committee of Guangxi Normal University. The studies were conducted in accordance with the local legislation and institutional

requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

MZ: Writing – original draft, Conceptualization, Formal analysis, Software. XY: Writing – original draft, Investigation, Funding acquisition, Data curation. MB: Writing – review & editing, Supervision, Methodology, Validation, Visualization.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2024.1419588/full#supplementary-material>

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Understanding the interplay between teacher self-efficacy, teacher–student interactions, and students' self-regulated learning skills at different levels of classroom ecology

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Introduction: Studies pinpoint the importance of exploring factors in the classroom environment that might foster students' SRL-skills in various domains. This study explored specific teacher and classroom factors, including self-efficacy for SRL-skills (TSE) and teacher–student interactions in relation to students' self-regulated learning skills in various domains (metacognitive, motivational, and behavioral). Additionally, the moderating role of teacher–student interactions in the relationship between TSE and SRL-skills was examined.

Methods: Third- to sixth grade students ($N=1,278$, 46.9% boys) from 63 classrooms of Dutch elementary schools completed reports about their metacognitive, motivational, and behavioral SRL-skills. Teachers reported on their TSE for eight randomly selected students from their classes. In addition, the Classroom Assessment Scoring System was used to observe the quality of teacher–student interactions.

Results: Multilevel analyses generally revealed that individual students reported better metacognitive, motivational, and behavioral SRL-skills when their teachers felt efficacious in teaching SRL-skills. However, none of the associations at the class level were significant. Moreover, when high-quality teacher–student interactions were observed, students reported lower levels of metacognitive, motivational, and behavioral SRL-skills. No moderating effect of teacher–student interactions on the relation between TSE and SRL-skills was found.

Discussion: These findings show that specific measures of TSE at the appropriate level of analysis may help to better explain variation in TSE and students' SRL-skills.

KEYWORDS

self-regulated learning skills, student-specific teacher self-efficacy, teacher student interactions, elementary schools, multilevel modeling

Introduction

Self-regulated learning skills (SRL-skills) refer to specific abilities, strategies, and behaviors that students employ while they systematically attempt to monitor, regulate, and control their own learning (Pintrich, 2004). Mastering these skills is believed to contribute to effective self-regulated learning, which is widely recognized as a crucial competence for becoming a lifelong

learner (Pintrich, 2004; Schunk and Greene, 2018). Previous research has indicated that students who cultivate their self-regulation skills from an early age tend to attain higher levels of performance and exhibit higher levels of motivation towards their academic tasks (e.g., Chung, 2000; Dent and Koenka, 2016; Harding et al., 2019). Accordingly, it seems relevant to understand which factors might foster students' SRL-skills already in elementary school. Teacher factors are the focus of the current study.

Theoretical model of self-regulated learning

Central to the present study is Pintrich's (2004) model of self-regulation, which includes metacognitive, motivational, and behavioral components of self-regulation. Students' metacognition is regarded as the core component of SRL (Veenman, 2017; Usher and Schunk, 2018). It encompasses a range of key skills and strategies for regulating and controlling learning behaviors, such as task-orientation, monitoring, and self-evaluation (Pintrich, 2004; Vandavelde et al., 2013). The regulation of motivation involves the motivational beliefs that students hold regarding a task, including their self-reinforcement, positive self-talk, and interest enhancement (Pintrich, 2004). Last, the regulation of behavior entails the regulation of effort, persistence, time management, and help seeking (Skinner et al., 2008; Usher and Schunk, 2018). The inclusion of the motivational and behavioral components make Pintrich's model one of the most comprehensive models available and particularly relevant for the elementary school context (Panadero, 2017). These components are considered to be crucial for elementary students' academic performance (Dignath and Büttner, 2008; Perry et al., 2019).

Teacher self-efficacy and students' SRL-skills

Two possible factors may promote students' SRL-skills, including teacher self-efficacy in fostering SRL-skills (Dignath, 2016; Karlen et al., 2023). Teachers' self-efficacy in SRL-skills, in short TSE for SRL-skills, reflects teachers' beliefs about their ability to affect students' SRL-skills (De Smul et al., 2018). Based on social cognitive theory it is commonly believed that TSE for SRL may play a role in students' SRL-skills by its influence on behaviors and competencies, such as goals and aspirations, outcome expectations, and metacognition (Bandura, 1997). Empirical studies indeed suggest a link between TSE and various SRL-skills, showing that feelings about their own abilities and their own level of self-regulation may be related to students' self-regulated learning (see Moos and Ringdal, 2012, for an overview).

Despite considerable progress in this literature, current findings seem to call for some nuance. First, it should be noted that general TSE can fluctuate according to the circumstances in the classroom or the tasks at hand (Bandura, 1997; Zee and Koomen, 2016). Unfortunately, however, only a few studies have considered the task- and domain specific nature of TSE in studies on SRL-skills (e.g., Dignath, 2016, 2021; De Smul et al., 2018; Lawson et al., 2019; Karlen et al., 2020). This may be problematic, as the outcome domain of interest specifies the type of TSE that weighs most heavily on a given SRL-skill.

Second, from these studies, the study by Dignath (2021) is the only study that included direct measures of students' SRL-skills. This study, which involved 191 third- to fourth-grade teachers and their students, assessed TSE for SRL-skills and the level of students' self-regulatory skills. Results showed that students did not report an increase in their levels of SRL-skills when their teachers reported higher levels of TSE for SRL-skills. These results deviate from the commonly assumed belief that TSE leads to higher SRL-skills in students. It may be that the informant of student SRL-skills (teacher or student reported) might play an important role in whether associations between TSE and students' SRL-skills appear to be positive. Hence we used student reports to measure SRL-skills in the current study.

Third, in Dignath's (2021) study the relation of TSE and students' SRL-skills has only been considered at the class level (Zee and Koomen, 2016). Little is known about the relation at the student level, that is between a teacher's self-efficacy toward individual students (student-specific TSE) and student's SRL-skills. Possibly, similar to studies in other teaching domains, the student-specific self-efficacy beliefs teachers hold are a better predictor of individual differences than general students' SRL-skills than teachers' general feelings of TSE (Zee et al., 2016a, 2018). Given these previous findings, we expect that a large portion of variance in the components of SRL is explained by student-specific TSE and that student-specific TSE has a stronger relationship with individual students outcomes (i.e., the student level), than general forms of TSE (i.e., teachers' judgments at the class level, based on a subsample of students; Zee et al., 2016a, 2018). Our aim is therefore to examine associations between TSE for SRL-skills and students' SRL-skills both within and between classes.

Quality of teacher–student interactions and student's SRL-skills

A second factor that may promote students' SRL-skills is the quality of teachers' interactions with their students (Dignath, 2016; de Ruig et al., 2023; Hofkens et al., 2023). The quality of daily interactions between teachers and students is considered a driving force behind learning and development, including the development of SRL-skills (Bronfenbrenner and Morris, 1998; Hamre et al., 2013). These interactions are conceptualized around three broad domains: instructional support, classroom organization, and emotional support (Hamre et al., 2013; Fauth et al., 2021).

Instructional support consists of the degree to which teachers are able to promote inquiry skills, use a variety of learning formats, provide high-quality feedback, involve students in instructional dialogue, and help them understand content at a deeper level (Pianta et al., 2012). It is commonly assumed that if instructional support is well-tailored to students' prior knowledge and includes real-life examples it will provide opportunities to show current skills, broaden knowledge, and develop new metacognitive SRL-skills (Hamre et al., 2013; Veenman, 2017). Moreover, direct forms of instruction by teachers are believed to help students obtain knowledge about strategy application and its benefits, which might also be related to their self-regulation (Veenman, 2017; Dignath and Veenman, 2021). Different reviews have demonstrated that instructional support can be an effective way through which teachers support students' metacognitive SRL-skills. However, in these reviews its positive relationship with the motivational

and behavioral SRL-skills appears to be less strong (Dignath and Büttner, 2008; Dignath and Veenman, 2021; de Ruig et al., 2023).

The domain of classroom organization represents teachers' organization of and managerial tasks within the classroom, such as behavioral management, daily routines, and maximization of learning time (Pianta et al., 2012; Fauth et al., 2021; Hofkens et al., 2023). Organized classrooms and daily routines are believed to help students focus on learning tasks such that they can achieve their learning goals (Hamre et al., 2013). In addition, teachers in well-organized classrooms are expected to provide students with enough instructional time so that students encounter sufficient challenges and receive enough strategy instruction. Findings of a recent review by de Ruig et al. (2023) showed that well-organized classrooms also had students with higher metacognitive SRL-skills. The association appeared to be less strong compared to the overall relation for instructional support (de Ruig et al., 2023). Findings were mixed for the relationships between teachers' classroom organization and motivational and behavioral SRL-skills.

Lastly, teachers who provide high levels of emotional support create a warm classroom climate, are sensitive, and have regard for students' perspectives by being flexible and providing autonomy (Pianta et al., 2012). Emotionally supportive teachers create a secure and safe learning climate, in which students may feel self-reliant, competent, and willing to take risks to explore the classroom environment (Hamre et al., 2013). Moreover, emotionally supportive teachers are expected to help students feel engaged, autonomous, and motivated to work on a task. It has been suggested that these feelings support students' SRL-skills (Rieser et al., 2013). Previous research has shown that when teachers were emotionally supportive they were also more likely to promote metacognitive SRL-skills in their students (de Ruig et al., 2023). However, emotionally supportive teachers did not always have students with higher levels of motivational or behavioral SRL-skills (Rimm-Kaufman et al., 2014; Havik and Westergård, 2020).

Two features of current evidence on the relation between teacher-student interactions and SRL-skills are of note. First, most studies in this field predominantly rely on teacher and student reports. de Ruig et al. (2023) found only four studies which included observations of the quality of interactions, all using the Classroom Assessment Scoring System (CLASS; Pianta et al., 2012). This is noteworthy as observations can provide valuable insights about the quality of teacher-student interactions, including real-time classroom dynamics, nonverbal behaviors, and other contextual factors (Pianta et al., 2012; Bell et al., 2019; Wang et al., 2020). It seems therefore likely that observations can provide additional information on how the quality of interactions within a classroom can promote students' SRL-skills.

A second feature of current evidence is that the four studies that did use classroom observations of the quality of teacher-student interactions were all focused on motivational and behavioral SRL-skills (de Ruig et al., 2023). Metacognitive SRL-skills were not included in these studies. Moreover, findings about the relationship between the quality of interactions and students' motivational and behavioral SRL-skills appeared to be mixed. Two cross-sectional studies revealed that when high levels of classroom organization were observed, lower and upper elementary school students were also more likely to show higher levels of motivational and behavioral SRL-skills (Cadima et al., 2015; van Dijk et al., 2019). Yet, two other studies did not find association of instructional support, classroom

organization, and emotional support with students' ability to regulate their motivation and behavior (Rimm-Kaufman et al., 2014; Schenke, 2018). Therefore, we go a step further than previous studies by examining whether observed interactions may be associated with all three SRL-skills, thus including metacognitive self-regulation skills.

The moderating role of teacher-student interactions

The role of interaction quality in promotion of SRL-skills seems rather complex, and may generate interaction effects in addition to the expected direct effects. These interaction have, to our knowledge, not been previously researched. This is notable, given the commonly held belief that the potential relationships between student-specific TSE and students' SRL-skills at different levels of classroom ecology cannot be examined in isolation from the context in which this relationship occurs (Bandura, 1997; Eccles and Wigfield, 2002).

It seems likely that the quality of teacher-student interactions provides teachers with positive and negative information regarding their own ability to teach SRL-skills to students and about their own performance in providing sufficient support. Lower-quality classroom interactions may therefore negatively effect the relationship between TSE and students' SRL-skills, whereas in classrooms with high-quality interactions a much stronger effect of TSE on SRL-skills may be expected. Hence, our third and final aim to explore the potential moderating effect of the quality of teacher-student interactions on the relationship between TSE and SRL-skills.

Present study

This study addresses three research questions that extend prior research on SRL-skills. The first question is how TSE for SRL-skills and SRL-skills are related at the student and the class level. Rather than taking a class-level only perspective, as an extension to previous research, we also examined these relationships at the student level to gain a deeper insight into how TSE might promote students' SRL-skills at different levels of classroom ecology. The second question concerns how teacher-student interactions are associated to students' SRL-skills. We used observations instead of teacher or student reports to obtain information about the quality of teacher-student interactions in class. The third question is whether teacher-student interactions moderate the relationship between TSE and SRL-skills.

Based on prior research, several hypotheses were tested. First, we hypothesized that associations between TSE for SRL-skills and SRL-skills may not be positive (Dignath, 2021). Second, we expected that student-specific TSE may have a positive relationship with individual students' outcomes (e.g., Zee et al., 2016a). Third, we hypothesized that associations between the three domains of teacher-student interactions and metacognitive SRL-skills may be positive (e.g., Rieser et al., 2013). Given that relationships with motivational and behavioral SRL-skills were mixed in prior research (Rimm-Kaufman et al., 2014; Cadima et al., 2015; Schenke, 2018; van Dijk et al., 2019), we assumed weaker relationships with motivational and behavioral SRL-skills than with metacognitive SRL-skills. Finally,

our fourth hypothesis was that a possible relationship between TSE for SRL-skills and SRL-skills was moderated by the quality of teacher–student interactions. We expected that high-quality interactions may positively moderate a potential relationship between TSE and SRL-skills, whereas lower-quality interactions may negatively effect such a association.

Method

Participants

The sample consisted of 1,278 third-to sixth grade students (46.9% boys) from 63 classrooms of 33 Dutch regular elementary schools in both urban and rural areas across the Netherlands. Of these students, 126 were in grade 3 (9.9%), 264 in grade 4 (20.7%), 401 in grade 5 (31.4%), and 452 in grade 6 (35.4%). Another 35 students (2.7%) did not report their grade. Students' age ranged from 7 to 13 years ($M = 10.00$, $SD = 1.19$). Of the participating students, 75.7% identified themselves as ethnically Dutch. Teachers' age ranged from 22 to 59 years old ($M = 34.72$, $SD = 10.75$). Teachers ($N = 63$) generally had 9.23 years of teaching experience ($SD = 7.54$) and class sizes ranged from 12 to 37 students per classroom ($M = 24.88$, $SD = 3.18$).

Teachers were asked to fill out a questionnaire on student-specific TSE for SRL-skills for eight students who were randomly selected from their classrooms. Completing questionnaires for eight students is considered to be a manageable workload for teachers and a good indication of the class mean for TSE (Zee et al., 2018, 2024; Zee and Rudasill, 2021). Due to illness or time constraints, not all teachers were able to complete the questionnaire for those eight students, resulting in completed questionnaires on teachers' TSE for SRL-skills for an average seven students per class. This resulted in a subset of 449 students for which information was available on student-specific TSE for SRL-skills.

Procedure

We reached out to school principals and teachers through various channels, including telephone, email, and LinkedIn. Invited teachers received an information brochure and were asked to sign an informed consent form. Of the teachers that were contacted, 13.2% agreed to participate. Moreover, parents were asked to provide consent for their child to participate. The average teacher consent rate per school was 73.3% and the parental consent rate for student participation per class was 84.9%.

Data was gathered in three ways, through: (1) classroom videos, (2) student-report questionnaires, and (3) teacher-report questionnaires. Trained research assistants or the first author made a 45-min video within each participating classroom to capture teacher and student behavior as well as classroom-level interactions (see Instruments). Videos were recorded at the beginning of a regular school day. After the video was recorded, on the same day, teachers and students were asked to complete a questionnaire. Completing the questionnaires took around 30 min. Data was collected during the fall of schoolyear 2019–2020. Teachers and students were allowed to stop at any given moment during the project. The study was approved by

the Ethics Review Board of the Faculty of Social and Behavioral Sciences of the University of Amsterdam (project 2019-CDE-10504).

Instruments

Teacher self-efficacy for SRL-skills

All participating teachers were asked to complete the Teacher Self-Efficacy Scale to foster SRL (De Smul et al., 2018) for eight randomly selected students from their classrooms. This scale includes four subscales: (1) Teacher Self-Efficacy for Direct Instruction (5 items), (2) Teacher Self-Efficacy for Providing Choices (5 items), (3) Teacher Self-Efficacy for Providing Challenges and Complex Tasks (5 items), and (4) Teacher Self-Efficacy for Building in Evaluation (3 items). Examples of questions are: "How well can you teach your students which self-regulated learning strategies exist?" and "How well can you let your students reflect on their own learning process?". Questions for each scale were changed to tap student-specific teacher self-efficacy for SRL by turning the general word "students" into "this student". For example, the question "How well can you teach your students which self-regulated learning strategies exist?" became "How well can you teach this student which self-regulated learning strategies exist?". Items were rated by teachers on a 5-point Likert-type scale, ranging from 1 (definitively not true) to 5 (definitively true). A prior study has provided support for the psychometric quality of the Teacher Self-Efficacy Scale to foster SRL, with factor loadings >0.54 and Bentler's p ranging between 0.80 to 0.91 (de Smul et al., 2018). The reliability coefficients for student-specific TSE for Direct Instruction ($\alpha = 0.95$), Providing Choices ($\alpha = 0.90$), Providing Challenges and Complex Tasks ($\alpha = 0.86$), and Building in Evaluation ($\alpha = 0.89$) in the current sample were satisfactory. In line with a previous study that combined the four general scales into a single TSE factor (De Smul et al., 2019), Cronbach's alpha for the combined Teacher Self-Efficacy for SRL factor was excellent ($\alpha = 0.96$). The combined scale was used in the current study.

Teacher–student interactions quality

The quality of teacher–student interactions in each of the 63 classrooms was assessed with the Upper Elementary Classroom Assessment Scoring System (CLASS; Pianta et al., 2012). The CLASS is considered one of the most extensively researched observation instruments for assessing the quality of teacher–student interactions (Hafen et al., 2015; Bell et al., 2019). This instrument consists of 11 specific dimensions for the broader domains of Instructional Support, Classroom Organization, and Emotional Support (Pianta et al., 2012). Instructional Support was measured using the dimensions Instructional Learning Formats, Content Understanding, Analysis and Inquiry, Quality of Feedback, and Instructional Dialogue. Classroom Organization was captured by the Behavior Management, Productivity, and Negative Climate subscales. Last, the Emotional Support domain consisted of the dimensions Positive Climate, Teacher Sensitivity, and Regard for Student Perspectives. Prior research has suggested that these domains can be reliably distinguished from one another (e.g., Hafen et al., 2015; Schenke, 2018). Cronbach's alphas for Instructional Support ($\alpha = 0.77$), Classroom Organization ($\alpha = 0.88$), and Emotional Support ($\alpha = 0.86$) were adequate in the present study.

Each dimension was rated by the first author on a 7-point Likert scale, ranging from low (1–2), middle (3–5), to high (6–7). The first author was a certified CLASS-observer, who attended a three-day coding training and passed yearly reliability tests during the project. Each coding cycle began by carefully noting down observations related to teacher and student behavior, as well as interaction patterns within the classroom. Afterwards, scores were assigned to each dimension using the descriptions provided in the CLASS manual (Pianta et al., 2012).

In total, seven videos (12%) were double coded by a certified CLASS-observer who had no other involvement in the project. Intra-class correlations (ICC) were calculated per dimension to obtain inter-rater reliability (see Table 1). Overall inter-rater reliability ranged between fair (between 0.40 and 0.59), good (between 0.60 and 0.74), and excellent (between 0.75–1.00), except for the Instructional Learning Formats dimension, which was below the critical value of 0.40 (Cicchetti, 1994). This dimension had no negative effect on the internal reliability of the Instructional Support scale, prompting our decision to include it in the score of this scale.

Students' metacognitive and motivational SRL-skills

Students reported on their Metacognitive and Motivational SRL-skills using four subscales from a slightly adapted version of the Children's Perceived Use of Self-Regulated Learning Inventory (CP-SRLI; Vandeveld et al., 2013; see Authors et al., for details about the adaptation process): task orientation (7 items), monitoring (8 items), self-evaluation (7 items), and motivational strategies (4 items). The Task Orientation items included students' approach to learning tasks, including their task demands and representations of learning goals and task requirements (Vandeveld et al., 2013). An example of an item is: "Before I start my schoolwork, I ask myself: will I succeed?". The Monitoring subscale includes items about students' monitoring of cognition, behavior, motivation, and the context while conducting learning tasks. An example of an item is: "During my

schoolwork, I ask myself: do I still understand everything?". The Self-Evaluation items consisted of students' Product and Process Evaluation. Students' Product Evaluation is the evaluation of learning outcomes, including checks for correctness and completeness. Questions on how students reflect on their approaches, strategies, and their effectiveness were captured by items on students' Process Evaluation (Vandeveld et al., 2013). Examples are: "After finishing my schoolwork, I check if I have done everything that was asked for" (product evaluation) and "After finishing my schoolwork, I ask myself: How did I feel about it? (fun, difficult, boring, interesting, ...)" (process evaluation). The Motivational Strategies scale consists of four items concerning students' self-reinforcement, positive self-talk, and interest enhancement. An example of an item is: "During my schoolwork, I motivate myself to keep working".

Factorial validity, reliability, and measurement invariance across gender have proven to be good in previous research (Vandeveld et al., 2013, 2017; Heirweg et al., 2019). Items from the CP-SRLI for both Metacognitive and Motivational SRL-skills were scored by students on a 5-point Likert-type scale, ranging from 1 (*definitively not true*) to 5 (*definitively true*). Average scores were calculated for both scales. Cronbach's alphas in the present study indicated satisfactory internal consistencies for Metacognitive SRL-skills ($\alpha = 0.88$) and sufficient for Motivational self-regulation skills ($\alpha = 0.62$).

Students' behavioral SRL-skills

Items regarding students' behavioral SRL-skills were taken from the short Dutch version of the Engagement Versus Disaffection with Learning questionnaire (Skinner et al., 2008; Zee and Koomen, 2020). Behavioral SRL-skills were measured with six self-report items, including items about students' effort, attention, and persistence before and during a learning task. Examples of items are: "I try hard to do well in school" and "When I am in class, I think about other things". Items from the Behavioral SRL-skills scale were scored by students on a 5-point Likert-type scale, ranging from 1 (*definitively not true*) to 5 (*definitively true*). Average scores were calculated for this scale, based upon the complete sample of students ($N = 1,278$). The reliability and construct validity for the short Dutch version have been found to be satisfactory (Zee and Koomen, 2020). Moreover, and in line with previous research (e.g., Skinner et al., 2008; Engels et al., 2021), Cronbach's alpha for the subscale was adequate ($\alpha = 0.77$).

Data analysis

An intercepts-and-slopes-as-outcomes multilevel model was fitted to test our research questions and corresponding hypotheses (Kreft and de Leeuw, 1998). This model takes the nested data structure of students within classrooms into account (Geiser, 2013). Accounting for the nested data allows for estimation of unbiased standard errors for the regression coefficients. Moreover, variables can be added to this model at both the student (student-specific TSE and SRL-skills) and the class level (aggregated TSE, teacher–student interactions, and class-average SRL-skills). Another advantage of the intercepts-and-slopes-as-outcomes model is that both the intercepts and slopes of student-level regressions can vary across classroom-level variables (Kreft and de Leeuw, 1998; Geiser, 2013). Any differences between classes in intercepts and slopes can, in turn, be explained by variables

TABLE 1 Intra-class correlation per dimension of the CLASS.

Domain	Dimension	ICC
Instructional support		
	Instructional learning formats	0.30
	Content understanding	0.82
	Analysis and inquiry	0.46
	Quality of feedback	0.76
	Instructional dialogue	0.66
Classroom organization		
	Behavior management	0.92
	Productivity	0.80
	Negative climate	1.00
Emotional support		
	Positive climate	0.76
	Teacher sensitivity	0.64
	Regard for perspectives	0.82

at the class level. Hence, this model enabled us to answer our first and second research question, that is, whether TSE for SRL-skills and the three interaction domains are associated with students' SRL-skills at the student and at the class-level.

The third research question, whether teacher–student interactions moderated the relationship between student-specific TSE for SRL-skills and SRL-skills, was examined by adding a cross-level interaction to the intercepts-and-slopes-as-outcomes model. This interaction specifies that the relationship between the student level predictor TSE for SRL-skills and the outcome variables, that is students' SRL-skills, is dependent on the level of the class-level predictors, that is the quality level of teacher–student interactions.

Maximum likelihood estimation with robust standard errors was employed to deal with potentially non-normal data (Kline, 2016). Missing data was handled using full information maximum likelihood (FIML; Muthén and Muthén, 2017). All student and class-level predictors were grand-mean centered to ease interpretation (Kreft and de Leeuw, 1998).

Modeling procedure

We used a modeling procedure that consisted of four consecutive steps (Hox et al., 2018). First, an intercept-only model was tested with student-specific TSE, Metacognitive, Motivational, and Behavioral SRL-skills as outcome variables and without any of the predictors. This model produced intra-class correlations and served as a baseline model for model comparison (Hox et al., 2018).

Second, the intercepts-and-slopes-as-outcomes model was fitted to the data to test our first and second hypothesis. Within this model, individual SRL-skills scores were regressed on student-specific TSE and the intercepts were allowed to vary across classes. In addition, aggregated TSE was added as a classroom-level predictor of class-average SRL-skills, together with the three domains of teacher–student interactions. This model is based on separate student and class-level correlations and provides unstandardized and standardized regression coefficients at both levels of analysis. The fit of this model was compared to the intercept-only model.

Third, random slopes were separately added to the intercepts-and-slopes-as-outcomes model for each combination of the student level predictor TSE with Metacognitive, Motivational, and Behavioral SRL-skills. Significant random slope coefficients indicate that the relationships between TSE and SRL-skills differed per class (Finch and Bolin, 2017). Only statistically significant random slopes were added to the final model (Hox et al., 2018).

Fourth, cross-level interactions were added to test our third hypothesis. Adding a cross-level interaction allowed the student level predictor TSE to interact with the class-level predictors Instructional Support, Classroom Organization, and Emotional Support (Hox et al., 2018). A significant cross-level interaction indicates a moderating effect of the quality of teacher–student interactions on the relationship between student-specific TSE and SRL-skills. Again, model fit was compared to the previous model and the baseline model.

The Satorra-Bentler adjusted chi-square difference test was used to determine whether alternative models fitted significantly better than the nested models (Finch and Bolin, 2017). The nested model refers to the model that remains when parameters are removed from a more general alternative model (Hox et al., 2018). For this test, log likelihood values were used to calculate the scaling correction factor

and the adjusted chi-square difference test. This approach was adopted as Mplus does not produce a chi-square deviance test or deviance values when maximum likelihood estimation with robust standard errors are used. A significant test indicates that the model has a better fit than the previous model.

Results

Descriptive statistics and data screening

Data was screened and descriptive statistics were evaluated before the multilevel models were fitted to the data. Most of the scales were approximately normally distributed following a threshold of ± 1.00 for skewness and kurtosis (Kline, 2016). However, for Classroom Organization, skewness (-2.06) and kurtosis (5.87) were considerably higher than ± 1.00 . To account for this non-normality, we used robust maximum likelihood estimation (Kline, 2016). In addition, no multivariate outliers were found using Cook's Distance and there was no sign of multicollinearity using variance-inflation factors with a threshold of five (Tabachnick and Fidell, 2014). Probability plots were inspected and showed no violation of the assumption of multivariate normality.

ICC1 and ICC2 values are displayed in Table 2. ICC1 indicates the percentage of the total variance in a variable that can be ascribed to the class-level. These percentages were 7.5% for Metacognitive, 2.2% for Motivational, and 8.8% for Behavioral SRL-skills occurred between classes. Even though these intraclass correlations are relatively small ($< 10\%$), it is still advised to use a multilevel modeling to account for the nested structure of the data (Kreft and de Leeuw, 1998).

In addition, we evaluated the reliability of the aggregated variables (ICC2; Marsh et al., 2012), including Metacognitive, Motivational, and Behavioral SRL-skills, and Student-Specific and Class-specific TSE. Metacognitive, Motivational, and Behavioral SRL-skills were based on the full sample of 1,278 students, whereas Class-specific TSE for SRL was based on eight randomly selected students per class. The ICC2 values were good for the Metacognitive (0.621) and Behavioral SRL-skills (0.664), and even excellent for student-specific (0.803) and Class-specific TSE for SRL (0.807; Cicchetti, 1994). The ICC2 value of 0.316 for the Motivational SRL-skills was not satisfactory. This value indicates that the class-average mean may be unreliable (Marsh et al., 2012). We therefore tested models with and without the Motivation SRL-skills, but did not find significant differences in coefficients at the class level or in model fit. Since the Motivational SRL-skills are considered to be important to the SRL process and also a reliable outcome variable at the within level, we retained this variable in the models that were tested.

Regarding the domains of teacher–student interactions, Instructional Support had the lowest overall mean, while Classroom Organization demonstrated the highest mean among the three interaction domains. This is in accordance with previous research (e.g., Schenke, 2018), and shows that the majority of classrooms are well-organized, while the average quality of instruction falls only in the lower midrange of the CLASS. The variance of Emotional Support shows that the quality varies more among teachers than in the other domains.

The student and class-level correlations are in Table 2. At the class level, the correlations between various domains of classroom

TABLE 2 Descriptive statistics, intra-class correlations, and correlations among the variables at the student and class level.

Level	Variable	Meta	Moti	Behav	SS-TSE	CO	ES	IS	CS-TSE	ICC2
Student	Meta									0.62
	Moti	0.66**								0.32
	Behav	0.45**	0.41**							0.66
	SS-TSE	0.17**	0.10*	0.38**						0.80
Classroom	Meta									–
	Moti	0.83**								–
	Behav	0.55**	0.72**							–
	CO	–0.35**	–0.36**	–0.11	–					–
	ES	–0.43**	–0.33**	–0.14	–	0.71**				–
	IS	–0.32**	–0.36**	–0.21	–	0.51**	0.71**			–
	CS-TSE	–0.05	–0.13	0.14	–	0.19	0.20	0.07		0.81
Mean		3.58	3.45	4.12	3.43	6.33	4.20	2.94	3.44	–
Variance		0.39	0.80	0.35	0.57	0.55	1.01	0.36	0.21	–
ICC1		0.08	0.02	0.09	0.38	–	–	–	–	–

Meta, metacognitive SRL-skills; Moti, motivational SRL-skills; Behav, behavioral SRL-skills; SS-/CS-TSE, student-/class-specific teacher self-efficacy for SRL; CO, classroom organization; ES, emotional support; IS, instructional support. * $p < 0.05$. ** $p < 0.01$.

TABLE 3 Standardized regression coefficients for regression of SRL-skills on TSE and domains of the CLASS.

Models	Variables	Meta	Moti	Behav
Three CLASS model	SS-TSE for SRL	0.17**	0.10**	0.38**
	CO	–0.09	–0.26	–0.04
	ES	–0.37	0.01	0.00
	IS	–0.03	–0.26	–0.20
	CS-TSE for SRL	0.03	–0.05	0.16
Combined CLASS model	SS-TSE for SRL	0.17**	0.10**	0.38**
	CLASS	–0.43**	–0.42*	–0.20
	CS-TSE for SRL	0.02	–0.04	0.17

Meta, metacognitive SRL-skills; Moti, motivational SRL-skills. Behav, behavioral SRL-skills. SS-/CS-TSE for SRL, student-/class-specific teacher self-efficacy for SRL. CO, classroom organization; ES, emotional support; IS, instructional support. CLASS, CO, ES, and IS combined. * $p < 0.05$. ** $p < 0.01$.

interaction quality were high, particularly between Classroom Organization and Emotional Support ($r = 0.71$, $p < 0.001$), and Emotional Support and Instructional Support ($r = 0.71$, $p < 0.001$). These correlations imply a significant overlap among these interaction domains. The various components of SRL were also correlated at the class level, but, as compared to the student level, several correlations were much stronger, such as the correlations between the Motivational and Metacognitive SRL-skills ($r = 0.83$, $p < 0.001$) and Motivational and Behavioral SRL-skills ($r = 0.72$, $p < 0.001$). It appears that these SRL-skills are more strongly interconnected between classrooms than within classrooms.

Contrary to expectations, there were negative correlations between the domains of classroom interactions and SRL-skills, including significant negative correlations between the three domains and Metacognitive and Motivational SRL-skills. These negative correlations suggest that as the quality of teacher–student interactions increases, the level of SRL-skills in students decreases.

Multilevel regression models

Our first model was the intercept-only model that served as a baseline model for model comparison. In step two, a random intercept model with the student-level predictor Student-Specific TSE and the classroom-level predictors Instructional Support, Classroom Organization, and Emotional Support and TSE was fitted to the data. This CLASS model with the three measures of the CLASS was a significant improvement over the intercept-only model, according to the Satorra-Bentler adjusted chi-square difference test ($\text{TRd} = 2326.75$ (27), $p < 0.01$). The standardized coefficients of this model are presented in Table 3. These coefficients demonstrate that student-specific TSE is significantly related to students’ Metacognitive ($\beta = 0.17$, $p < 0.05$), Motivational ($\beta = 0.10$, $p < 0.05$), and Behavioral SRL-skills ($\beta = 0.38$, $p < 0.05$).

Standardized coefficients for the relationship between the three domains of class-level interactions and SRL-skills were generally non-significant and predominantly close to zero (see Table 3). The three interaction domains did not have an independent association with each of the SRL-skills. Their effect was likely determined by what they collectively contributed to the dimension of SRL. Therefore, the three domains of teacher–student interactions were combined into a single measure. The combined measure had excellent internal consistency (Cronbach’s $\alpha = 0.91$). The combined CLASS model appeared to have better model fit than the intercept-only model ($\text{TRd} = 901.16$ (17), $p < 0.01$). The results of the combined CLASS model showed significant negative standardized coefficients between teacher–student interactions and students’ Metacognitive and Motivational SRL-skills.

In step three, we added random slopes to the random intercept model for each combination of the student level predictor TSE with Metacognitive, Motivational, and Behavioral SRL-skills. Random slopes were non-significant for the association between TSE and students’ SRL-skills when they were separately added to the combined

CLASS model. This implies that the variation among classes for students' SRL-skills is not significant in our data. Hence, there is no indication for a moderating effect of the quality of teacher–student interactions on the relationship between TSE and SRL-skills, given that significant slope variation is a precondition for such an effect (Hox et al., 2018).

An extra step was added to our modeling procedure as we observed positive associations between TSE and SRL-skills at the student level, whereas at the class level the coefficients were near zero and non-significant. Contextual effects for aggregated TSE and the three SRL-skills in the combined CLASS model were therefore calculated, based on three newly created parameters. These parameters match with the differences between the corresponding student and class-level variables for the relationships between TSE at the class level and the three SRL-skills. The contextual effects then reflect the effect of the aggregated class-level variable of TSE, after controlling for the effects of student-specific TSE at the student level (Marsh et al., 2012). Results showed significant negative context effects for TSE at the class level and Metacognitive ($B = -0.25, p < 0.001$), Motivational ($B = -0.21, p < 0.01$), and Behavioral SRL-skills ($B = -0.37, p < 0.001$). These findings indicate that the relationship between student-specific TSE and the three SRL-skills is negatively moderated by TSE at the class level.

Discussion

The current study had three main research questions. Our first question was about the association of TSE for SRL-skills with students' SRL-skills at both the student-specific and class-level. Our second question was whether observations of the quality of teacher–student interactions were related to students' metacognitive, motivational, and behavioral SRL-skill. Our third question was whether the quality of teacher–student interactions moderated the relationship between TSE for SRL-skills and students' SRL-skills.

Results generally showed that teachers who reported higher levels of student-specific TSE for SRL-skills were also more likely to have students in their class with higher levels of SRL-skills, while at the class level such a positive relationship was not found. Moreover, our study revealed that when high-quality teacher–student interactions were observed, students reported lower levels of metacognitive, motivational, and behavioral SRL-skills. In addition, findings indicated no significant moderating effect of teacher–student interactions on the relationship between TSE and SRL-skills.

Relationships between teacher self-efficacy and students' SRL-skills

Relationships between TSE and students-SRL skills were examined at both the student and the class level. At the student level, teachers who reported higher levels of student-specific TSE for SRL had students who reported higher levels of metacognitive, motivational, and behavioral SRL-skills. These findings are in line with our hypothesis and with previous research in which the effects of student-specific TSE on student outcomes were examined (Zee et al., 2016b, 2018). Such a positive association between TSE and various SRL-skills is not surprising, as teachers

may be better able to make judgments about their capacity to support a particular student when they consider the concrete needs, behaviors, and actions of individual students rather than an entire group (Zee et al., 2016b). Moreover, it seems that a domain and student-specific form of TSE is well-tailored to the outcome of interest, increasing the predictive merit of TSE in relation to self-regulation skills (Bandura, 1997). Our study is, to our knowledge, the first to demonstrate that judgments of teachers about whether they are able to foster SRL-skills for specific students are associated with higher levels of SRL-skills. It appears therefore important for teachers to consider how they may enhance their sense of self-efficacy for SRL-skills for individual students, as it seems that individual students' SRL-skills benefit the most from this approach.

However, at the class level, the average level of TSE for SRL reported by teachers, based on their student-specific TSE, was not related to the average level of SRL of a class as reported by the students. This finding is not in line with the commonly recognized belief that higher levels of TSE lead to higher levels of SRL-skills in students (e.g., De Smul et al., 2018). A main explanation for why our results deviate from most previous findings, is that the level of SRL-skills is often not directly assessed in other studies (e.g., De Smul et al., 2018; Karlen et al., 2020). Rather, in most studies, teachers were asked to report on both their TSE for fostering SRL and SRL-skills in their students. In that case, teachers are the same informant for both the predictor and outcome variables. The use of the same informant for TSE and students' SRL-skills seems to overestimate their relation (Vandevelde et al., 2013; De Smul et al., 2018). Our findings resonate with the results of a recent study in which the associations between teachers' self-reported judgments and students' perceived levels of SRL-skills were nonsignificant as well (Dignath, 2021). In this study and the current study, TSE was based on teacher reports and the level of SRL-skills was directly assessed through student reports.

Another reason for the absence of a relation between student-specific TSE and students' SRL-skills at the class level, is that in earlier studies teachers rated their TSE based on general judgments about their self-efficacy towards an entire class. In the current study an aggregated measure of student-specific TSE was used. This aggregated measure was based on teachers' judgments of a random sample of individual students within each class. Previous research has shown that general and aggregated TSE are only moderately correlated, which may result in different relationships with student outcomes (Zee et al., 2016b, 2018). An explanation for these differences is the distinction between aggregated TSE as a classroom context variable and general TSE as a classroom climate variable, which are both based on different referents (Marsh et al., 2012). Aggregated TSE is a representation of teachers' feelings of self-efficacy towards specific students in a particular classroom, and therefore based on individual students who each receive an individual score. General TSE, on the other hand, uses the entire class as referent (Zee et al., 2018). Hence why students in the same class all receive the same score. The differences in referents may have a fundamental influence on the interpretation of both construct, which is why they may have different relationships with the outcome variables (Marsh et al., 2012; Morin et al., 2014).

The positive associations between TSE and SRL-skills at the student level and the lack of relationships at the class level,

suggests a contextual effect of the class (Marsh et al., 2012). The contextual effect is the effect of the class-level variable of TSE, after controlling for the effects of student-specific TSE. Indeed, in our study the contextual effect shows that teachers who feel more confident about fostering SRL-skills in their classes are likely to teach students in those classes who perceive their own self-regulated learning skills as lower. In contrast, in classes where TSE for SRL-skills is reported to be lower, students perceive their SRL-skills on average to be higher. We had not anticipated this effect and it is not straightforward to provide an explanation. One possibility is that teachers use the teacher report scale somewhat differently, resulting in, for instance, one teacher consistently assigning higher ratings than another teacher about their TSE for SRL-skills. Consequently, the relationship between TSE and SRL-skills may be predominantly a within-class effect. Another possible explanation is that teachers' efficacy beliefs directly influence teachers' behavior and may therefore serve as a good proxy for how teachers support students within their classrooms (Bandura, 1997; Zee and Koomen, 2016). Thus, if teachers feel highly self-efficacious in teaching SRL, they may invest considerable time in this area and potentially scaffold many SRL-skills for their students. This may have two consequences. First, due to teacher's emphasis on SRL-skills, students may become more aware of the strategies they do or do not employ, leading to rate themselves lower on these skills. Second, due to the focus on SRL-skills, the students may feel that they need to apply fewer skills themselves to regulate their own learning as the teacher is already doing it for them.

Quality of teacher–student interactions and student's SRL-skills

A main finding of this study is that in classes with higher quality teacher–student interactions students reported lower mean class-levels of their SRL-skills. This is particularly evident for students' metacognitive and motivational SRL-skills. Based on previous research that used student and teacher reports, we had expected the opposite outcome (e.g., Rieser et al., 2013). That is, higher teacher–student interaction quality would, at least for the metacognitive SRL-skills, be associated with a higher mean class-level of SRL-skills. Our results deviate from these expectations.

Until now, there were four studies that reported no or weak correlations between domains of the CLASS and students' SRL-skills (Rimm-Kaufman et al., 2014; Cadima et al., 2015; Schenke, 2018; van Dijk et al., 2019). There are two explanations for this findings. First, absent or weak correlations may be expected because the total score of the CLASS could be disproportionally influenced by a small number of students. Teacher–student interactions consist of both teacher and student behavior that are observed simultaneously. For example, observers score teacher behavior on the Instructional Learning Formats scale, such as promoting involvement and teacher interests, and at the same time also active participation and sustained attention of students (Pianta et al., 2012). Another example is when two students are arguing during the observation, while there is little else happening in the classroom. Their actions probably taint the scores, while this situation may not necessarily

impact all students. Hence, it seems that the CLASS, although considered to be a classroom climate measure, also encompasses aspects related to specific student behaviors and actions in class.

Second, another explanation for this unexpected finding is that classroom interaction quality and students' SRL-skills are measured at different levels of classroom ecology. Whereas interaction quality refers to the overall, more objective atmosphere of the classroom (i.e., contextual variable), the average SRL-skills of a class are based on the subjective ratings of all students in that particular class (i.e., climate variable). Each score is assigned equal weight when aggregated to the class level. In that case, the aggregated outcome measure is based on a different level of analysis than the overall classroom measure. This may potentially lead to correlations and coefficients that are lower than expected (Marsh et al., 2012; Morin et al., 2014). A suggestion for future research may therefore be to design and use an observation instrument that is aimed at the quality of dyadic, one-on-one, interactions instead of the classroom as a whole. The predictor and outcome variables are then both at the student level and reflect the same level of analysis and theory, also when aggregated to the class level (Marsh et al., 2012).

However, in the current study negative relationships between the quality of teacher–student interactions and students' SRL-skills were found. This may not be fully explained by differences in the levels of analysis. There seem to be two main reasons for the negative relationships. First, it is possible that higher quality interactions made students believe that they have less SRL-skills, because they are provided with relatively better support from their teachers. Second, even though the quality of interactions are high and teachers provide numerous opportunities for learning, these high-quality interactions may also take away some of the necessity for students to regulate their own learning in their experience. For example, when teachers provide high-quality instructional support they demonstrate, guide, and model extensively, which might reduce the necessity for students to actively use their SRL-skills to some extent during instruction. Consequently, when asked to report about their SRL-skills, students may indicate a lower use of these skills. Further research investigating relationships between the domains of the CLASS and SRL-skills seems therefore needed to determine if the negative associations from the current study persist across different classroom and school contexts.

The third and final aim of the study was to examine the moderating role of instructional support, classroom organization, and emotional support on the relationship between student-specific TSE with the three SRL-skills. Notably, none of the random slopes for each combination of TSE with metacognitive, motivational, or behavioral SRL-skills were statically significant. As a result, we were unable to identify any moderation effect for one of the domains of teacher–student interactions. These findings do not align with our hypothesis that a moderation effect would be present. Rather, our findings demonstrate that relationships between TSE and SRL-skills are relatively less sensitive to the influence of the classroom ecology.

Limitations

There are three limitations in the current study that need to be addressed. First, our study is cross-sectional and correlational in

nature, preventing us from drawing causal conclusions. Although our findings offer insight into the complex relationships between TSE and SRL-skills at both the student and class level, it is possible that these associations are reciprocal (Bandura, 1997). This would be in line with social-cognitive theory suggesting that teachers' personal factors, behaviors, and the classroom context interact with each other bidirectionally. Future research could employ longitudinal, cross-lagged multilevel designs to disentangle causal effects and examine whether these relationships are indeed reciprocal.

Second, we did not add a general measure of TSE for SRL to our study in addition to the aggregated TSE variable at the class level. Previous research has demonstrated that general TSE and aggregated TSE are only moderately correlated and may have different relationships with student outcomes (Zee et al., 2016b, 2018). Inclusion of a general measure of TSE would have made our results more comparable with those from previous studies. However, as seen in previous research, relatively weaker relationships are found between general TSE and student outcomes as compared to a specific measure of TSE (Zee and Koomen, 2016; Zee et al., 2018). This is the primary reason why we relied on specific-student measures for TSE.

Third, despite intensive training and a yearly recertification, inter-rater reliability was poor or just fair in two areas of the instructional support domain of the CLASS. These findings are in line with previous studies, in which variability among multiple raters was found (Hamre et al., 2013; Mashburn et al., 2013). However, Cronbach's alpha for the total score of the instructional support domain appeared to be good in the current study, which is why we still included it and believe it is a reliable scale for the instructional support domain. Yet, it seems necessary for future research to explore methods to enhance inter-rater reliability of the CLASS, by for example increasing the number of raters per classroom or by improving existing observational measures.

Conclusion

The current study's findings highlight that it is crucial to recognize the multilevel nature of TSE for SRL-skills. Similar to previous studies on TSE (e.g., Zee et al., 2018), relationships with SRL-skills at the student level were positive in the present study, while there were no associations with self-regulation at the class level. These findings demonstrate that the associations between TSE for SRL and students' SRL-skills in elementary schools are complex and need further attention in future studies. Moreover, it seems that student-specific TSE for SRL is important for promoting SRL, and since TSE serves as a good proxy for teachers' behaviors and actions in the classroom, it would likely help teachers to provide them with more concrete tools to teach SRL-skills. This does not only apply to metacognitive SRL-skills, but also to motivational and behavioral self-regulation skills. Additionally, it seems that teaching general strategy use may not be as beneficial to SRL-skills at the class level as compared to a student-specific approach. This approach, in which the needs of each individual student is carefully considered, may offer a more effective method for teachers to help their students to learn and apply SRL-skills.

Our study also revealed, contrary to expectations, that high-quality teacher–student interactions were negatively associated to students' metacognitive, motivational, and behavioral SRL-skills. This unexpected finding may be attributed to our study being among the first to have used classroom observations to measure interaction quality in relation to SRL-skills. Our findings show that the classroom interactions play a highly complex role in promoting SRL-skills. The contextual effect suggests the importance of finding a balance between providing too much support through high-quality interactions and allowing for complete self-regulation. It may also be possible that this balance is also highly dependent on age. Moreover, these findings highlight the importance for future researchers to use other methodologies and instruments than the commonly used self-reports, to better understand the complex dynamics between teacher–student interactions and students' SRL-skills.

Data availability statement

The datasets presented in this article are not readily available because of restrictions imposed by the ethical committee. Requests to access the datasets should be directed to the corresponding author.

Author contributions

NR: Writing – original draft, Writing – review & editing. MZ: Writing – original draft, Writing – review & editing. PJ: Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Helping teacher education students' understanding of self-regulated learning and how to promote self-regulated learning in the classroom

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This research investigated the details and effects of a short online Professional Learning Program designed to develop teacher education students' knowledge about how to promote self-regulated learning (SRL) in the classroom. The Program was based on a new framework for how teachers can promote SRL, the SRL Teacher Promotion Framework (SRL-TPF), which focused on the promotion of SRL strategies, students' knowledge about learning, and students' metacognition. It consisted of seven modules describing the different SRL promotion types and SRL capabilities and ways to promote them through teacher talk and action. Modules included written information and video examples taken from observations of real classrooms, which were used to illustrate the transfer of SRL theory to instructional practice. Each module concluded with several assessment items. During the Program the participants, 91 teacher education students, were asked to use a simplified scoring system based on the SRL-TPF to code lesson transcripts taken from classroom observations. The results showed that by the end of the program over 85% of the participants were able to provide teacher instructions that included explicit SRL promotion and/or promoted students' SRL knowledge. Our study contributes to research findings on teacher education students' knowledge of SRL, their promotion of SRL to students, and the contribution of short duration SRL professional development.

KEYWORDS

self-regulated learning promotion, teacher education student, SRL strategies, SRL capabilities, knowledge and beliefs about learning

1 Introduction

Self-regulated learning (SRL) is a significant conceptual framework that has been developed within the education research literature for several decades (Bjork et al., 2013; Panadero, 2017). Typically, SRL is defined as "the process of systematically organizing one's thoughts, feelings, and actions to attain one's goals" (Usher and Schunk, 2018, p. 19) in relation to learning. An SRL framework focuses on actions learners can initiate and control while involved in learning. As noted by Winne and Hadwin (1998) there is a focus in the SRL framework on the actions of the *self* to organize the regulating of learning. Bjork et al. (2013, p. 436) noted that the construct of SRL "implies that the student wants to regulate his or her

learning” and therefore actions learners undertake to manage their learning require attention by themselves and their teachers, particularly in relation to the ways in which students approach and work on their learning (Butler, 2021).

SRL definitions make clear that it is multidimensional (Boekaerts, 1997; Panadero, 2017; Pintrich, 2000; Winne, 2011; Zimmerman, 2008).

Lawson et al. (2023) recently identified seven categories of regulative activity types—regulation influenced by beliefs about learning, by emotion, by motivation, by cognition, by metacognition, regulation of the learning environment, and regulation emerging from social interaction. This paper focuses on several of these regulative activity types—in particular—knowledge and beliefs about learning, motivation and emotion, cognition, metacognition, and resource management.

A recent meta-analysis of the correlates of under-achievement reinforces the importance of SRL for effective learning (Fong et al., 2023). A meta-analysis of studies by Dignath et al. (2023, p. 32) on interventions focused on the monitoring element of metacognition concluded that “learners who are encouraged to engage in some form of monitoring show improved performance, strategy use, and motivation with respect to their learning.” However, other research suggests that students may not have access to a variety of effective SRL tactics and strategies (Azevedo et al., 2008; Pintrich, 2000). Winne (2014) suggested that this situation was likely due to the infrequent teaching of these strategies in regular classrooms.

The positive effects of the dedicated SRL strategy interventions suggest that many of the students taking part in these interventions either were previously not aware of the strategies or were not aware of when or how to use the strategies effectively. This also implies that it is likely that explicit attention to these strategies by teachers would also show positive effects for such students. However, there is evidence that teacher attention to these student needs may be less widespread than desirable.

Findings in observational research involving elementary and middle school teachers in the United States by Moely et al. (1992), Spruce and Bol (2015), and Hamman et al. (2000) all showed infrequent teaching of SRL strategies. The same pattern of findings emerged in research on German primary and secondary teachers who showed very little direct instruction of SRL strategies, with instances of promotion being mostly implicit and focused on cognitive strategies (Dignath and Büttner, 2018). Similarly, Vosniadou et al. (2024) found very little promotion of explicit strategies as well as of knowledge and beliefs about learning and about SRL in Australian secondary school classrooms.

In this paper we argue for the explicit and detailed promotion of SRL strategies, knowledge about SRL, and metacognition. The rationale for explicit and detailed teacher promotion of knowledge about SRL and SRL strategies is clear. If students are expected to take effective control of their learning, then they need to know how to exercise such control. And if students’ knowledge of SRL is not well-developed then teachers have clear opportunities in lessons to explicitly promote such knowledge. However, as noted above, findings from research examining teacher promotion of SRL has shown that such explicit and detailed SRL promotion is not widespread. In reviews of this research Dignath and Mevarech (2021) and Dignath and Veenman (2021) concluded that although research did provide examples of indirect strategy promotion by teachers who arranged

supportive classroom environments, the explicit promotion of SRL strategies is relatively infrequent. Although studies have shown that practising teachers and teacher education students can be supported to set up more explicit strategy promotion (Askill-Williams et al., 2011; Gillies and Khan, 2009), this has not become common practice in classrooms, and other studies have shown little positive impact of SRL professional development on teachers’ SRL promotion (Heirweg et al., 2021; McKeown et al., 2019).

This pattern of research findings suggests that because promotion of SRL strategies by practising teachers during lessons is critical for students’ learning, teacher education programs should ensure that the participants involved in these programs have both good knowledge of SRL and know how to effectively assess and explicitly promote this knowledge in the students they will teach. During both their teaching practicums and their subsequent teaching these teacher education students will benefit if they know how to assist their students to develop and use effective knowledge of how to manage their learning (English and Kitsantas, 2013; Michalsky and Schechter, 2013; Peeters et al., 2014).

In response to the need for more explicit promotion of SRL strategies by teachers, the need for more, and different, professional development has been a focus for researchers working with teachers and teacher education students. Part of this recent concern has been to give greater attention to the different types of SRL promotion identified in recent research noted above. This need for greater emphasis on explicit promotion of SRL strategies was one of the motivations for the design of the professional development delivered in this study.

The design of the Program described below was based on the arguments above that promotion of SRL strategies during lessons is critical for students, and SRL professional development is needed by teachers for increased SRL knowledge, self-efficacy and subsequent self-regulated teaching (SRT) in classrooms. This implies that teacher education programs should ensure that the education students involved have good knowledge of SRL and know how to effectively assess and promote this knowledge in their teaching practices for the students they will teach.

However, other research raises doubts about the extent to which many teacher education students have achieved such standards of preparation. Research such as that by Panadero (2017) and Moos and Ringdal (2012) have recognized that a lack of SRL training during teacher education may be contributory factors in teachers’ classroom neglect of SRL in their classrooms. In related research Ohst et al. (2015) characterized the German pre-service education students they observed as having fragmentary, disorganized and sometimes inaccurate knowledge about learning. Endedijk et al. (2012) also suggested that programs of teacher education rarely involve adequate stimulation of the development of good quality SRL knowledge, suggesting that such a situation can arise because teaching practicum assignments do not place sufficient emphasis on the SRL knowledge and skill of the teacher education students, but focus more on the actions of the pupils they will teach.

More encouraging is the research showing that teacher education students can be helped to develop greater knowledge about SRL and how to promote it when teaching (Michalsky and Schechter, 2013). The need for this development has been supported by Arcoverde et al. (2020) and Kramarski and Kohen (2017). Michalsky and Schechter (2018) examined the effect on pre-service teachers of instructional situations that involved learning from both problematic and successful

experiences. They found that these multifaceted situations led to greater preservice teachers' promotion of SRL to students than others that did not involve both successful and problematic situations. These studies have pointed to the need for further research on more extensive teaching about SRL to teacher education students and the assessment of effects on the participants' observed SRL knowledge and use of that knowledge.

One major objective of this study was to provide teacher education students with a professional learning program on the nature of SRL, which included provision of knowledge about ways to effectively promote SRL strategy use in lessons and of ways to promote student metacognition in the classroom (Zepeda and Nokes-Malach, 2021). Despite the findings of meta-analytic research on the importance of metacognitive reflection (Dignath et al., 2008; Dignath and Büttner, 2008; Hattie et al., 1996), its promotion has not been included in frameworks that investigate the direct promotion of SRL, except in the form of the teaching of metacognitive strategies.

The length and context of professional development programs in this area were also issues that emerged in reviewing past research. Peeters et al. (2014) recommended professional development occur using a school-wide approach with all staff contributing to an environment supporting students' SRL. In many situations, including that of teacher education students who may be on placements in schools for only relatively brief periods, such an approach may not be feasible. Even with a school-wide approach, a one-year school-wide study by Heirweg et al. (2021) showed little positive impact on teachers' self-efficacy for promoting SRL or on their students' achievement. Kramarski and Heaysman (2021) proposed that one-year was perhaps insufficient time for desired change and that the teachers involved in Heirweg et al.'s (2021) study lacked skills to transfer the SRL professional development knowledge from general to domain-specific needs. In addition, Kramarski and Heaysman (2021) noted a lack of attention to the need for explicit strategy promotion in the Heirweg et al. (2021), study and in similar professional development research.

For example, Harris et al. (2012) also undertook domain-specific school-based professional development across a period of four to six weeks, and found increased teachers' SRL self-efficacy and SRL instructional use but less effect on learner outcomes. Conversely, McKeown et al. (2019) drawing from Harris et al., completed a mixed method professional development study, involving two professional development days, in class teaching observations, and support, with a domain-specific randomized trial resulting in positive outcomes for teacher participants and their students. Both Harris et al. (2012) and McKeown et al. (2019) utilized evidence-based professional development of self-regulated strategy (SRSD) in the writing genre yet the outcomes for learners were different. Harris et al. (2012) found that although SRSD led to improvements in genre specific writing elements the overall writing quality did not improve. McKeown et al. (2019) participants however reported positive changes in learners' writing self-concept, ability, and actions. The lack of a clear pattern in the Harris and McKeown et al. sets of findings suggests that extended time on its own is not associated with effective outcomes for professional development programs and raises the possibility that shorter programs that attend to factors such as explicit promotion of SRL strategies and knowledge should be investigated to see if they could generate positive effects.

Indeed, a recent model of professional development for SRL has proposed the delivery of shorter programs. Kramarski and Heaysman's (2021) conceptual framework developed Zimmerman's (2008) three phases of SRL into a spiraled three-step professional development program, differentiating teachers' as both self-regulated learners and self-regulated teachers, with a final stage focused on the influence of teachers' self-regulated teaching (SRT) for students' SRL. This paper draws on Kramarski and Heaysman's (2021) first stage, teachers' learning about SRL, and the final stage, teachers promoting SRL for students. We identify the final stage by using the term self-regulated teaching (SRT) in this paper. Each of their study's phases incorporated *self-questioning prompts* and generic SRL strategies in the specific domains of, mathematics or language. Their 30-h professional development program incorporating explicit instruction, collaborative learning, role playing, reflection on beliefs and practices, and teaching SRL to students, yielded positive outcomes with teachers SRT improved and their students' academic results increased.

An objective of the present research was also to provide teacher education students with an even shorter professional learning program, which still provided rich information about the nature of SRL and included an emphasis on the need for explicit SRL promotion and discussion of how such promotion could be done. With respect to length of the program we focused on a duration that might more easily be incorporated into existing teacher education courses.

We also followed the suggestions by Kramarski and Heaysman (2021) that a program of relatively short duration could consider elements of both self-regulated learning and self-regulated teaching. Our focus in this paper has been concerned with both elements. First, we investigated the extent to which teacher education students can develop their own knowledge about SRL, specifically knowing about specific SRL promotion types. Secondly, we focused on how they could modify the design of teaching tasks so that these could be more effective in stimulating SRT activity. Our assessments of test items requiring participants to increase the SRLTP in teacher statements also considered evidence that participants could demonstrate their knowledge of ways in which they could promote SRL to students.

1.1 The present research

The Program presented to participants in this study used innovative methods to create an awareness of the discourse and actions teachers can use in the classroom to help students develop their knowledge of SRL and, SRL strategies. This was done by requiring them to use a scoring guide based on the SRL Teacher Promotion Framework (SRL-TPF) to code a lesson transcript taken from a classroom observation. We reasoned that this activity would make the teacher education students more aware of the specific instructions teachers give students during lessons and how these instances of teacher talk can influence students' SRL knowledge, beliefs, and learning actions.

The Program was based on the recommendations of the SRL-TPF developed in previous work (Vosniadou et al., 2024) for the direct promotion of SRL in the classroom. The SRL-TPF drew from several theoretical approaches to SRL to analyze classroom teaching and learning approaches (Boekaerts and Cascallar, 2006; Efklides, 2011; Pintrich, 2000; Schunk and Greene, 2017; Winne and Hadwin, 1998; Zimmerman, 2008). More specifically it built on Dignath and

Veenman's (2021) work and the Assessing How Teachers Enhance Self-Regulated Learning (ATES) guide to the analyzing of types of SRL promotion (Dignath-van Ewijk et al., 2013; Dignath and Büttner, 2018; Dignath et al., 2022). For the present study we used a simplified version of the ATES focusing on the three types of SRL promotion and four capabilities shown in Table 1.

As in the ATES guide, the SRL-TPF differentiated explicit from implicit strategy instruction. *Explicit strategy instruction* was recognized when teachers made their intention to teach a strategy clear to students and described the strategy in detail, using the word *strategy* or providing a name for it. It is important for teachers to name the strategy they teach because this helps students attend to the details of the strategy, remember it, and increases the likelihood that students will transfer its use to other situations (Brown et al., 1981; Dignath and Büttner, 2018; Veenman, 2013). *Implicit strategy instruction* involved the instruction of a procedure without using the word 'strategy' to describe it or without naming or identifying what was being described as a strategy. In these cases, the teacher was not explicitly making students aware of the strategy.

In addition, the Program introduced two more types of SRL promotion, the promotion of knowledge and beliefs about learning, and metacognitive reflection and support. Previous research approaches have not investigated how teachers promote students' knowledge about SRL through providing students with information about how learning happens, and they have not identified that having a repertoire of learning strategies is an important SRL promotion type. Talking to students about mathematics anxiety, for example, can help them understand what such anxiety is and how it influences mathematics performance. It can also help them to better understand some of their own negative academic emotions and help them to find ways to control them (Carey et al., 2019; Szucs and Mammarella, 2020).

A third type of SRL promotion identified in the SRL-TPF was metacognitive reflection and metacognitive support. Despite the findings of meta-analytic research on the importance of metacognitive reflection (Dignath et al., 2008; Dignath and Büttner, 2008; Hattie et al., 1996), its promotion has not been previously included in frameworks that investigate the direct promotion of SRL, although it has been included in observation protocols that investigate support of metacognition (Zepeda and Nokes-Malach, 2021). In the SRL-TPF, we used the term *Metacognitive reflection* to refer to instances during which teachers encourage students to reflect on their knowledge and/or strategies (Brown, 1987; Schraw, 1998; Schraw and Moshman, 1995; Zepeda and Nokes-Malach, 2021). *Metacognitive support*, on the other hand, was used to refer to instances when teachers reminded students, or helped them think

about, their existing knowledge of learning or learning strategies that might be relevant.

The SRL-TPF also considered whether the strategies or knowledge being promoted were *domain-general* or *domain-specific*. Knowledge and strategies are domain-specific when they are helpful in one subject area but not in another. For example, knowledge about how to subtract or divide and relevant subtraction or division strategies are useful in mathematics but not in English, as opposed to information and strategies about how to appreciate a poetic device, which might be helpful in English but not mathematics. Domain-specific learning strategies were included in the present framework because their explicit promotion has been associated with learning gains in the subject areas (Brown et al., 1981; Dignath et al., 2008). However, they are not intrinsically related to SRL the way domain-general learning strategies are. Strategies are domain-general when they span across different subject disciplines. They form a widely applicable body of knowledge about how to learn that has been built up by educators, psychologists, cognitive scientists, and neuroscientists and on which learners rely to monitor and control their learning across subject areas. It is important to distinguish domain-general from domain-specific strategies for a better understanding of teacher practices related to SRL.

Regarding SRL capabilities, the SRL-TPF distinguished amongst cognitive, metacognitive, motivational/emotional and resource management capabilities. Cognitive capabilities refer to the knowledge and strategies employed by learners to support information processing during learning. Strategies supporting cognitive capabilities include focusing attention, task analysis, imagery, elaboration, storage, paraphrasing, and rehearsal (Askell-Williams et al., 2011; Paris and Paris, 2001; Vosniadou et al., 2021; Winne, 2017).

Metacognitive capabilities refer to the knowledge and strategies used by learners to plan, monitor, and evaluate their learning. Strategies supporting metacognitive capabilities include planning, checking, and reflecting on one's learning process and progress (Askell-Williams et al., 2011; Efklides, 2011; Nückles et al., 2009).

Motivational/emotional capabilities refer to the knowledge and strategies used by learners to regulate their motivation for learning. Strategies supporting motivational and emotional capabilities include appropriate goal setting, learning orientation, controllable attributional effort, and emotional regulation (Efklides, 2017; Winne, 2017).

Resource management capabilities draw on knowledge, beliefs, and strategies to manage one's social and physical environment for learning optimization. Strategies supporting resource management capabilities included recognizing and seeking help when needed, organizing space, resources, and time management for required learning (Pintrich, 2000; Vandeveldt et al., 2013).

Three research questions are addressed by this study. These research questions respond to the previously discussed needs for teachers and education candidates to be knowledgeable about SRL and approaches supporting SRT in classrooms for students' development of SRL skills.

- 1 How well did the participants understand (a) the information about SRL; (b) the distinction between the different SRL promotion types; (c) the distinction between the different SRL capabilities; and (d) distinguishing domain-specific from domain-general SRL promotion?
- 2 In what areas were participants successful and unsuccessful in their use of the SRL-TPF to code a lesson transcript?

TABLE 1 A simplified version of the SRL-TPF used in the present study.

SRL promotion type	SRL capability	Domain
SRL knowledge/beliefs	Cognitive	Domain-specific
SRL strategies: implicit strategy and explicit strategy	Metacognitive	Domain-general
Metacognitive support and reflection	Motivational	
	Resource Management	

- 3 How well did participants apply their knowledge of the SRL-TPF to provide high SRL instruction to students?
- 4 Was the SRL intervention associated with a change in participants' confidence in teaching SRL to students?

2 Materials and methods

2.1 Participants

The participants were 91 teacher-education students from two Australian universities, with a median age of 27.8 years. Seventy-seven participants were undertaking a Masters' degree and indicated they had previous teaching experience, the majority with less than 5 years' experience. The remaining 14 participants indicated they had no teaching experience and were undertaking a Bachelor of Education (n = 10) or Master of Education (n = 4). The majority of participants (63.7%) could not recall covering Program material in any of their Education courses or professional development. Participants level of teaching experiences or prior engagement with SRL was not considered in data analysis. Participants were recruited through direct email and course announcement appeals. The research was undertaken with approval from the Human Research Ethics Committee of each university. All participants signed an online consent prior to accessing the Program.

2.2 Procedure

Verbal and written poster announcements for the study were made in teacher education courses at two universities. Interested teacher education students scanned a QR code to read the letter of introduction and plain language statement explaining the study. If the teacher education student wanted to participate in the study, they proceeded to sign an online consent form and complete one pre Program item. Program login instructions were sent following signed consent. Participants then completed the Program, consisting of 7 sequential modules at a time or times convenient to them, and multiple logins being possible. Participants could complete the Program in less than 4h. Participants were excluded from the study if they failed to complete all seven modules and enter at least one response in the post and delayed items. Each module, described in detail in the following section, included activities that could only be attempted on one occasion. At the end of the seven modules, participants completed one post test item and provided Program feedback. Approximately four to six after Program completion participants responded to a delayed item. Participants received a certificate of completion and \$30AUD in gift cards.

2.3 Materials

2.3.1 Pre, post and delayed items

One 4-point-scale item identifying participants' SRT confidence was asked pre, post and approximately 6 weeks following participants' completion of the Program. The post-test included two additional multiple choices and two free text items seeking feedback on the Program.

One 4-point-scale question was completed by participants to measure their confidence teaching SRL to students. It asked *how confident are you that you can teach SRL to your students?*

Participants responded to one two-point-scale item related to the program's usefulness and relevance and one three-point-scale item asking; *Have you covered the material in this program in any of your Education topics/courses or professional development courses.* Following each scaled item participants had an opportunity to provide further details through a *brief description*.

2.3.2 The modules

Table 2 describes the contents of the seven modules. Each module included written examples, and three of the seven modules included video examples that illustrated the transfer of SRL theory to classroom contexts. All examples in the modules, including the video excerpts, were taken from observations of real classrooms. Video excerpts showed teachers in standard Australian classrooms instructing students on undertaking specific activities, such as mathematics rules or activating prior knowledge. All modules included activities testing participants' comprehension of the module's content. In the final module a lesson transcript was provided for participants to code using the SRL-TPF, and participants used their knowledge of SRL promotion from the Program to complete two scenario activities that required them to transform low SRL scenarios into high SRL scenarios. Participant responses to the module activities were examined to determine whether they could effectively use and apply the SRL-TPF to the excerpts of teacher talk and actions included in the Modules.

TABLE 2 The SRL program structure including assessment items and instruments.

Program Item (est. completion time)	Description
Module 1	What is SRL? Multiple-choice items 1 and 2.
Module 2	SRL Capabilities and their benefits Multiple-choice items 3 and 4. Matching items 5–8.
Module 3	Promoting SRL in the classroom: The SRL teacher promotion framework (SRL-TPF) Multiple-choice items 9 and 10.
Module 4	SRL-TPF1: The promotion of knowledge and beliefs about learning and SRL Matching items 11–15.
Module 5	SRL-TPF2: The promotion of learning strategies Multiple-choice items 16, 17 and 18. Matching items 19–24.
Module 6	SRL-TPF3: Providing metacognitive support Multiple-choice items 25 and 26.
Module 7	Activities for your consideration Two open text scenario items 27 and 28. Coding activity items 29–42.

For each matching item participants were presented with lists in two columns. They were then required to connect each item from one column with its match in the other column. Open text scenario items and coding activity items are presented in the results section.

Module 1 (approximately 20 min) introduced participants to SRL by defining SRL, outlining its importance to teachers and students, and introducing four SRL capabilities.

Module 2 (approximately 30 min) introduced definitions of implicit and explicit strategy instruction and description of knowledge and beliefs about learning and the benefits of SRL capabilities (cognitive, metacognitive, motivational/emotional, and resource management). Each SRL capability type was defined with written examples for how they might be observed in beginning SRL and skilled SRL learners. For example, cognitive capabilities may be observed in a beginning SRL learner becoming distracted when doing tasks and needing assistance to refocus on the task, whereas a skillful SRL learner finds ways to control their attention and refocus when distracted. The benefits of SRL for academic performance were described, along with explanation of the significance of teacher promotion of SRL capabilities.

Modules 3 to 6 were dedicated to the SRL-TPF and its use. Module 3 (approximately 30 min) explained how SRL capability development in learners may be supported through teachers' explicit attention to the words and actions they used in their class lessons to directly or indirectly promote SRL. The forms of SRL promotion and SRL capabilities (Table 1) were explained with connection to examples from lessons.

Module 4 (approximately 30 min) focused on the promotion of knowledge and beliefs about learning characteristic of self-regulatory activity, including the belief that learning activity can be regulated or managed by the learner. For example, utilizing cognitive modeling or explicitly discussing SRL strategies such as resource management and motivational strategies. Videos and written examples of classroom practices and implementation approaches for SRL were provided to participants. Videos of teaching from prior research in Australian classrooms were used in discussion of classroom implementation of SRL activities and promotion.

Module 5 (approximately 40 min) drew attention to the promotion of learning strategies to enhance learning through domain-general and domain-specific strategies and provided further examples of implicit and explicit strategy promotion. Videos and written examples of classroom practices were included to support participants' recognition of these concepts in classroom contexts.

The focus for module 6 (approximately 30 min) was on metacognitive reflection and metacognitive support through prompting students to use their existing knowledge and beliefs in ways that require the evaluation of their thinking. Teacher-talk statements, a video of classroom practices, and a lesson transcript excerpt were presented to support conceptual application to classroom contexts.

Module 7 (approximately 60 min) provided four classroom scenarios demonstrating opportunities for teachers to adjust their instructional language to increase promotion of SRL capabilities in students. Participants were then presented with two low SRL scenarios and tasked with rewriting these to transform them into high SRL scenario examples.

2.4 Module assessment items

Multiple-choice questions, matching activities, coding activities, and an open text activity were used to test participants comprehension of Program modules. Table 2 shows the placement of comprehension items within the Program. Throughout the Program there were 11

multiple-choice items, 15 matching activities, one two-part open text activity, and one coding activity.

2.5 Data coding

Multiple-choice, coding and matching items received a score of 1 when correct and 0 when incorrect. Module open text items were scored on a scale of 0 to 5 and 0 to 6 using a coding guide. Two researchers rated a sample of open text item responses and discussed issues arising from their coding trials. Where necessary coding definitions were revised, and further coding trials were run until substantial agreement was achieved (84% with a Cohen's *k* of 0.68). Coding was then completed by one researcher. The post multiple choice items were scored 1 when answered yes and 2 when answered no, and open text items were coded by one researcher.

3 Results

3.1 Research question 1: how well did the participants understand (a) the information about SRL; (b) the distinction between the different SRL promotion types; (c) the distinction between the different SRL capabilities; and (d) distinguishing domain-specific from domain-general SRL promotion?

Results from assessment items undertaken following engagement with information provided in modules 1 and 3 of the SRL-TPF showed most participants had a sound understanding of SRL. Module 1 focused on defining SRL and module 3 focused on SRL promotion. 82.8% of participants demonstrated understanding of SRL and almost all participants understood the significance of SRL promotion by correctly identifying how teachers could promote students' SRL. Overall participants' understanding of SRL information provided in the SRL-TPF was strong with the average response across 4 items being 90.65%.

3.1.1 Distinguishing different SRL promotion types

Participants were mostly successful (80.77%) in identifying distinctions between implicit and explicit SRL promotion and identifying statements supporting students' metacognitive reflection with an average of 80.77% correct in three test items. Almost all participants correctly identified when a provided statement was an example of explicit strategy promotion (93.9%) and most correctly distinguished the statement that was not an example of metacognitive support and reflection (70.7%). A statement with no connection to SRL promotion was correctly recognized by 83.5% of participants. However, when asked to match a statement to an SRL strategy they were mostly (52.7%) incorrect in recognizing the statement as being metacognitive.

3.1.2 Distinguishing different SRL capabilities

Participants were tested multiple times on their understanding of the distinctions between SRL capabilities. When presented with

two short descriptions of teacher actions participants were mostly successful (81.3%) in distinguishing SRL capabilities. Almost all participants, average 96.23%, were successful in matching the SRL capability with its definition in three test items. When presented with teacher talk statements, however, participants difficulties in understanding the distinction between different SRL capabilities was evident; in seven test items the average correct responses was 81.29%. Resource management (91.9%) and motivational/emotional (85.35%) capabilities were most easily identified by participants while identification of cognitive capabilities (60%) and metacognitive capabilities (74.7%) proved the most challenging for participants.

3.1.3 Distinguishing domain-specific from domain-general SRL promotion

Participants understanding of domain-general and domain-specific SRL learning strategies was tested in two items in Module 5. Most participants correctly distinguished the domain-general statement (85.9%) but when tasked with identifying a domain-specific statement, from a series of four provided statements, significantly less participants were able to do so correctly (61.6%). These results indicate further attention is needed within the Program to support participants' understanding and recognition of domain-specific and domain-general strategy promotion.

3.2 Research question 2: in what areas were participants successful and unsuccessful in their use of the SRL-TPF to code lesson transcripts?

A coding activity in Module 7 presented participants with a mathematics lesson transcript consisting of teacher and student talk. The transcript was structured into seven sections, each section requiring participants to code for SRL strategy and SRL capability. To support participants who were not mathematics teachers the transcript did not focus on specific mathematical procedures. The average percentage of participant correct responses across the seven sections for SRL strategy was 51.1% and 54.1% for SRL capability.

Considering the participants' SRL strategy responses, most successfully identified explicit strategies with results in the two test items ranging from 79.8% to 61.6% correct. Implicit strategies were correctly identified by 62.6% in one test item. Metacognitive support was tested in three items with most correctly identifying it in 2 items 60.6% (average) and only 11.1% correct in 1 item. Knowledge and beliefs promotion was not successfully identified as an SRL strategy by most participants with only 21.2% correctly identifying this SRL strategy in the lesson coding activity.

SRL motivational/emotional capability was the most successfully coded section of the lesson transcript with 83.8% of participants correct. Resource management was successfully coded by 69.7% of participants and most participants, 56.6%, correctly coded metacognitive capability. Cognitive capability was tested on 4 occasions with the average correct responses by participants being 42.1%, and responses ranging from a low of 23.2% to a high of 58.2%.

3.3 Research question 3: how well did participants apply their knowledge of the SRL-TPF to provide high SRL instruction to students?

Participants were tasked with writing a high-SRL version for each of two provided low-SRL scenarios. As shown in Table 3 the first SRL statement related to an exam revision task with participants instructed to promote a strategy for effective exam revision in their response. The second statement instructed participants to provide a high-SRL version providing knowledge about the benefits of feedback.

Responses were scored using the SRL-TPF on a 0–5 scale for item 27 and a 0–6 scale for item 28 with zero being scored where there was no response, or a response that did not refer to SRL promotion in any way. Tables 4, 5 show the classification for each score in each activity was varied slightly to recognize the different SRL focus; strategy instruction for the first activity and knowledge and beliefs about learning for the second activity. Examples for each response score are also shown in Tables 4, 5 along with the overall percentage of responses for each score.

Responses to the first scenario (item 27), which required the respondents to provide an explicit strategy for exam revision, showed 67% of the participants provided statements with an explicit SRL strategy, a score of 3 or higher, thus demonstrating an ability to promote high SRL strategies in the classroom (Table 4). Apart from 5.5% of the participants who did not provide an adequate response, the remaining (27.5%) included implicit strategy promotion in their responses.

The second scenario asked participants to provide a high SRL statement promoting *knowledge about the benefits of feedback*. Just over half of the participants (56%) demonstrated high-SRL strategy promotion, receiving a score of 3 or higher, by incorporating a statement about knowledge and beliefs about learning by using feedback in their response (Table 5). A further 24.2% of participants promoted SRL by including two SRL promotion types, receiving a score of 2, but did not address knowledge and beliefs about learning by using feedback in their response.

Overall most participants did increase the level of SRL promotion in each scenario. In both items most participants utilized the specific SRL promotion type sought. Further, approximately one quarter of participants increased the SRL level of the low SRL statement but did not use the specific SRL promotion type sought in each item.

TABLE 3 Assessment items testing participants ability to write high-SRL version for two scenarios.

Item 27. Write a high-SRL version of the following scenario. Providing a strategy for effective exam revision. The test will cover everything we have done this term. Do not just cram for this exam all in one night.
Item 28. Write a high-SRL version of the following scenario. Providing knowledge about the benefits of feedback. On the task outline you'll see a final due date and an earlier date when you should give me a draft of the paper. If I do not get your draft, I cannot give you any comments.

TABLE 4 Example and percentage of participant responses for each item 27 score.

Score	Response categories and example for each	% of participant responses
0	No response, or a response that does not refer to SRL promotion in any way Example: Exams can help us detect loopholes in the previous learning process, help us check for deficiencies, and [you] do not need to be too nervous (S18).	5.5%
1	Strategy implicit with one or less of knowledge/beliefs or benefit of use or metacognitive support Example: The test will cover the 4 topics we have covered this term. Before you start studying for this exam in the next month, try to plan your studies ahead and spread the tasks out instead of cramming everything in the last few days (S61). Example: The test integrates all the contents we have learned this term. You should be able to link the prior knowledge to figure out the test (S26).	12%
2	Strategy implicit with at least two of: knowledge/beliefs or benefit of use or metacognitive support Example: The test will cover everything we have done this term. To improve the effectiveness of your revision, you could take some strategies to help you. For example, a mind map will help you have a clearer picture of the topic. And the flashcards can help you test yourself whether you have memorized specific content. Different tools can help you achieve different aims, you should choose whatever suits your needs (S95).	15.4%
3	Strategy explicit without knowledge/beliefs or benefit of use or metacognitive support Example: Okay so you have a test upcoming. So let us spend some time working out what you can recall in detail and what's information you need more time revising. I want you to go through all the key knowledge points and put a triangle if you can put plenty of details to expand on the points. I want you to a square if you cannot remember much about the point. Then focus most of your revision on the red squares and touch on the triangles. Then map out your revision schedule for the upcoming week (S8).	5.5%
4	Strategy explicit with knowledge/beliefs or benefit of use or metacognitive support Example: The test will cover everything we have done this term. So what I will do is set a learning goal and plan early, think about what I understand and write them down, the write down some questions or anything I am still confused about, and try to comprehend and make these points clear before the test. So when you are prepare the test, write down what you know, what you still confused, and think about how you solve these difficult problems before (S76).	24.2%
5	Strategy explicit with at least two of knowledge/beliefs or benefit of use or metacognitive support Example: Think about all the topics we have studied this term. The test you are going to write will cover all the topics. Remember to plan your study sessions in advance. Space out your study sessions in order not to cram for the exam. Plan and follow a study schedule in order not to procrastinate. Give yourselves enough time to go over your notes and test yourself (S80).	37.4%

3.4 Research question 4: was the SRL intervention associated with a change in participants’ confidence in teaching SRL to students?

Participants were asked to rate their confidence on a 4-point scale for teaching SRL to students prior to commencing the Program, immediately after, and then approximately 6 weeks after completing the Program. Results showed a significant increase in participants’ confidence about their capacity for teaching SRL to students immediately following the Program with 87.8% moderately to very confident compared to 39.2% prior to completing the Program. On the delayed item given 4 to 6 weeks after, almost the same percentage (86.8%) were moderately to very confident in teaching SRL to students.

The Program supported participants’ confidence about teaching SRL students. For some participants this was their first exposure to SRL; *“this was the first time I heard about SRL”* (S54). Participants appreciated the SRL knowledge gained, and examples provided. *“The course was informative and helpful especially its examples of how to teach SRL explicitly”* (S12). *“It provides a detailed framework knowledge about SRL which is really helpful for me to adjust my class and adopt more SRL strategies”* (S91). A comment by participant S25 that they *“learnt some new strategies and ways to approach facilitating SRL in the*

classroom” shows their confidence to transfer Program knowledge to SRT classroom practices.

4 Discussion

Developing knowledge and understanding of SRL conceptual frameworks is essential for teachers’ and teacher education students’ ability to transfer concepts into practice (Woolfolk and Murphy, 2001). SRL professional development for teachers and teacher education students has been found to positively impact participants’ self-efficacy in relation to SRL understanding and SRT practices, and learner outcomes benefit when this is the case (Arcoverde et al., 2020; Kohen and Kramarski, 2017; Michalsky and Schechter, 2013; Peeters et al., 2014; Perry et al., 2006). Our research aimed to develop a Program that would improve teacher education students’ knowledge about SRL and about how to promote SRL in the classroom through SRT practices.

The Program was based on a novel conceptual framework for SRL promotion, the SRL-TPF, that distinguished three promotion types – SRL knowledge, SRL strategies and specific SRL capabilities. An innovation of the Program was the positioning of participants to use a scoring guide based on the SRL-TPF to critically examine a lesson transcript. A goal was to increase participants’ awareness and

confidence about how teachers' discourse and actions through SRT practices can support the development of students' SRL capabilities. Results from the post test demonstrated achievement of this goal with a 44.7% ($n = 47$) increase in participant's confidence about teaching SRL to students. Further, our program was noticeably short when compared with other professional development programs for teacher education students. In a synopsis of SRL professional development studies, Ciga et al. (2015) identified only two, of 12, that considered the professional development impact on student teachers' learning. These two were the longest interventions, each running for 6 months, with both reporting the significance of mentoring discussions and modeling in developing student teachers' metacognitive awareness and teaching practices. Our Program did not include mentoring discussions and the only modeling provided was in the form of several videos of classroom SRL practices. Since Ciga et al.'s (2015) review we are aware of two subsequent SRL studies, in addition to ours, that were specifically designed for student teachers' SRL professional development. One, a study by Kramarski and Kohen (2017) involved 28-h, across 14 weeks, and found specific prompts supported preservice teachers' as self-aware SRLs and noticing of students' SRL, and that preservice teachers self-regulated teaching actions were supported through lesson design with a focus on SRT. Another, Arcoverde et al.'s (2020) 30-h SRL theory and activities intervention, ran across 5 weeks, and found improvements in teacher education students' SRL skills and self-efficacy. Our Program, able to be completed in less than a day, was significantly shorter than both Arcoverde et al. (2020) and Kramarski and Kohen (2017).

One of the points of interest with our study was whether it was possible to achieve positive effects on participants' knowledge of SRL and capacity to promote SRL in the classroom without the need for intensive school-wide programs such as those mentioned above or those shown to be effective in research on writing (McKeown et al., 2019). Our results indicate that a very short Program may support and develop participants' SRL knowledge and confidence with classroom SRL promotion through SRT. The Program design concluded with activities positioning participants to code a lesson transcript positioning themselves as teachers providing high SRL instruction. Participants were required to apply their knowledge about SRL to analyze a classroom scenario for a teacher's promotion of SRL to students. Both concluding Program activities have some alignment with research undertaken and proposed by Kramarski and Heaysman (2021, p. 298) "to make SRL processes more explicit...hope[ing] to promote the successful implementation of SRL and SRT in schools." Our Program demonstrates that teacher education students' SRL knowledge and confidence for SRL teaching practices can be supported in professional development programs of far shorter duration than those previously reported.

The findings regarding Research Question 1 show that most participants (90.65%) were successful in understanding the SRL information presented in the SRL-TPF. They correctly defined SRL and distinguished the difference between SRL and self-directed learning. Further, participants showed understanding for identifying SRL promotion in the classroom scenarios and the distinctions among the different SRL capabilities. The data for correct identification of SRL capabilities is more mixed for cognitive and metacognitive capabilities. It appears that the participants understood the importance of SRL and its promotion in general terms, could recognize the definitions of types of promotion and of SRL capabilities and had stronger

understanding about resource management and motivational/emotional capabilities than they did of cognitive and metacognitive capabilities. The participants also had stronger understanding of explicit promotion than of implicit promotion and did not show strong understanding of instances of knowledge and beliefs about learning.

Regarding Research Question 2, the coding activity was more difficult for participants than their responses in the comprehension questions. Although participants had previously coded teacher statements for SRL strategy and SRL capability identification with high accuracy in matching activities, this was the first time they were exposed to more complex statements with both strategy and capability elements in the one assessment item. Asking the participants to code data from a lesson transcript required them to not just decide about one item (SRL strategy) but to maintain in memory the details of another (SRL capability) and the coding scheme. This likely increased the load on working memory substantially with several students noting the difficulty of this activity; "I found the last [coding] exercise really difficult if would be great to have more assistance on how to differentiate between the different SRL promotions and capabilities" (S58). This activity, reinforced by participant feedback, showed that the participants' recognition of types of SRL strategy promotion and which SRL capabilities were being promoted would benefit from more detailed and extensive attention within the Program. Providing more time and practice would likely develop participants' understanding of classroom complexities for both SRL strategy promotion and SRL capabilities. Regardless of the failure to obtain 100% accuracy in the use of the scoring system, the coding exercise was important in sensitizing the participants to the kinds of teacher discourse that happens in the classroom relating to the promotion of SRL knowledge and strategies.

Results for Research Question 3 showed that when asked to generate statements related to a strategy promotion 67% of participants provided explicit SRL strategy instruction and of these 37.4% incorporated more than one SRL promotion type in their responses. In this task, these teacher education students successfully transferred Program content knowledge to teaching activities. Thus, many participants successfully transferred general SRL strategies from the Program to increase SRL promotion in classroom scenarios. Our results indicate that it was possible to incorporate both knowledge about SRL and teacher-focused SRT promoting students' SRL as proposed and undertaken in research by Kramarski and Heaysman (2021).

Research question 4 provided evidence of the Program's influence on participants' confidence promoting SRL to students (87.8%). Approximately four to six weeks following Program completion these positive results remained quite stable (86.6%). These results are encouraging given only 36.3% of participants identified engagement with the Program's SRL content prior to its completion. As a novel conceptual framework, alongside evidence of participants' confidence for teaching SRL to students through engagement with a very short Program, we recognize its achievements and opportunities for improvements. Participants' knowledge, understanding, and distinction of metacognition and cognition and the subsequent promotion of both to students through classroom teaching is an area that would benefit from further development. These and other areas of SRL and SRT knowledge are discussed in the limitations and future research section below.

TABLE 5 Example and percentage of participant responses for each item 28 score.

Score	Response categories and example for each	% of participant responses
0	No response, or a response that does not refer to SRL promotion in any way.	3.3%
1	No statement of knowledge/beliefs but with one of metacognitive support or strategy implicit or explicit Example: On the task outline you'll see two dates, your draft-paper's due date and then the final paper's due date. I'll need your draft by the earlier date so that I have enough time to read and reflect on it to give you meaningful feedback to improve and strengthen your work for the final submission (S14).	16.5%
2	No statement of knowledge/beliefs but includes two of benefit of use or metacognitive support or strategy implicit or explicit Example: You should give me a draft of the paper before the deadline and I will give you opinions about the paper. The purpose of this is to allow you to plan and monitor your progress as quickly as possible to ensure that it is completed on time and with high quality (S39).	24.2%
3	Knowledge/beliefs statement without: benefit of use or metacognitive support or strategy implicit or strategy explicit Example: Feedback will help you make sense of your problems and you can have a better attempt next time. Please remember our time of deadline and I will remind you at that time (S47).	2.2%
4	Knowledge/beliefs statement with one of benefit of use or metacognitive support or strategy implicit or strategy explicit Example: Please pay attention to the final due date and an earlier date on the task outline. You need to give me your draft of the paper and I can provide detailed feedback for you. You can learn something you need to correct and improve from my feedback (S32).	19.8%
5	Knowledge/beliefs statement with two of benefit of use or metacognitive support or strategy implicit or strategy explicit Example: On the task outline you'll see a final due date and an earlier due date when you should give me a draft of the paper. This is very important as the process of getting feedback on your work is key to learning. When another person gives you feedback you are able to gather information on how you are progressing, what are you doing right, where can you make some changes, and how can you improve. This information allow you to make the most growth possible in your learning (S56).	28.8%
6	Knowledge/beliefs statement with all of benefit of use and metacognitive support and strategy implicit or strategy explicit Example: Remember when we all gave each other feedback on our writing last week and how hard it was to provide something meaningful when I only gave you a little bit of time? And how when we had more time to complete it you could provide something valuable to your peers? This will be the same for me when I go to mark your work. If you would like the opportunity for me to offer some useful comments for you to reflect on before the final due date, you need to give me enough time to do it. That is why you can see in the task outline a final due date and an earlier one (S1).	5.5%

4.1 Limitations and future directions

Our results provide evidence of participants' understanding and recognition of SRL strategies and capabilities following a short professional learning program. We believe, as has been consistently shown in other research with interventions focused on one or more SRL strategy, that participants will have positive effects from Program engagement (Butler, 2021; Dignath et al., 2023; Perels et al., 2009). By developing participants' SRL and SRT knowledge we expect an increase in participants' self-efficacy for SRL promotion and consequently the likelihood of SRT promotion in their future classroom teaching practices (Butler, 2021; Karlen et al., 2020).

While our Program was not experimental and we acknowledge assessment items may not enable participants' deeper level of understandings to be identified, our results indicated important areas for redesign of professional learning programs for both teacher education students and practicing teachers. Our results point to a need for giving higher levels of support, and more opportunities, to teacher candidates and teachers in applying knowledge about SRL and its promotion in practical situations within the classes. A possible future extension of the program developed for this study would be to incorporate such practical applications to classroom contexts. In this respect the designers of teacher education programs could provide opportunities for

consideration of SRL strategies and their promotion in both courses concerned with the nature of learning, in courses focusing on the teaching of specific areas of the curriculum, and in courses designed to help students prepare and design tasks for use in their teaching practicums. In Australia, such inclusion would contribute toward meeting the federal and state governments explicit requirement for initial teacher education courses to include content regarding the science of learning (AITSL, 2023) and could be expected to transfer to teacher education students' classroom practices during professional placement experiences. Objective measures, such as observations, of the Program's effectiveness promoting SRL for SRT could then be implemented. The pattern of our results also may be relevant to programs on SRL that have involved practicing teachers and which have found that teachers have not continued to take up the ideas in their classroom practice (e.g., Nibali, 2017). Presentation of the ideas and development of understanding of these ideas do not appear to guarantee their practical application in lesson design or classroom practice. Recognition of this element as a necessary addition to professional learning programs is needed.

We believe our research is the first to use the SRL-TPF, or a similar coding tool, as an expanded measure of participants' understanding of SRL theory in practice. Coding a lesson transcript showed that participants were mostly successful. However, future research that

requires participants to code lesson activity or statements should increase scaffolding within the task. We further recommend providing immediate feedback for transcript sections to support learners self-monitoring and correction. Immediate feedback would be expected to support participants' subsequent coding and monitoring of learning as has been shown in [Vosniadou et al. \(2024\)](#).

Our Program involved participants from two Australian universities and did not explicitly address or target teacher education students personal SRL practices, such as the SRL skills they utilize, or involve mentoring, something that has been shown to influence teachers' confidence with implementation of SRT. While generally effective in supporting the comprehension of SRL capabilities and promotion, it would be of interest in future research to examine the effect of increasing connection of the Program content to wider populations of teacher education students and incorporate personal and classroom practices as recommended by [Endedijk et al. \(2012\)](#). Seeking feedback from participants would benefit future developments of the Program. Strengthening the direct relationship between the theory and personal practices during preparation programs may be expected to further increase the level of SRL promotion in their teaching practice and subsequent teaching.

5 Conclusion

The research developed and evaluated a short online Program to help teacher education students learn about SRL and how to promote SRL to students through SRT. The Program was based on the SRL-TPF which pays attention not only to the explicit teaching of SRL strategies, but also to participants' promotion of knowledge and beliefs about SRL and the promotion of metacognitive reflection and support. Our research focused on education students' ability to use our SRL-TPF, including the coding guide and provide high SRL instruction to students in teachers' SRT. Results showed the Program was mostly effective in helping teacher education students develop detailed knowledge of SRL capabilities, types of SRL promotion and the application of the SRL-TPF to identify SRL strategies and capabilities within a transcribed lesson. The study contributes research findings addressing two components of SRT – knowledge of SRL and knowledge for promoting SRL in students – in SRL professional development of short duration with beliefs about SRL included. In addition, the pattern of our findings points to key issues that should inform the design of future programs of professional learning on SRL and its promotion for teacher education and practicing teachers.

Data availability statement

Datasets are available on request: The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Flinders University Human Research Ethics Committee (Project# 8320) and

the University of Melbourne Human Research Ethics Committee (Project# 195.4516.1). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

HS: Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation. ML: Writing – review & editing, Visualization, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. L-AN-K: Writing – review & editing, Formal analysis, Data curation. SK: Writing – review & editing, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation. SV: Writing – review & editing, Visualization, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. CM: Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation. LG: Writing – review & editing, Resources, Project administration, Investigation, Funding acquisition, Conceptualization. EW: Writing – review & editing, Project administration, Investigation.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Professionalizing schools on self-regulated learning: roles, responsibilities and challenges of process coaches

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The implementation of self-regulated learning (SRL) in primary and secondary schools is complex and requires a sustainable long-term development of the complete school. To support school leaders and their school team to implement SRL, a two-year school-wide professionalization trajectory was designed in collaboration with an in-service teacher professionalization organization. School leaders participated in a professional learning community (PLC) and were guided by process coaches from the in-service teacher professionalization organization. This study focuses on these coaches and more specific on (1) their roles and responsibilities and (2) the challenges they face in guiding SRL-focused professionalization programs. Bi-monthly focus group discussions with the process coaches were executed to gain more insight in their perspectives. In total, nine focus group discussions were organized, and thematic analysis was used to examine the qualitative data collected during these. Four roles for the process coaches could be identified throughout the two-year professionalization trajectory, namely the roles of a coach, an expert, a coordinator, and a learner. In these roles, the process coaches experienced various challenges and tensions. For example, they faced challenges in defining their role as either a content expert or a facilitator of group learning. Furthermore, the results indicate that challenges were also experienced at other levels, such as within the organization of the PLC, dealing with the diversity among participating school leaders, and involving the school team when implementing SRL school-wide.

KEYWORDS

self-regulated learning, school-wide implementation, professional learning communities, school leaders, process coaches

1 Introduction

In today's diverse and rapidly changing knowledge society, there is increasing acknowledgment of the pivotal role of self-regulated learning (SRL) as a fundamental competency for both school success and effective lifelong learning (Dent and Koenka, 2016). SRL encompasses a complex, demanding, multifaceted learning process, which involves the combination of a metacognitive (e.g., planning, setting goals, organizing, self-monitoring, and self-evaluating), cognitive (e.g., selection of learning strategies, environmental structuring), motivational (e.g., self-efficacy, task interest, self-attributions) and emotional component (e.g., managing affective states, coping with frustration) (Efklides, 2011; Zimmerman, 2002).

Because self-regulation does not develop automatically, achieving effective SRL skills in students is contingent upon teachers' competencies to foster such skills, and teachers' role

in supporting students with SRL appears critical at all school levels (Dignath-van Ewijk, 2016; Donker et al., 2014; Kistner et al., 2010). As SRL involves assigning students increased autonomy and responsibility in their learning, the implementation of SRL in classrooms requires a redefinition of the teacher's role, transforming them into coaches for students' learning processes (Bolhuis and Voeten, 2001; James et al., 2006a,b). While individual teachers play a crucial role, teacher competencies are nurtured through school-wide initiatives promoting SRL, supported by a shared vision and robust leadership. Indeed, research increasingly emphasizes that SRL implementation is a collective responsibility across the entire school community (De Smul et al., 2020; Peeters et al., 2014; Thomas et al., 2020). A systematic and comprehensive approach with ongoing professional development is crucial for the effective implementation of SRL, positioning the school as a learning organization and highlighting the importance of a systematic approach to professionalizing schools in SRL (James and McCormick, 2009; Muijs et al., 2014; Peeters et al., 2014). It emphasizes the urgent need for educational policies and practices aimed at strengthening the capacity of both teachers and schools to develop an SRL vision and integrate SRL into the curriculum, as well as into everyday classroom and school practices. SRL implementation needs to be encouraged by a supportive school climate (James et al., 2006a,b). In this respect, school leaders can potentially play a positive role in facilitating this climate and in the improvement of teacher performance (Day et al., 2016; De Smul et al., 2020; Duby, 2006). In view of being able to realize this, there is growing acknowledgment that school leaders' practices significantly influence teachers' actions during change processes, highlighting the necessity for targeted professional development at the leadership level (Grissom et al., 2019; Ni et al., 2019).

Effective professionalization initiatives for school leaders must meet various criteria (Daniëls et al., 2019; Goldring et al., 2012). A critical aspect is the significant emphasis on networking and relationship-building with peers (Goldring et al., 2012; Tingle et al., 2019). To facilitate collaborative learning and networking among school leaders, it is essential to form small groups guided by an experienced process coach (Daniëls et al., 2023). However, the role of these coaches in supporting school leaders' professional growth remains underexplored. Given that substantial support and leadership are essential to effect meaningful changes first at the teacher level and subsequently at the student level, further investigation into these areas is imperative. The present study therefore aims to offer an "insider" perspective on process coaches in a professionalization program focusing on the school-wide implementation of SRL and examines how these process coaches can contribute to the effective implementation of SRL across schools.

2 Theoretical background

2.1 School-wide implementation of SRL: an educational innovation

Students differ in their ability to self-regulate and not all are naturally inclined toward self-regulated learning (Boekaerts, 1999). Therefore, it is essential for teachers to foster SRL

during classroom practice (Dignath and Büttner, 2008). Meta-analyses have shown that SRL is positively associated with student achievement, motivation, and engagement (Dent and Koenka, 2016; Dignath and Büttner, 2008; Elhusseini et al., 2022). These findings underscore the potential of SRL as a powerful educational approach to improve learning outcomes across diverse student populations. However, despite its proven benefits, research shows that individual teachers' SRL implementation is often limited (Dignath and Büttner, 2018) and that the entire school community must work together to implement SRL (Peeters et al., 2014; Thomas et al., 2020). Promoting SRL in classrooms involves a substantial shift in teaching practices, requiring teachers to adopt new methods (James et al., 2006a,b). This transition necessitates a supportive school-wide climate that establishes the necessary structures, making SRL a collective mindset and practice rather than an individual responsibility (De Smul et al., 2020; James et al., 2006a,b).

The changes expected of the school can be seen as an educational innovation (James et al., 2006a,b). Successful SRL implementation requires the gradual integration of a shared SRL vision across all grade levels (Hallinger, 2003). This effort requires a significant time investment and the collective commitment from the entire school team (Hilden and Pressley, 2007). Establishing a supportive school climate is essential for fostering the capacity for sustained innovation (Hallinger, 2010; Hopkins et al., 2014; Wahlstrom and Louis, 2008). In this respect, the overall capacity of the school can significantly influence individual teachers' classroom practices (Thoonen et al., 2012).

According to Thoonen et al. (2012), school capacity refers to a school's ability to create a supportive environment for teacher learning and innovation. Regarding the implementation of SRL, little is known about what constitutes such a supportive environment at the school-level (Muijs et al., 2014). Addressing this gap, De Smul et al. (2020) investigated the role of school climate, SRL implementation history, and the role of the school leader in the school-wide adoption of SRL. Their findings suggest that successful SRL implementation is bolstered by a school environment characterized by partnership, communication, collaboration, and participation. Moreover, the study emphasizes the crucial role of a supportive school leader in fostering a positive school climate and driving SRL implementation (De Smul et al., 2020). This aligns with other research on educational innovations, which also emphasizes the importance of strong leadership (Bryk, 2010; Leithwood and Jantzi, 2006).

School leaders play a crucial role in fostering an environment that encourages the development of learning skills for both students and teachers. In the context of SRL, they are responsible for creating a supportive environment where teachers can reflect on and implement SRL strategies (James and McCormick, 2009). As the school-wide implementation represents an educational innovation, school leaders become change agents (Acton, 2021). "A change agent is anyone who has the skill and power to stimulate, facilitate, and coordinate the change effort" (Lunenburg, 2010, p.5). Literature frequently highlights that school leaders hold the primary responsibility for the challenging task of continuously implementing school reforms and innovations (Acton, 2021; Leithwood and Jantzi, 2006). However, research of Acton (2021) indicates that school leaders often receive minimal formal

professional development on effectively managing and influencing change in their schools. There is growing recognition that school leaders need to engage in professional development to acquire the necessary skills and knowledge for effective leadership. Adequate and tailored preparation for school leaders is crucial (Goldring et al., 2012; Grissom et al., 2019; Ni et al., 2019). Despite increased attention to the professionalization of school leaders, research on their professional development remains limited (e.g., Daniëls et al., 2019; Goldring et al., 2012; Grissom et al., 2019).

2.2 Professionalization of schools on SRL via PLC with school leaders

Research on the professionalization of schools has predominantly focused on the professional development of teachers, with less emphasis on the continuous learning of school leaders. In the realm of teacher professionalization, professional learning communities (PLCs) have become a standard practice in schools (Vangrieken et al., 2017). PLCs address the limitations of sporadic and decontextualized professional development initiatives, such as study days and lectures, which are often isolated from practical application (Watson, 2014).

The concept of a PLC is challenging to decipher due to the various interpretations and diverse terminology used in the literature (Lomos et al., 2011). Despite the lack of a universal definition, there is a broad international consensus that a PLC is “a group of people sharing and critically interrogating their practice in an ongoing, reflective, collaborative, inclusive, learning-oriented, growth-promoting way” (Stoll et al., 2006, p. 223). Stoll et al. (2006) distinguish three key characteristics of PLCs: collective responsibility, reflective dialogue, and deprivatised practice (Stoll et al., 2006; Wahlstrom and Louis, 2008). While collective responsibility, a common interpersonal PLC characteristic, refers to the idea that participants in successful PLCs do not consider school improvement, innovation and student learning as a responsibility solely assigned to one school, reflective dialogue and deprivatised practice are more behavioral, interpersonal PLC characteristics (Wahlstrom and Louis, 2008). Reflective dialogue involves participants engaging in deep discussions with colleagues and deprivatised practice refers to participants sharing their methods openly to enhance their effectiveness (Stoll et al., 2006). This may include activities such as observing each other or providing and receiving feedback.

Involving teachers in PLCs within schools can change teachers' perceptions, positively impact their instructional practices, and enhance student learning outcomes (Christensen and Jerrim, 2025; Lomos et al., 2011). However, most literature on PLCs in schools focuses on teacher learning, resulting in a scarcity of research on the collective learning of school leaders and cross-school PLCs involving school leaders (Coenen et al., 2021).

The limited studies that focus on PLCs with school leaders reveal that, despite being time-consuming, school leaders perceive their participation in PLCs as a valuable investment (Coenen et al., 2021). Tanghe and Schelfhout's (2023) research on a longitudinal professionalization program for school leaders via PLCs indicates that the most effective approach combines theoretical frameworks,

peer learning, concrete action plans, and school-specific coaching (Tanghe and Schelfhout, 2023). This combination fosters learning-driven actions within schools. This aligns with the three key organizational conditions identified by Coenen et al. (2021): clear and realistic group objectives, effective steering and preparation, and embedding participation logically in participants' daily routines and activities (Coenen et al., 2021). Daniëls et al. (2023) support these findings, emphasizing the importance of reflection in combination with peer learning, peer feedback, and the need for small groups guided by experienced process coaches (Daniëls et al., 2023). Similarly, school leaders in Tanghe and Schelfhout's (2023) study highlighted the crucial role of process coaches in the professionalization program, noting the positive effect and added value they experienced from this support.

2.3 The role of the process coach in PLCs

Previous research underscores the critical role of leadership within PLCs (Coenen et al., 2021; Margalef and Roblin, 2016; Prenger et al., 2019; Tanghe and Schelfhout, 2023). It emphasizes the necessity of having an experienced individual to guide learning processes through feedback, reflection, and providing access to relevant sources while cultivating an open and trusting environment (Daniëls et al., 2023; Margalef and Roblin, 2016). This individual, referred to as the “process coach,” can significantly impact the effectiveness of learning processes, either positively or negatively (Tanghe and Schelfhout, 2023). Poor leadership by the process coach can notably decrease participants' satisfaction with the PLC initiative, as well as their perceived acquisition of knowledge and skills (Honig and Rainey, 2014; Prenger et al., 2017). Despite its importance, the specific responsibilities of a process coach remain inadequately defined in the existing literature. Coenen et al. (2021) and Prenger et al. (2017) distinguish three roles: the process coach as a coach, an expert and a coordinator.

2.3.1 Process coach as a coach

As a coach, it is essential to stimulate reflection and learning among group members (Coenen et al., 2021). The coach acts as a team facilitator, paying attention to group development processes and allowing time for mutual understanding, professional inquiry, and connecting shared stories (Prenger et al., 2017). By doing so, the process coach fosters a critical yet constructive discussion, emphasizing the benefits of diversity, conflict, and failure, as each of these elements serves as a learning opportunity (Schelfhout et al., 2015). In the research of Coenen et al. (2021), the coaching role was most prominent during the PLCs.

2.3.2 Process coach as an expert

As an expert, the coach provides information and answers content-specific questions (Coenen et al., 2021). However, Coenen et al. (2021) found that school leaders often perceived the knowledge of the process coach as inadequate. This finding aligns with the research of Assen and Otting (2022), which indicated that process coaches tend to pay little attention to theory as a source of learning.

For the school-wide implementation of SRL, it is crucial for process coaches to possess both content knowledge about SRL (CK-SRL) and pedagogical content knowledge about SRL (PCK-SRL) (Karlen et al., 2020). CK-SRL encompasses understanding fundamental concepts, such as terminology and theoretical models, as well as the ability to justify various motivational, cognitive, and metacognitive strategies for SRL (Karlen et al., 2020). PCK-SRL involves knowing how to stimulate SRL in the classroom and support students through both direct instruction (e.g., modeling, explaining learning strategies) and indirect instruction (e.g., creating an optimal learning environment) (Barr and Askell-Williams, 2020; Karlen et al., 2020).

2.3.3 Process coach as a coordinator

A third role involves acting as a coordinator. In this role, the process coach structures the meetings according to the groups' predefined goals, allowing space for exchange, discussion, and reflection (Prenger et al., 2017). The coordinator manages logistical arrangements and ensures that the meetings do not stagnate in merely sharing personal anecdotes and/or frustrations, but instead move toward in-depth reflection and actual co-creation (Schelfhout et al., 2015).

3 The present study

Evidence from several meta-analyses indicates that fostering SRL enhances students' academic achievement (Dent and Koenka, 2016; Dignath and Büttner, 2008; Elhusseini et al., 2022). Developing SRL skills in students requires substantial support from teachers (Dignath-van Ewijk, 2016). However, teachers often struggle with SRL implementation (Dignath and Büttner, 2018). Effective SRL implementation necessitates a collective effort from the entire school community (Peeters et al., 2014; Thomas et al., 2020). Studies highlight the crucial role of supportive school leaders in positively influencing school climate and driving SRL implementation, viewing it as an educational innovation (Bryk, 2010; De Smul et al., 2020; Leithwood and Jantzi, 2006). There is increasing recognition of the need for school leaders to engage in tailored professionalization to acquire essential skills and knowledge. However, research on school leaders' professional development remains limited (Daniëls et al., 2019; Goldring et al., 2012; Grissom et al., 2019; Ni et al., 2019). While most research focuses on within-school PLCs on the teacher level (Chapman and Muijs, 2014), the present study focuses on between-school PLCs involving school leaders. The focus on SRL in the PLCs is grounded in meta-analytic evidence showing its positive impact on student learning (Dent and Koenka, 2016; Dignath and Büttner, 2008; Elhusseini et al., 2022). Previous research underscores the critical role of leadership within a PLC (Coenen et al., 2021; Margalef and Roblin, 2016; Prenger et al., 2017). It emphasizes the need for an experienced individual to guide learning processes through feedback, reflection, and providing access to relevant sources, while cultivating an open and trusting environment (Daniëls et al., 2023; Margalef and Roblin, 2016). Given that effective SRL integration hinges on robust leadership and cohesive support systems, these process coaches play a critical role in guiding PLCs. However,

their specific responsibilities and impact are underexplored. The present study therefore aims to provide an insider perspective on the role and challenges faced by process coaches in SRL-focused professionalization programs. It examines how they contribute to effective SRL implementation across schools and argues that a deeper understanding of this role is essential for enhancing school leadership and, ultimately, student learning outcomes.

The following research questions are addressed:

- (1) Which specific roles and responsibilities of process coaches in SRL-focused professionalization programs come to the fore?
- (2) What challenges do process coaches face in guiding SRL-focused professionalization programs, and how do they address these challenges?

4 Materials and method

4.1 Context of the study

This study follows a qualitative case study approach (Thomas, 2011), aiming to explore the role of process coaches within the specific context of an SRL-focused professional development program (PDP). To gain deeper insights, the researchers collaborated with an in-service teacher professionalization organization that provides pedagogical support and professional development opportunities for school leaders and teachers. As part of their work, they launched the professionalization program "Everyone is a leader of learning," aimed at supporting school leaders in enhancing their ability to foster effective learning environments in their respective schools, with a particular focus on the implementation of SRL. The program spanned a 2-year professionalization trajectory, engaging 16 primary and 22 secondary school leaders. In Belgium, school leaders typically participate in structured networks. For this professionalization program, groups of school leaders from the same network voluntarily enrolled as cohorts forming PLCs. School leaders varied considerably in terms of leadership experience, school context, and motivation for joining: some joined to collaborate within PLCs, others to focus on SRL, and some because participation was encouraged by their network. Table 1 presents background information on the participating school leaders.

During the first year of the professionalization, the school leaders participated in collaborative learning within PLCs focused on SRL and its implementation. Eight PLCs with five or six school leaders each were set in motion, supported by a process coach. The process coaches are employed by the in-service teacher professionalization organization, where guiding school leaders is part of their job. Throughout this first year, school leaders engaged in various activities within their PLCs, including viewing and discussing knowledge clips on SRL. All 21 SRL skills from Zimmerman's (2002) framework (e.g., goal setting, self-monitoring, help-seeking) were addressed. The PLCs met on average seven times during the first year of the professionalization program. Due to COVID-19 restrictions, most of the meetings were held online.

In the second year, PLCs were able to meet in person, averaging five meetings per group. During this period, school

leaders applied insights gained from their PLCs to support their school teams in implementing SRL practices, with personalized guidance from their process coaches. Thus, the process coaches not only facilitated school leader professionalization but also helped foster a supportive, school-wide climate for SRL.

To ensure a certain degree of consistency across the PLCs, the professionalization trajectory was centrally coordinated by a staff member of the in-service teacher professionalization organization. This coordinator, a former academic with specific expertise in SRL, provided both theoretical and practical support to the process coaches. While this coordination fostered alignment between the PLCs, each group retained the flexibility to adapt their meetings to the specific needs of their members.

Additionally, the researchers, coordinator, and process coaches jointly organized plenary sessions on leadership, SRL theory, and its classroom and school-level implementation to enhance school leaders' knowledge. Following these sessions, school leaders applied the acquired knowledge in PLC discussions, contextualizing it to their schools. An overview of the key actors involved in this study—including researchers, the coordinator, process coaches, and school leaders—is presented in [Table 2](#).

TABLE 1 Background information about school leaders.

Variable	N/mean (M)	Range
Gender		
Male	N = 10	
Female	N = 28	
School level		
Primary education	N = 16	
Secondary education	N = 22	
Age (years)	M = 44.7	29–58
Experience in education (years)	M = 20.7	7–38
Experience as school leader in current school (years)	M = 4.6	1–13
Number of teachers at the school	M = 63	15–282

TABLE 2 Overview of actors in the professional development program (PDP).

Actor	Task in the PDP	Affiliation	Relationship to others	Recruitment
Researchers	Design and analyze the study; organize plenary sessions	Employed at the university	Collaborate with coordinator	External to PDP organization
Coordinator	Provides theoretical and practical support to process coaches; organize plenary sessions	Employed at the in-service teacher professionalization organization	Support process coaches	Internal role within the organization
Process coaches	Guide and support PLCs; organize plenary sessions	Employed at the in-service teacher professionalization organization	Directly support and guide school leaders within PLCs	Assigned as part of their job within the organization
School leaders	Participate in PLCs	Employed by their respective schools; members of school networks	Supported and guided by process coaches	Voluntary registration as groups from same school network

4.2 Participants

The eight PLCs were each guided by a process coach. The sample included 75% female process coaches. The average age was 49.10 years ($SD = 6.58$). Coaches' average experience in the in-service teacher professionalization organization was 6.20 years ($SD = 4.33$), implying that most of them already had some experience in guiding change and innovation processes in schools at the start of the professionalization trajectory. To master SRL theory, the process coaches participated in a train-the-trainer course, offered at no cost and facilitated by the authors of this article. Participation in the training was part of their professional duties within the scope of the professional development program. Additionally, they held regular meetings with the coordinator, who possesses extensive experience in SRL, to ensure consistency and alignment throughout the professionalization trajectory. Moreover, some PLCs experienced changes in their assigned process coach due to illness or employment transitions, and not all participants were able to attend every focus group discussion for similar reasons, such as illness or other work-related obligations.

4.3 Data collection

Focus group discussions with the process coaches were conducted every 2 months to gather information about their experiences, opinions, expectations, questions, and needs concerning the coaching of the school leaders in their respective PLCs. Unlike quantitative research, focus group discussions provide more in-depth information due to the opportunity for asking open-ended questions, probing on provided answers, and observing the interaction between participants ([Morgan et al., 1998](#)).

A structured step-by-step protocol guided each focus group to initiate discussion ([Morgan et al., 1998](#)). After a brief introduction and a review of the summary from the previous group discussion, participants were invited to individually write down their experiences, opinions, and concerns regarding the PLCs they organized with school leaders, as well as their own knowledge, skills, and professional approaches.

Subsequently, various themes—both personal and related to their experiences with the PLCs—were discussed in depth. [Table 3](#)

TABLE 3 Overview of the main themes in the focus group discussions.

Focus group discussion:	1	2	3	4	5	6	7	8	9
Format: online (O) or in-person (I)	O	O	O	I	I	I	I	I	I
Content of the focus group discussion:									
A. Introduction	x	x	x	x	x	x	x	x	x
B. Review of the previous group-specific report		x	x	x	x	x	x	x	x
C. Individual time to reflect		x	x	x	x	x	x	x	x
D. Questions and discussions about following themes:									
<u>PLC with school leaders</u>									
- Strengths of school leaders		x	x	x	x	x	x	x	x
- School leaders' SRL vision and implementation	x				x	x			x
- Challenges and opportunities for school leaders	x	x	x	x	x	x			x
- Challenges within the PLC		x	x	x	x	x			
- Challenges in schools		x	x	x	x	x			x
- Contextual factors		x	x	x	x	x			x
<u>Process coaches</u>									
- Challenges for process coaches	x	x	x	x	x	x	x	x	x
- Coaches' growth and action planning	x	x	x	x	x	x	x	x	
- In-depth content work on SRL		x	x	x			x	x	x
E. Concluding reflection	x	x	x	x	x	x	x	x	x

provides an overview of the main themes that emerged across the focus group discussions.

In total, nine focus group discussions with the process coaches took place, resulting in 987 min of data. Due to COVID-19 restrictions, the first three discussions were held online. Each discussion lasted ~2 h on average. All focus group discussions were audio-recorded and transcribed, after obtaining informed consent from the participants.

4.4 Data analysis

A coding scheme was used to analyse the data thematically in Nvivo. Thematic analysis was chosen because it allows for identifying, analyzing, and reporting patterns (themes) within data, making it particularly suitable for exploring the complex and nuanced experiences of process coaches (Braun and Clarke, 2006). The coding was performed in three consecutive steps. First, the data from each focus group discussion were summarized in a focus group-specific report (i.e. within-case analyses) (Miles and Huberman, 1994). These summaries guided the construction of themes that aligned with the research questions. Second, in order to ensure the interpretive quality and to minimize potential misinterpretations by the researchers and unclear wording and complexity, all participants in the focus group discussions were asked to review the summary of the previous focus group discussion and reflect on the themes. This resulted in the refinement, removal and consensus-building of items across focus groups. Third, the results of the within-case analyses were integrated in a cross-case analysis. The categories and themes used for the cross-case analysis

were informed by both deductive and inductive approaches. Deductively, we drew on existing research on SRL (e.g., Karlen et al., 2020) and literature on process coaches (e.g., Coenen et al., 2021; Prenger et al., 2017) to define a number of a priori codes. At the same time, inductive coding allowed for the identification of new themes and categories that emerged directly from the data, capturing context-specific insights. An overview of the resulting coding categories, along with their theoretical origin (deductive or inductive), is provided in Table 4.

5 Results

5.1 The different roles of the process coaches

For the first research question, which examined the different roles and responsibilities of process coaches in SRL-focused professionalization programs, the thematic analysis identified four distinct roles. Although these roles were not explicitly addressed during the focus group discussions, the analysis revealed their presence, along with some tensions between them.

5.1.1 Process coach as a coach

In this first role, all process coaches prioritize encouraging reflection among the participating school leaders of the PLCs throughout the professionalization trajectory. By focusing on stimulating reflection, process coaches created valuable learning opportunities for the participants. Participant four reflects on the

TABLE 4 Overview of coding categories.

Code	Origin	Source
Level of the process coach—as a coach		
Goal setting	Deductive	Coenen et al., 2021; Prenger et al., 2017
Feedback	Deductive	Coenen et al., 2021; Prenger et al., 2017
Group process	Deductive	Coenen et al., 2021; Prenger et al., 2017
Providing learning opportunities	Deductive	Coenen et al., 2021; Prenger et al., 2017
Developing materials	Inductive	
Level of the process coaches—as an expert		
CK-SRL	Deductive	Karlen et al., 2020
PCK-SRL	Deductive	Karlen et al., 2020
Beliefs about SRL	Inductive	
Self-efficacy to support schools when implementing SRL	Inductive	
Level of the process coaches—as a coordinator		
Structuring meetings	Deductive	Coenen et al., 2021; Prenger et al., 2017
Staying focused	Deductive	Coenen et al., 2021; Prenger et al., 2017
Ensuring active participation	Inductive	
Level of the process coaches—in general		
Studying theoretical frameworks	Inductive	
Self-reflection	Inductive	
Peer learning	Inductive	
Tensions	Inductive	
Level of the PLC		
Collective responsibility	Deductive	Stoll et al., 2006; Wahlstrom and Louis, 2008
Reflective dialogue	Deductive	Stoll et al., 2006; Wahlstrom and Louis, 2008
Deprivatised practice	Deductive	Stoll et al., 2006; Wahlstrom and Louis, 2008
Vision and expectations within the PLC	Inductive	
Shared vision on SRL	Inductive	
PLC goals vs. individual needs	Inductive	
Level of the school leaders		
Expectations	Inductive	
Motivation	Inductive	
Leadership	Inductive	
Prior knowledge on SRL	Inductive	
Own SRL skills	Inductive	
Feeling uncertain	Inductive	
Diversity in experience, school context, school size,...	Inductive	
Level of the school team		
Motivation of school team	Inductive	
Approaches	Inductive	
Context factors		
Teacher shortage	Inductive	
COVID-19	Inductive	
Visit from the education inspectorate	Inductive	
Curriculum changes	Inductive	

first year of the professionalization program in the fifth focus group discussion as follows:

We consistently initiated discussions with reflective questions, integrating theory to ensure a practical application. This approach was highly valued as it effectively engaged participants; without, their involvement would have been limited. Thus, by continually connecting questions to theory and insights, we fostered meaningful understanding and participation.

To further support this learning process, coaches developed materials that link SRL with existing frameworks already used within the participating schools. This approach aimed to create a shared language among school leaders and teachers, grounded in established theoretical models such as Zimmerman's (2002) framework. By aligning SRL with familiar concepts, coaches sought to make the integration process more accessible and relatable for the participants. In addition, these materials encouraged deeper collective reflection, prompting school leaders to explore concrete ways of embedding SRL practices into daily classroom activities.

In addition to nurturing reflective practices and material development, one coach highlighted the importance of providing targeted feedback. Moreover, all coaches mentioned engaging in goal-setting during the initial PLC discussions, although these goals tended to focus primarily on the objectives of individual schools rather than on the collective aims of the group.

Setting goals collectively presents a challenge, as does maintaining focus on these goals, for both myself and the schools. Schools are currently in an experimental phase, and there is a significant task of integrating these initiatives. Moreover, individual schools have articulated a strong vision, which needs exploration by all participants, particularly in terms of incorporating aspects of SRL. (participant 7, focus group discussion 1)

Despite these important elements that emerged in the role as coach, several challenges also surfaced during the focus group discussions. Some coaches reported difficulties in encouraging reflection when school leaders were eager to shift quickly toward operational issues, which hindered deeper engagement with SRL theory. Others noted that school leaders often needed more time to reflect on SRL principles, which is essential for sustaining progress.

In the domain of goal-setting, the varying motivations of school leaders and the differences in school contexts made it challenging to establish shared, group-level objectives, thereby limiting the focus on collective development processes within the PLCs. Additionally, the infrequent mention of feedback provision suggests potential gaps in the coaches' ability or opportunity to provide appropriate, expert feedback to the school leaders. This gap can also be linked to the coaches' role as an expert, which will be discussed in the following section.

That discrepancy between the role as an expert and the role as a coach requires deep knowledge acquisition. To provide effective feedback and engage with the input of the school leaders,

you need to be very familiar with those SRL frameworks yourself. Personally, I still find that aspect challenging. You cannot solely focus on the process because then you cannot provide sufficient feedback on what they bring. This is where your credibility as a coach comes into play, and I find that aspect quite challenging. We have been trained extensively and studied hard in recent months, which has helped us succeed. However, as a coach, you need to study for it, and I cannot emphasize that enough. (participant 4, focus group discussion 4)

5.1.2 Process coach as an expert

Across the focus group discussions, participants mentioned various types of substantive knowledge (e.g., knowledge of PLCs, knowledge of SRL). Given the scope of the study, we focus only on the specific content and pedagogical content knowledge on SRL in the present manuscript. Most coaches recognized the importance of acquiring sufficient content knowledge on SRL (CK-SRL) to effectively guide school leaders in implementing SRL school-wide. They noted that mastering this knowledge is a complex process that demands focused study and commitment.

In addition, grappling with the substance of SRL has consumed considerable time. I needed to create a mind map, engage in study, and pose questions to myself. There is a concern for me about being able to engage in detailed discussions at that level. While I grasp the overarching concept, I find it quite demanding. (participant 2, focus group discussion 1).

Furthermore, it is noteworthy that the same coaches frequently referred to CK-SRL throughout the professionalization program, whereas one coach never delved into this topic. This raises questions about whether this coach has adequately mastered the underlying SRL theory herself.

In contrast, PCK-SRL was less explicitly addressed in the discussions. Only one coach demonstrated a clear transition from CK-SRL to PCK-SRL. For instance, participant two identifies in the third focus group discussion the different methods of teaching SRL (direct instruction vs. indirect instruction) when discussing the instructional approach.

Simply gathering what is present in the PLC and linking it to whether it is direct or indirect instruction, that seems to me, at first glance, a safer framework where I increasingly feel comfortable.

Finally, although not explicitly solicited during the discussions, some coaches expressed awareness of their own beliefs regarding SRL, specifically indicating feeling uncertain in their role as experts.

The tools are clear, the theory is clear, and we delve deeper, which I find very challenging. I feel like I am on thin ice because I am somewhat uncertain in this area, which unconsciously causes me to hold back a bit. (participant 2, focus group discussion 4)

5.1.3 Process coach as a coordinator

Throughout the focus group discussions, process coaches assigned the least emphasis to their coordinating role in the PLC. Initially, many coaches invested considerable effort in structuring PLC meetings, including drafting agendas, maintaining portfolios, and managing other organizational aspects. The shift to online meetings due to the COVID-19 pandemic introduced notable challenges in ensuring active participation of all school leaders in the PLC. These challenges went beyond technical difficulties; coaches also struggled to foster spontaneous interaction and to keep participants focused on the PLC tasks. Since participants joined the meetings remotely from their own schools, they were often prone to distractions, which further hindered their engagement and the overall group dynamics. Over time, however, attention to coordination declined, with its importance increasingly taken for granted rather than actively addressed. Only one coach consistently underscored the need to engage and organize school leaders, highlighting the persistent challenges associated with this responsibility.

5.1.4 Process coach as a learner

Beyond the three previously identified roles, we observed that throughout the two-year trajectory, many coaches perceived themselves as learners, highlighting a fourth role for process coaches engaged in providing in-service professionalization.

As SRL experts, the process coaches repeatedly emphasized the need for independent study to master the various theoretical frameworks. In both the initial and final focus group discussions, this ongoing learning was seen as a strength, as it aligned their own learning process with that of the school leaders. However, it also posed challenges in relation to their coaching. More particularly, coaches sought to balance working within the school leaders' zone of proximal development while building enough expertise themselves to effectively guide the PLC.

Self-reflection and peer learning emerged as crucial aspects of this role. Coaches valued sharing experiences, approaches, and materials, as mentioned by participant one in the first focus group discussion:

Also, this focus group is very helpful. It is fascinating to hear how each PLC navigates their path and how each coach approaches it. It makes me reflect on my own journey and facilitates decision-making. A second opportunity that I see: we as coaches are also invited to learn, which fosters connection with the group school leaders. Now, we are truly doing it together!

By the end of the trajectory, some coaches recommended two coaches to facilitate a PLC to reflect and learn from each other in a large group setting (e.g., in the focus groups) but also in pairs shortly after each PLC meeting to collaboratively shape the PLC.

Finally, the role as a learner was strongly related to the roles of expert and coach, shaping how responsibilities were enacted. However, significant differences emerged among the process coaches. Notably, those who emphasized their role as experts also strongly focused on their own learning process. In contrast, coaches who seldom mentioned theoretical frameworks and coaching skills in the focus group discussions tended to see themselves less as

learners. Due to the limited mention of the coordination role, no clear connection could be established between it and the role of learner.

5.1.5 Tensions between roles

Tensions between the various roles emerged during the focus group discussions. First, there was a tension between the roles of expert and learner. Some process coaches struggled to balance learning alongside school leaders while maintaining their position as experts with preexisting knowledge and expertise. Second, also related to the expert role, tensions arose between providing theoretical input to school leaders and adopting a coaching stance by encouraging reflection, asking questions and building on existing group knowledge. Participant two struggled with both tensions and formulated her reflections as follows:

It might be that you feel the need to fully master everything before taking the next step with your PLC. Or perhaps not; maybe you are learning by doing. However, what has been emerging for me in recent years, and this relates to the way our organization works, is that our role as process coaches is evolving, along with the associated expectations from the schools. I struggle with this a lot. I constantly question what we are as process coaches. Are we still content experts? Where does our expertise lie?

Finally, uncertainties regarding the coaching role emerged, particularly in the first year of the professionalization trajectory. Two process coaches questioned their position as PLC coaches. Since the school leaders were already collaborating as part of an existing network, with one of the school leaders taking on a coordinating role, these two process coaches observed that this coordinating leader could assume the role of coach within the PLC. However, this was not a uniform pattern across all PLCs and heavily depended on the leadership style of this coordinator and the extent of collaboration prior to the start of this professionalization program.

5.2 Challenges faced by the process coaches

The challenges faced by the process coaches themselves have already been mentioned when discussing their roles. However, for the second research question, challenges and corresponding approaches will be discussed at other levels (i.e., the PLC, individual school leaders and the school team) as well.

5.2.1 Level of PLC

Focusing on the core characteristics of PLCs, namely deprivatised practice, collective responsibility and reflective dialogue, we noticed that the process coaches mainly emphasized the latter. In the first focus group discussion, coaches highlighted many growth opportunities for the participants in the PLC regarding these characteristics. Some groups of school leaders were accustomed to working together but tended to focus solely on exchanging ideas and materials without assuming collective

responsibility. They were used to being directed and had no experience with group reflection. During the subsequent focus group discussions the process coaches identified stimulating this group reflection as a key focus of their role. Deprivatised practices and collective responsibility were subsequently seldom mentioned or rarely brought up in the next discussions. This finding prompted a critical assessment of how well the PLCs in this professionalization program met the key criteria. One process coach shared this perspective at the end of the first year. Participant one questioned in the fifth focus group discussion whether she had guided a PLC:

Regarding the PLC, we have reviewed the theory and the prerequisites, but we have not yet implemented it. Our collaboration has not functioned as a PLC this year; the sessions were heavily guided by me, and I introduced the theory on SRL and so on... The school leaders did actively participate, but upon critical examination, it did not constitute a PLC.

Subsequently, a concept linked to collective responsibility is the shared vision on SRL and on what constitutes a PLC. This was discussed during the first focus group sessions, where coaches noted that such a shared vision was often lacking among participants. For example, one process coach explained that several participants viewed the PLC primarily as a space for exchanging practical ideas, rather than for engaging with underlying concepts or theories. When attempts were made to deepen the conversation, some participants became impatient, indicating a preference for quick, concrete outcomes. They addressed this by initiating discussions on the topic. In connection with this shared vision, the coaches perceived the participants' expectations as a challenge. They mentioned that these expectations were not always clear and aligned with the goals of the professionalization program (e.g., the participants expected the coach to be an expert who provides all the content, allowing them to immediately move to operational matters at their school without engaging in reflection). This required time to make these expectations explicit. This issue was not only present at the beginning of the trajectory but also resurfaced at the start of the second year. Coaches emphasized the importance of clearly articulating vision and expectations within the PLC.

Lastly, we observed that many coaches reported a shift in their approach at the start of the second year of the professionalization program. They placed less emphasis on the collective dynamics within the PLC and instead focused more on addressing the individual needs of the school leaders and their respective schools.

5.2.2 Level of individual school leader

At the start of the professionalization program, all process coaches noticed a diversity in the motivations of the school leaders for participation. Some school leaders joined the PLC because it was a requirement from their school network, while others had already been working on SRL at their school for several years and wanted to deepen their understanding. Several process coaches explored these motivations further, aiming to address each one and link it to specific PLC goals.

The diversity also extended to the prior knowledge on SRL of the school leaders, their leadership and their own SRL skills.

In the sixth focus group discussion, participant eight noticed the following:

What I have also observed is that a few highly capable school leaders are participating, whereas others have not yet fully developed their own SRL skills to effectively support their teams in the future. The more capable leaders often communicate with each other, exchange ideas, and appreciate each other's strengths. They also openly acknowledge the areas where they still need to improve.

Additionally, substantial differences among school leaders emerged in their experience as a school leader, their tenure at their current school, and the size of the school. Notably, when process coaches in the focus group discussions were asked about the challenges they encountered, these factors were frequently mentioned. One process coach, in particular, highlighted the difficulty of effectively addressing these challenges, emphasizing that the participation of numerous new school leaders in the PLC posed a significant barrier to progress. This coach felt that these leaders needed to prioritize various other school-related matters before fully engaging in the PLC.

Besides diversity, uncertainty among school leaders was another frequently cited challenge. At the start, three process coaches mentioned that some school leaders do not yet see themselves in a coaching role with their teaching staff. They were concerned that implementing SRL on a school-wide basis might be too overwhelming and might take too much time for their team.

Finally, one participant noted that school leaders projected their own uncertainty onto their school team. For example, they may state in the PLC that their team of teachers is not innovation-oriented. However, the process coach suspected that it was, in fact, the school leaders themselves who harbor uncertainties about implementing SRL as a school-wide educational innovation.

5.2.3 Level of the school team

Although the process coaches did not work directly with teaching staff in this professionalization trajectory, many challenges at this level were still discussed in the focus group discussions. These challenges were either mentioned by the school leaders in the PLC or observed by the coaches themselves.

Similar to individual school leaders, considerable diversity was observed among school teams. The challenge of motivating these teams frequently arose, with several process coaches highlighting that school leaders viewed this as their most significant hurdle. In recent years, school teams faced numerous challenges: teacher shortages, the COVID-19 pandemic, visits from the education inspectorate, and curriculum changes. As a result, school leaders worry that their teams will perceive the implementation of SRL as an additional burden. Additionally, in almost all participating schools, SRL implementation is just one of many priorities.

At the start of the second year, several coaches reflected on the emerging disparities between school leaders and their teams. Participation in the PLC had enabled many school leaders to make significant progress and to master a substantial amount of knowledge. As a result, some leaders then expected teachers to

quickly implement these changes, which led to a lack of support and more top-down decision-making. Notably, some PLCs used these concerns as a starting point for group reflection, while other process coaches focused only on acknowledging these challenges.

Throughout all the focus group discussions, various approaches were examined, revealing several key insights. School leaders recognized that teachers must also follow a similar learning process, documenting their own challenges to better support their teams. In other PLCs, leaders critically examined the theory of SRL and decided to present it differently to their teams. They started by acknowledging what teachers were already doing in their classroom and briefly connecting it to the theory, helping teachers realize they are already fostering students' SRL skills. These reflections and connections were then collaboratively explored within the PLC, where practical examples were identified and integrated into the discussion.

6 Discussion

In what follows, we elaborate on the results from the focus group discussions with the process coaches. Throughout the discussion, we address the study's limitations, explore potential directions for future research, and present the practical implications of this study for SRL implementation and further professionalization of schools on SRL with process coaches.

6.1 Four roles of a process coach

This study is an added value to prior research studying leadership and roles within a PLC (e.g., Coenen et al., 2021; Margalef and Roblin, 2016) by including between-schools PLCs with school leaders focusing on the school-wide implementation of SRL. While the roles process coaches can assume in this professionalization program were not explicitly questioned in the focus group discussions, three key results regarding these roles emerged.

First, in line with prior research (e.g., Coenen et al., 2021; Prenger et al., 2017), the distinction between the roles of the process coach as a coach, an expert and a coordinator can also be made in this study. Similar to the research of Coenen et al. (2021), the coaching role is most prominent in our study. More specifically, coaches highlight encouraging reflection among school leaders as their main task. Next, goal setting for the PLC occurs only at the beginning of the professionalization trajectory and providing feedback as a coach is rarely addressed. Most coaches recognize their role as an expert and the importance of acquiring sufficient CK-SRL to effectively guide school leaders in implementing SRL school-wide. Acquiring this knowledge requires process coaches to actively study and familiarize themselves with the theoretical frameworks on SRL. This finding contradicts the study by Assen and Otting (2022), which suggests that process coaches often disregard theory as a learning resource. At the same time, it is consistent with the recent study by Vekeman et al. (2023), where participants emphasize the importance of process coaches using their subject matter expertise to provide concrete examples and suggestions tailored to the needs of school leaders. We also

observe significant differences among coaches, not only in the importance they attach to CK-SRL but also in the attention they give to PCK-SRL. The latter is mentioned far less frequently, despite Karlen et al. (2020) emphasizing the importance of both types of knowledge. Moreover, differences apparent not only in the knowledge of the process coaches but also their self-efficacy beliefs as experts. Some coaches explicitly reflect on their own feelings of competency and acknowledge their uncertainty in guiding the PLC due to their (limited) knowledge on SRL implementation. Here we observe a parallel with studies on teachers' competencies and more specific teachers' self-efficacy in implementing SRL, which refers to teachers' personal beliefs about their abilities to foster SRL in the classroom (De Smul et al., 2018). It is plausible that similar self-efficacy beliefs among coaches may influence this first phase of SRL implementation, namely the PLCs with the school leaders. Research specifically targeting the general and self-efficacy beliefs of coaches regarding the implementation of SRL is needed in this regard. Lastly, regarding the coordinator role, we observe that process coaches give it less explicit attention. When they do address it, it is mostly at the program's outset, which aligns with the findings of Margalef and Roblin (2016).

Second, we elaborate on the additional, fourth role that became apparent through the data, namely the process coach as a learner. This role influences how coaches assume their responsibilities as both coach and expert. However, significant differences among process coaches are noticed. Notably, those who emphasize their role as experts also strongly focus on their own learning process. Seeing themselves as a learner (e.g., by studying SRL theoretical frameworks, needing reflection time and sharing experiences, approaches, and materials with colleagues) or more specifically as a self-regulated learner could be a strength of this professionalization program. Similar to the research of Karlen et al. (2020), which highlights that teachers are not only agents of SRL but also learners of SRL, this perspective can be extended to actors at the supra-school level, who must first develop their own understanding of SRL before effectively supporting schools and teachers in its implementation. Although the process coaches in this study align their own learning process with that of the school leaders, this contradicts previous research, such as the study by Assen and Otting (2022), where coaches did not view studying theory as a source of learning.

Third, tensions arise between the various roles of the process coaches, particularly between their roles as expert and learner, as some seek to balance learning with school leaders while maintaining their position as knowledgeable experts. Additionally, tension is often felt between their roles as expert and coach. On the one hand, they act as experts, providing theoretical input to school leaders. In this way, they take on a more prominent leadership role, which aligns with previous research that emphasizes the importance of leadership within a PLC (Coenen et al., 2021; Margalef and Roblin, 2016; Tanghe and Schelfhout, 2023). On the other hand, they serve as coaches, fostering reflection, encouraging participation, and building on the group's existing knowledge, which aligns with a core characteristic of PLCs, namely stimulating reflective dialogue (Stoll et al., 2006). Furthermore, some coaches experience tensions regarding their role as coaches during the first year of the professionalization program, especially when a coordinating school leader, also a PLC participant, assumed this

role. As mentioned, previous research underscores the critical role of leadership within a PLC (Margalef and Roblin, 2016; Coenen et al., 2021; Prenger et al., 2017; Tanghe and Schelfhout, 2023). However, more research is needed to determine who specifically should take on this role.

In summary, we observed process coaches assuming four roles: coach, learner, expert, and coordinator. However, these roles are not always distinct in practice, and the coaches experience significant tension between them, which impacts their trajectory within the PLC with school leaders.

6.2 Challenges at different levels

In addition to their own role and the challenges experienced by the process coaches, the focus group discussions also address challenges at other levels. Three key levels are discussed below.

At the PLC level, we find, similar to the study by Coenen et al. (2021), that different PLC setups lead to varying process coaching behaviors. In general, process coaches focus primarily on stimulating reflective dialogue, a key characteristic of a PLC (Stoll et al., 2006). However, this is not always straightforward to achieve. Some groups of school leaders are used to working together but mainly exchange ideas and materials, without developing collective responsibility or a shared vision on SRL. As a result, these coaches initially focus more on “collective responsibility” within the PLC, which they find challenging. Moreover, as the PLCs progress, deprivatized practices and shared responsibility are discussed less frequently in the focus groups. This finding raises the question of how well the PLCs in this trajectory align with these fundamental criteria.

At the level of the individual school leader, the process coaches observe a range of motivations among school leaders for participating in the PLC. While some participate out of obligation, others have already been working on SRL for years and are looking for ways to deepen their understanding. This diversity of motivation represents a professional boundary that becomes even more significant for within-school PLCs, where participants come from different school cultures, resulting in varying reasons for participation (Prenger et al., 2019). The variety of motivations in this study is further complicated by variations in prior knowledge of SRL, leadership experience, personal SRL skills and size of the school. Moreover, the uncertainty among school leaders is frequently highlighted as an obstacle by the process coaches. Some school leaders do not perceive themselves as coaches for their staff, fearing that the implementation of SRL would be overwhelming and time-consuming for their teams and indicating that their teams were not innovation-oriented.

Finally, although process coaches do not directly engage with teaching staff in this professionalization trajectory, numerous challenges at this level emerge in the focus group discussions, either are reported by school leaders or are identified by coaches. A common issue is motivating school teams to implement SRL, with several coaches noting that school leaders view this as their main challenge. Some coaches observed a growing gap between school leaders and their teams. As school leaders advanced in the PLC and

gained knowledge, some expected rapid changes, raising concerns about limited support and top-down decisions. This challenge underscores the necessity of accommodating different paces of progress when implementing SRL across the entire school. Schools may require tailored approaches that consider the varying levels of readiness, experience, and engagement among team members.

6.3 Practical implications of the study

Firstly, since process coaches perceive themselves as learners and some experience uncertainty, it is essential to provide professional development for those guiding the schools in the school-wide implementation of SRL. Here, a long-term professional development program seems to be more recommended than short-term, standalone initiatives (Prenger et al., 2019). The process coaches need sufficient time to study and to reflect on the challenges they face before and during the collaboration with school leaders. A critical consideration in this regard is the significant time investment required. Since the school-wide implementation of SRL is highly complex, it demands time not only at the school level but also at a broader, meta-level, particularly for the coaches supporting the process. Moreover, the learning process of these coaches is emblematic of the learning that occurs at subsequent levels, including school leaders and teachers.

Secondly, with regard to the challenges faced by process coaches at the level of school leaders, it is crucial to focus on and give attention to their knowledge, as well as their beliefs and self-efficacy, in order to reduce their sense of uncertainty. Similar to teachers, school leaders can be viewed both as agents and as learners of SRL (Karlen et al., 2020). In future PLCs, these aspects can be addressed not only by fostering reflection among participants but also by providing theoretical frameworks, sharing concrete strategies and materials for SRL implementation, and encouraging collaborative learning. Creating a safe and supportive environment where school leaders can openly discuss their uncertainties and exchange experiences is important to strengthen their self-efficacy and enhance their understanding of SRL.

Finally, as the entire school community must work together to implement SRL school-wide (Peeters et al., 2014; Thomas et al., 2020), there is a need for supportive conditions at all levels, such as adequate time and space for reflection. To achieve changes in students' SRL skills, we must start by supporting process coaches who guide schools, thereby gradually moving toward the implementation of effective classroom practices.

6.4 Limitations and suggestions for future research

We conclude with additional research suggestions in addition to the ones already referred to, while also acknowledging the limits of the current study.

Firstly, although this professionalization trajectory is not a short-term professional development initiative but a long-term trajectory, which allows for deeper and more sustainable growth (Watson, 2014), it also presents a challenge: the

inevitable turnover of participants throughout the learning process. This is a limitation, as continuity in guidance is not always guaranteed. Moreover, these changes do not only occur at the school level, affecting school leaders and teachers, but also among the process coaches who support the schools. This turnover highlights a key issue in the broader discourse on education quality: strengthening and professionalizing teachers is difficult when coaches with accumulated experience are replaced, forcing new coaches to start from scratch.

Although this study adopts a two-year longitudinal approach, further research is needed to examine how the process continues beyond this period. Learning at various levels requires time, and therefore, research should also extend over a longer duration. Additionally, as previously mentioned, turnover presents a challenge, causing delays in the process. Turnover at the level of the process coaches is emblematic of similar changes occurring at subsequent levels, including school leaders and the school team. Moreover, although rich longitudinal qualitative data were collected through frequent focus groups with process coaches, the current analysis did not systematically explore changes over time in key constructs such as coaches' expectations, knowledge, beliefs or self-efficacy. Because the focus group protocols evolved to match the coaches' developing needs and each session was analyzed independently, it was not possible to track developmental patterns throughout the program. Future research could use a longitudinal mixed-methods design to better understand how process coaches develop in their role and how this affects coaching outcomes.

Thirdly, although the data were analyzed systematically, one methodological limitation is that the coding process was not double-checked by a second coder. As a result, interrater reliability was not formally assessed, which may affect the dependability of the findings.

Fourthly, this study only considers the perspective of process coaches. While this focus is a key strength, as process coaches play a critical role in guiding school leaders and teams through the stages of SRL implementation, future research should explore how PLC members perceive the coaches' role and how their perspectives align or differ from those of the coaches.

Finally, while this study's exploratory approach offers an in-depth, insider perspective of process coaches in SRL-focused professionalization programs, its findings cannot be broadly generalized. Future research should examine whether the roles, patterns and challenges observed here are also present in other contexts. This could ultimately contribute to the development of a research-based framework for comprehending the coaching processes within PLCs.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Faculty of Psychology and Educational Sciences of Ghent University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

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The author(s) declare that Gen AI was used in the creation of this manuscript. Generative AI was used to suggest improvements for clearer and more effective wording of the results and discussion.

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Student perception of teacher encouragement of self-regulated learning and its relationship with self-regulation learning strategies

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Introduction: Self-regulated learning significantly impacts academic achievement and learning effectiveness; however, a significant portion of students do not engage in optimal self-regulated learning. Teachers can influence self-regulated learning in various direct and indirect ways, such as teaching students effective learning strategies or structuring the learning environment. Research indicates that teachers moderately encourage self-regulated learning, with direct/explicit teaching methods being underutilized despite their stronger contribution to fostering learning self-regulation. Teachers often overestimate their encouragement of learning self-regulation compared to students' perceptions. There is a scarcity of research on encouraging self-regulated learning in teaching practices, particularly from the students' perspective. Hence, the aim of this study was to examine how students perceive teacher encouragement of self-regulated learning and its association with their own self-regulated learning.

Methods: The research was conducted on a sample of 2,154 students who assessed the teacher's encouragement of self-regulated learning and their own self-regulated learning in a specific subject.

Results: Students perceive that teachers moderately to relatively highly encourage self-regulated learning. Statistically significant moderate correlations were found between students' assessments of learning self-regulation and the encouragement of self-regulated learning. Girls perceive that teachers encourage self-regulated learning to a greater extent, as do secondary school students compared to primary school ones. Teacher encouragement of self-regulated learning explains from 0 to 32% of the variance in self-regulated learning strategies. Defensive self-regulation strategies (avoiding work, self-handicapping, and focusing on minimal demands) are explained to the least extent, while proactive self-regulation strategies (orientation towards acquisition, elaboration, and goal setting) are explained to a considerably greater degree.

Discussion: The research results suggest that students' perception of teacher encouragement of self-regulated learning is a significant predictor of learning self-regulation in students. The data obtained in the research contributes to understanding the encouragement of self-regulated learning from the students' perspective and highlights the importance of students' assessments of encouragement of self-regulated learning.

KEYWORDS

self-regulated learning, teachers' encouragement of self-regulated learning, student perception, relationship, primary and secondary school

1 Introduction

Theories of self-regulated learning emphasize that self-regulated learning (SRL) is a cyclic, multidimensional process involving the interaction of personal (cognitive, metacognitive, motivational, emotional), behavioural, and environmental factors (Panadero, 2017). These factors enable students to better manage their learning. Self-regulated learners are those that are proactive in their efforts to learn; i.e., they plan their learning, set goals, choose task-appropriate strategies, monitor goal attainment and the effectiveness of learning strategies, evaluate what they have learned, which reflects on their motivation and behaviour in the next learning cycle. In recent years, literature and empirical studies have underscored the importance of self-regulated learning when it comes to educational outcomes, and there have been several reasons put forward as to why this seems to be the case. Firstly, students whose learning is self-regulated achieve more positive educational outcomes. It is undeniable that self-regulated learning has a significant impact on academic achievement and learning effectiveness, with numerous studies indicating that self-regulated learning positively associates with academic achievement (Broadbent and Poon, 2015; Hattie, 2013; Richardson et al., 2012; Zimmerman, 1990). Students whose learning is self-regulated become adaptable, lifelong learners, think critically and creatively, solve problems and are able to work and learn independently and in collaboration with others (Perry et al., 2017). However, the learning of a significant portion of students does not appear to be optimally self-regulated (Kramarski and Michalsky, 2009). On the other hand, teachers can influence self-regulated learning in various direct and indirect ways: by teaching students effective learning strategies or structuring the learning environment (Dignath-van Ewijk and van der Werf, 2012; Karlen et al., 2020; Kistner et al., 2010). Moreover, teaching students how to self-regulate their learning and engaging them in a stimulating environment seems to improve their performance (de Boer et al., 2012; Dignath and Büttner, 2008) but also encourages the development of students' metacognition, motivation and strategic action. These fundamental learning competencies improve students' academic, social, emotional and career outcomes (Brenner, 2022; Conesa et al., 2023; Depaeppe et al., 2010). Teachers can promote self-regulated learning directly through teaching learning strategies both implicitly and explicitly. Implicit teaching involves demonstrating certain behaviours, such as modelling strategy use or verbalizing thought processes by the teacher, while explicit teaching entails instruction-based demonstrating on why, how, and when a particular strategy is to be used. In indirect teaching, the teacher creates a learning environment based on constructivist theory: by activating prior knowledge and actively constructing new knowledge (constructivism), enabling student autonomy in SRL (self-determination), fostering social interaction among students (collaboration), embedding learning in authentic situations to encourage transfer (value), developing self-regulation skills (self-direction), encouraging engagement in SRL (expectancy of success), and supporting positive emotions and relationships (student support; De Corte et al., 2004; Dignath et al., 2022).

Most teachers agree that students need assistance in making their learning self-regulated, showing positive beliefs about SRL, but they feel uncertain about how to accomplish this task (Dignath-van Ewijk and van der Werf, 2012). The research also indicates that teachers only moderately encourage SRL, particularly through infrequent use of

direct/explicit instruction, which has been shown to more strongly contribute to the development of learning self-regulation (Bolhuis and Voeten, 2001; de Kock et al., 2005; Dignath and Büttner, 2018; Dignath-van Ewijk and van der Werf, 2012; Karlen et al., 2020; Kistner et al., 2010, 2015; Spruce and Bol, 2015; Šimić Šašić et al., 2023a; Vadevelde et al., 2012; Zimmerman, 2002).

Research shows that differences in SRL encouragement depend on both teacher and student characteristics, including factors such as gender, age, level of education, etc. (De Smul et al., 2018; Hargraves, 2005; Moos and Ringdal, 2012; Šimić Šašić et al., 2023b; Vadevelde et al., 2012). Therefore, it is important to investigate the differences in students' perception of SRL encouragement with regard to student characteristics. It is known that there are differences in teacher behaviour in the classroom depending on the gender of the teacher, as well as differences in student perception of teacher behaviour depending on the gender of the student. Differences in academic achievement and learning self-regulation also seem to exist between male and female students, and the same goes for teacher perception of male and female students. Women, in line with their gender role as "caring teachers," more often utilize student-directed, active, and constructivist teaching approaches, all of which tend to be welcomed by students in general (Chen, 2000). Šimić Šašić et al. (2023a) have determined that female teachers are more inclined to encourage SRL. On the other hand, female students were shown to perceive their teachers as more dominant, positive, and cooperative in comparison to their male colleagues (den Brok et al., 2006), thus establishing closer and less conflictual relationships with them (Baker, 2006), and viewing them as more demanding and responsive, whereas male students perceive a higher level of coercive control from teachers (Slobodzin and Batista, 2021). Female students generally achieve better academic success and demonstrate higher levels of learning self-regulation (Bidjerano, 2005; Lončarić, 2010; Niemivirta, 1997; Šimić Šašić, 2008), and teachers perceive them as such while having lower expectations of male students, whom they perceive as dependent, idle, and unmotivated (Åhslund and Boström, 2018). Research indicates that teachers perceive greater utility in promoting SRL in primary schools (De Smul et al., 2018; Yan, 2018). De Smul et al. (2018) found that teachers in higher grades of primary school (middle school) and in secondary school provide opportunities for learning self-regulation but rarely engage in direct teaching of learning strategies to students. On the other hand, Moos and Ringdal (2012) found that teachers in lower grades of primary school (up to 6th grade) predominantly encourage learning self-regulation. Šimić Šašić et al. (2023a) did not find differences in teacher assessment of SRL promotion based on the type of school where teachers work (primary/secondary school-grammar/vocational school).

Research on SRL encouragement in teaching practice is scarce (Dignath-van Ewijk et al., 2013; Kramarski and Michalsky, 2009), especially from the perspective of students. Most studies have focused on the effectiveness of interventions and teacher training for encouraging SRL. When it comes to research on SRL encouragement by teachers, most studies have relied on teacher self-assessment or observation. In fact, the predictive value of teachers' self-assessment of SRL encouragement in students may be weak due to bias (Winne, 2010; Winne and Perry, 2000). Teachers may report what is appropriate and socially desirable rather than their actual practices, and the terminology in questionnaires may potentially be unfamiliar to them. Using questionnaires is advantageous due to their

practicality with large samples, whereas observation tends to be time-consuming and inconvenient, especially in relation to teachers who may change their behaviour due to awareness of being observed. Nevertheless, observation has the advantage of assessing behaviour rather than someone's opinion, but it also faces sampling and construct visibility issues. We believe that it is preferable to use various sources of information, including the students' opinions. Student perceptions of the learning environment and their teacher behaviour are important sources of information. Unlike observer assessments, students' ratings are based on a larger sample of teacher behaviour over a greater number of teaching hours, and the limitation of observation is that observers themselves may be a potential source of variation in the observed results. The research on different teaching perceptions has shown that students' perceptions determine their behaviour and thus have a greater impact on student learning than external observations (De Jong and Westerhof, 2001). Students' perceptions of the learning conditions are thus considered among the most relevant factors mediating between teaching quality and students' utilization of learning opportunities (Seidel and Prenzel, 2006). Newmann et al. (1996) argue that teaching methods are less important than the quality of students' educational experiences. Generally speaking, the research agrees on the mismatch between the objective environment and subjective perception of the environment, as well as discrepancies between teacher and student assessments. Šimić Šašić et al. (2024) found that students rated teacher encouragement of SRL lower than teachers did, having also found a low but statistically significant correlation between teacher and student assessments of SRL encouragement. The correlation coefficients ranged from 0.21 to 0.32, which was expected, considering that the correlated assessments were based on the average ratings of a larger number of students. Similar results have been reported by Dignath-van Ewijk et al. (2013), who found that there is some agreement in the assessments of teachers, students, and observers regarding teacher encouragement of SRL, and the agreement was higher between teacher and student assessments than those of observers. Additionally, the authors in this study found that student and observer assessments have greater predictive value for student self-regulation than teacher assessments, which is consistent with the view that students are able to provide valuable information about teaching that influences their learning experiences (McCombs et al., 2008).

In this study, we aimed to examine how students perceive teacher encouragement of SRL and explore the association between students' perception of SRL encouragement and SRL itself.

The specific objectives were: (a) to examine students' perception of SRL encouragement, (b) to investigate potential differences in the perception of SRL encouragement based on gender, grade, and type of school attended by students, and (c) to explore the association and contribution of students' perception of SRL encouragement to their learning self-regulation strategies.

Research hypotheses: (a) we anticipate that students will positively evaluate the degree of teacher encouragement of SRL; (b) although we expect female students to rate SRL encouragement more positively, we do not expect differences in students' perception of SRL encouragement based on grade and type of school; and (c) we expect students' perception of SRL encouragement to be associated or contribute to the explanation of students' evaluations of their self-regulated learning in a specific subject.

2 Method

2.1 Sample

The study was conducted on a sample of 2,154 primary and secondary school students across 17 counties in the Republic of Croatia. A request to participate in the research was sent to one primary school and one secondary school in each of Croatia's 21 counties. For each teacher who agreed to participate, the school coordinators agreed to include one of their classes in the research. Of the total number of respondents, there were 1,277 female students (59.29%), while the distribution of students by type of school was as follows: primary schools 50.93%, grammar schools 16.25%, and vocational schools 32.82%. The distribution of students by grades was as follows: 5th grade (8.03%), 6th grade (15.13%), 7th grade (14.53%), 8th grade (13.28%) in primary schools, and 1st grade (10.77%), 2nd grade (17.32%), 3rd grade (10.45%), and 4th grade (10.49%) in secondary schools.

2.2 Measurement instruments

General Data Questionnaire—included questions concerning gender, age, type of school, grade level, and academic performance in the subject taught by a specific teacher for whom the degree of SRL encouragement was assessed.

Self-Regulated Learning Encouragement Scale (Šimić Šašić et al., 2024)—measures the student perception of teacher's encouragement of self-regulated learning across five different areas:

- (a) Encouragement of Learning Planning and Learning Organization Strategies (ELPLO)—assesses the degree of support provided for students' learning planning (setting goals, managing time and learning strategies, organizing the learning environment, encouraging task assessment, identifying causes of success or failure in learning, etc.) and the encouragement of learning organization strategies (breaking down content into smaller meaningful units, identifying key concepts, summarizing, and asking questions). It consists of 15 statements (e.g., *The teacher encourages us to set goals before learning or completing a task*).
- (b) Encouragement of Metacognitive Monitoring of Learning (EMML)—involves encouraging students to direct and sustain their attention during learning, experiment with different ways of learning/problem-solving, and engage in activities when motivation drops and negative emotions arise, such as: supporting interest in learning, investing additional effort, reminding students of task value, etc. It consists of 10 statements (e.g., *The teacher encourages us to maintain focus on the content we are learning/during learning*).
- (c) Encouragement of Elaboration and Evaluation (EEE)—measures the encouragement of explanations/discussions among students, graphical representation of information, application of knowledge/creation, assigning less structured tasks, independent task solving, working in pairs/small groups, involving students in setting evaluation criteria, self-assessment, and evaluating others' work. It consists of 10

statements (e.g., *The teacher encourages us to explain the content we are learning to each other*).

- (d) Encouragement of Understanding (EU)—consists of statements aimed at activating previously acquired knowledge, initiating teaching with intriguing tasks, encouraging drawing conclusions, connecting information from different sources, correcting misunderstandings, and linking information to everyday life situations. It consists of 12 statements (e.g., *The teacher provides us with enough time to explore and gain understanding of new content*).
- (e) Encouragement of Effort Investment (EEI)—statements refer to encouraging students that they can accomplish tasks, motivating their effort investment, attributing success to effort, and emphasizing the value of knowledge. It consists of 4 statements (e.g., *The teacher encourages us to believe that we can learn/complete the task*).

The scale was originally developed to assess teacher encouragement of SRL and was adapted for students. The factor structure in the student sample revealed a four-factor structure and somewhat different distribution of items across factors. However, as the study was conducted as part of a broader project aimed at examining the relationship between teacher and student assessments, factor analyses were performed separately for the subscales (with the number of factors fixed at 1). The items in the student sample showed satisfactory factor loadings and robust coefficient values for internal consistency. Due to high correlations among the factors, it is possible to use the scale as a single-factor scale with a total score indicating overall encouragement of SRL (ESRL).

The scales of self-regulated learning components (Lončarić, 2014) measure motivational and cognitive beliefs and learning strategies. The following subscales were used in this study:

- (a) General belief in control capacity—this scale contains 4 statements (e.g., *I can achieve good success in this subject if I decide to do so*) and measures students' belief in their ability to control situations in learning.
- (b) Motivational beliefs
 - Self-efficacy in the learning process—measures motivational beliefs related to the expectation of success in the learning process (4 statements; e.g. *It is easy for me to learn the assigned material for a test or examination*).
 - Goal orientations—represent the value component of motivational beliefs, and include as follows: mastery goal (4 statements; e.g. *It is important for me to acquire and learn as much new knowledge and skills as possible*); competition goal—outperforming others (4 statements; e.g. *I am very satisfied when I perform better than others in this subject*); avoidance goal (4 statements; e.g. *I want to spend as little time as possible on school obligations in this subject*).
- (c) Motivational strategies—measure the motivational component of SRL, and include as follows: goal setting (4 statements; e.g. *When I study, I specify exactly what I want to achieve through learning*); effort regulation (4 statements; e.g. *If I get stuck on difficult material, I encourage myself and say to myself that I can*

solve it); self-handicapping (5 statements; e.g. *I always leave studying for this subject until the last moment*).

- (d) Learning Strategies—refer to cognitive and metacognitive learning strategies, and include as follows: control of learning processes and outcomes—a strategy (metacognitive control) related to the learning process (4 statements; e.g. *After studying in this subject, I check my knowledge and understanding of the material*); organization—strategies related to learning content and involve deep processing (6 statements; e.g. *In this subject, I try to summarize extensive texts and come up with a few important sentences or key points*); elaboration—strategies related to learning content and involving deep processing (4 statements; e.g. *While reading the material from this subject, I try to connect it with what I already know*); setting minimal demands—refers to a low level of cognitive effort investment in learning (4 statements; e.g. *I only learn as much as is necessary to pass the grade*).

2.3 Procedure

The research was conducted using an online questionnaire. The questionnaire link was sent to school coordinators who forwarded it to the students who were then informed about the research objective, purpose, and implementation method, and participation in the research was voluntary and anonymous. Permission for conducting the research was obtained from the Ministry of Science and Education of the Republic of Croatia, the Ethics Committee of the University of Zadar, school principals, and parents of students under 14 years of age. Filling out the questionnaire took about 15 min. Students assessed the encouragement of self-regulated learning by a specific teacher (who also participated in the research) and their own learning self-regulation in the subject taught by the teacher in question.

2.4 Data analysis

The Kolmogorov–Smirnov test determined that the distributions of the results for all variables deviated from the normal distribution. The values shifted towards the higher end, indicating a negatively asymmetric distribution. However, the skewness and kurtosis indices remained within the expected indices for a normal distribution (skewness index <3, kurtosis index <8; Kline, 2005, Table 1). Levene's test was used to check the homogeneity of variances between groups. In case the condition of homogeneity was violated, the Welch test was additionally calculated. A t-test was used to test gender differences. Given that inhomogeneous variance among groups with regard to school and grade was determined for most subscales, Welch tests were performed in addition to ANOVA. In order to assess the relationships between variables, Pearson's correlation coefficient and regression analysis were performed.

3 Results

Table 1 presents descriptive statistics for students' evaluations of teacher encouragement of self-regulated learning (SRL) and their

TABLE 1 Descriptive statistics, internal consistency coefficients, and skewness and kurtosis indices.

	M	SD	Range	α	Skewness	Kurtosis
ELPLO	3.40	0.90	1–5	0.93	−0.34	−0.37
EMML	3.92	0.93	1–5	0.93	−0.92	0.35
EEE	3.31	0.83	1–5	0.84	−0.15	−0.36
EU	3.79	0.83	1–5	0.91	−0.76	0.39
EEL	4.13	0.89	1–5	0.82	−1.24	1.20
ESRL	3.63	0.79	1–5	0.97	−0.59	0.17
Control	4.33	0.82	1–5	0.89	−1.31	1.33
Self-efficacy	3.77	0.92	1–5	0.83	−0.47	−0.29
Mastery goal	3.99	0.91	1–5	0.88	−0.86	0.47
Competition goal	3.34	1.13	1–5	0.90	−0.32	−0.68
Avoidance goal	2.98	1.07	1–5	0.86	0.06	−0.60
Goal setting	3.80	0.95	1–5	0.89	−0.57	−0.04
Effort regulation	3.64	0.99	1–5	0.89	−0.43	−0.36
Self-handicapping	2.69	1.06	1–5	0.89	0.31	−0.58
Control of learning processes and outcomes	3.84	0.92	1–5	0.86	−0.58	0.02
Organization	3.83	0.91	1–5	0.89	−0.51	0.02
Elaboration	3.70	0.93	1–5	0.90	−0.56	0.07
Setting minimal demands	2.83	1.1	1–5	0.84	0.13	−0.77
Academic achievement	4.06	1.01	1–5		−0.87	−0.02

ELPLO, encouragement of learning planning and learning organization strategies; EMML, encouragement of metacognitive monitoring of learning; EEE, encouragement of elaboration and evaluation, EU, encouragement of understanding; EEL, encouragement of effort investment; ESRL, overall encouragement of SRL.

assessments of their own learning self-regulation in the subject taught by the teacher in question.

Students assess that teachers moderately to relatively highly encourage self-regulated learning. They believe that teachers mostly encourage effort investment, followed by metacognitive monitoring of learning, understanding, learning planning, and organizational strategy, while elaboration and evaluation of learning are perceived as least encouraged. Additionally, students rate proactive self-regulation strategies relatively highly: general beliefs about control, goal adoption orientation, goal setting, effort regulation, monitoring the course and outcomes of learning, organization, and elaboration, while they rate defensive self-regulation strategies lower: orientation toward avoiding effort, self-handicapping, and setting minimal demands. Academic achievement is very good (Table 1).

A statistically significant difference was found in the encouragement of metacognitive monitoring of learning, encouragement of understanding, encouragement of effort investment, and overall encouragement of SRL between male and female students. Female students perceive that teachers encourage self-regulated learning to a greater extent (Table 2).

The difference in perception of encouragement for learning planning and organization strategies, metacognitive monitoring, understanding, effort investment, as well as SRL encouragement overall, is statistically significant between primary school students and secondary school students (grammar school and vocational schools), while the difference in perception of encouragement for elaboration and evaluation is significant only between primary school students and grammar school students (Table 3).

A statistically significant difference in ELPLO was found between 4th-grade secondary school students and all others except 5th-grade primary school students. In EMML, a significant difference was observed between 4th and 2nd-grade secondary school students and 7th and 8th-grade primary school students and 3rd-grade secondary school students, as well as between 5th-grade students and 7th and 8th-grade primary school students. Significant differences in EEE were found between 4th-grade secondary school students and all other grades. In EU and EEL, differences were statistically significant between 4th-grade secondary school students and 6th, 7th, and 8th-grade primary school students and 3rd-grade secondary school students, as well as between 2nd-grade secondary school students and 7th-grade (8th-grade and 3rd-grade secondary school students additionally for EEL) primary school students. Overall, when it comes to encouraging SRL, significant differences were observed between 4th-grade secondary school students and all others except 5th-grade primary school students, as well as between 2nd-grade secondary school students and 7th and 8th-grade primary school students (Table 4).

The results indicated a statistically significant, moderate correlation between students' assessments of learning self-regulation and teacher encouragement of self-regulated learning (Table 5). Proactive learning self-regulation strategies showed positive and higher correlation coefficients, while defensive learning self-regulation strategies exhibited negative and/or low (positive) correlation coefficients with the perception of SRL encouragement. Academic achievement also demonstrated a significant association with the

TABLE 2 Testing gender differences in students' perception of SRL encouragement.

	Mmale	Mfemale	t	df	p	Welch F	Welch p
ELPLO	3.37	3.41	−1.00	2,152	0.32		
EMML	3.84	3.97	−3.19	2,152	0.00		
EEE	3.28	3.33	−1.59	2,152	0.11		
EU	3.69	3.85	−4.49	2,152	0.00		
EEI	4.02	4.20	−4.72	2,152	0.00	21.38	0.00
ESRL	3.57	3.67	−2.93	2,152	0.00		

ELPLO, encouragement of learning planning and learning organization strategies; EMML, encouragement of metacognitive monitoring of learning; EEE, encouragement of elaboration and evaluation; EU, encouragement of understanding; EEI, encouragement of effort investment; ESRL, overall encouragement of SRL.

TABLE 3 Testing differences in students' perception of SRL encouragement according to the type of school they attend.

	Primary school	Grammar school	Vocational school	F	df	p	Welch F	Welch p	Post-hoc
ELPLO	3.32	3.46	3.49	8.70	2/2151	0.00			Ps < Gs, Vs
EMML	3.84	4.00	4.01	8.83	2/2151	0.00	8.86	0.00	Ps < Gs, Vs
EEE	3.25	3.43	3.35	6.78	2/2151	0.00			Ps < Gs
EU	3.70	3.96	3.84	15.32	2/2151	0.00	15.98	0.00	Ps < Gs, Vs
EEI	4.01	4.20	4.26	17.47	2/2151	0.00	17.70	0.00	Ps < Gs, Vs
ESRL	3.55	3.73	3.71	11.87	2/2151	0.00	11.93	0.00	Ps < Gs, Vs

ELPLO, encouragement of learning planning and learning organization strategies; EMML, encouragement of metacognitive monitoring of learning; EEE, encouragement of elaboration and evaluation; EU, encouragement of understanding; EEI, encouragement of effort investment; ESRL, overall encouragement of SRL.

TABLE 4 Testing differences in students' perception of SRL encouragement according to their grade.

	5.	6.	7.	8.	1.	2.	3.	4.	F	p	Welch F	Welch p	Post-hoc
ELPLO	3.46	3.39	3.22	3.25	3.41	3.46	3.27	3.78	9.99	0.00	11.89	0.00	5,6,7,8,1,2,3 < 4
EMML	4.09	3.94	3.67	3.75	3.93	4.07	3.77	4.21	11.12	0.00	11.66	0.00	7,8 < 5,2,4; 3 < 2,4
EEE	3.36	3.24	3.25	3.21	3.36	3.30	3.19	3.71	9.77	0.00			5,6,7,8,1,2,3 < 4
EU	3.84	3.75	3.62	3.63	3.83	3.88	3.74	4.07	8.16	0.00	8.91	0.00	6,7,8,3 < 4; 7 < 2
EEI	4.15	4.12	3.91	3.94	4.11	4.36	4.00	4.41	12.54	0.00	14.39	0.00	6,7,8,3 < 4;7,8,3 < 2
ESRL	3.71	3.61	3.46	3.49	3.66	3.72	3.52	3.97	11.28	0.00	13.16	0.00	6,7,8,1,2,3 < 4;7,8 < 2

ELPLO, encouragement of learning planning and learning organization strategies; EMML, encouragement of metacognitive monitoring of learning; EEE, encouragement of elaboration and evaluation; EU, encouragement of understanding; EEI, encouragement of effort investment; ESRL, overall encouragement of SRL.

encouragement of self-regulated learning, as well as with self-regulated learning strategies.

In order to address the question regarding the contribution of self-regulated learning encouragement in the explanation of self-regulated learning, we conducted a series of regression analyses (Table 6). As the correlation coefficients among individual components of SRL encouragement showed moderate to high associations (0.54–0.84), we decided to use the overall score on the SRL encouragement scale to calculate the contribution of students' perception of SRL encouragement in explaining SRL strategies.

The results have indicated that students' perception of SRL teacher encouragement significantly contributes to explaining all components of SRL except for setting minimal demands. The percentages of explained variance range from 0 to 32% of the variance of self-regulated learning strategies. Defensive self-regulation strategies (work avoidance, self-handicapping, and orientation towards minimal demands) are explained the least, while proactive self-regulation

strategies (orientation towards acquisition, elaboration, and goal setting) are explained to a much greater extent.

4 Discussion

The question posed in this research is how students perceive teacher encouragement of SRL in regular classroom instruction, and whether there is a correlation between students' perception of SRL teacher encouragement and students' learning self-regulation in a particular subject. Students' perception of teacher encouragement of SRL during regular instruction has been shown to be moderate to relatively high. Students believe that teachers primarily encourage effort investment, followed by metacognitive monitoring of learning, understanding, learning planning, and organizational strategy, while elaboration and evaluation of learning are perceived to be encouraged the least. Šimić Šašić et al. (2024, 2023b) found a correlation between students' and teachers' assessments, but when compared to teachers'

TABLE 5 Correlation coefficients between the perception of SRL encouragement and SRL.

	ELPLO	EMML	EEE	EU	EEI	ESRL
Control	0.37**	0.49**	0.36**	0.49**	0.48**	0.48**
Self-efficacy	0.47**	0.53**	0.46**	0.52**	0.46**	0.54**
Mastery goal	0.46**	0.56**	0.44**	0.55**	0.49**	0.56**
Competition goal	0.20**	0.18**	0.23**	0.18**	0.15**	0.22**
Avoidance goal	−0.07**	−0.13**	0.00	−0.11**	−0.11**	−0.09**
Goal setting	0.50**	0.53**	0.46**	0.52**	0.46**	0.56**
Effort regulation	0.46**	0.48**	0.43**	0.47**	0.41**	0.51**
Self-handicapping	−0.03	−0.11**	0.05*	−0.08	−0.09**	−0.05*
Control of learning processes and outcomes	0.48**	0.53**	0.43**	0.53**	0.46**	0.54**
Organization	0.48**	0.47**	0.46**	0.51**	0.41**	0.53**
Elaboration	0.50**	0.53**	0.47**	0.56**	0.46**	0.57**
Setting minimal demands	0.07**	0.00	0.10**	−0.01	−0.05*	0.04
Academic achievement	0.22**	0.29**	0.25**	0.29**	0.27**	0.29**

p < 0.001**, *p* < 0.05*.

TABLE 6 The results of regression analyses with SRL encouragement as a predictor and SRL components as criterion variables.

Criterion variables	ESRL β	
Control	0.48	$R = 0.48, R^2 = 0.23, F_{(1,2,152)} = 631.05, p = 0.00$
Self-efficacy	0.54	$R = 0.54, R^2 = 0.30, F_{(1,2,152)} = 905.20, p = 0.00$
Mastery goal	0.56	$R = 0.56, R^2 = 0.31, F_{(1,2,152)} = 969.31, p = 0.00$
Competition goal	0.21	$R = 0.21, R^2 = 0.05, F_{(1,2,152)} = 104.74, p = 0.00$
Avoidance goal	−0.09	$R = 0.09, R^2 = 0.01, F_{(1,2,152)} = 17.46, p = 0.00$
Goal setting	0.56	$R = 0.56, R^2 = 0.31, F_{(1,2,152)} = 995.09, p = 0.00$
Effort regulation	0.51	$R = 0.51, R^2 = 0.26, F_{(1,2,152)} = 746.38, p = 0.00$
Self-handicapping	−0.05	$R = 0.05, R^2 = 0.003, F_{(1,2,152)} = 5.56, p = 0.02$
Control of learning processes and outcomes	0.54	$R = 0.54, R^2 = 0.30, F_{(1,2,152)} = 905.29, p = 0.00$
Organization	0.53	$R = 0.54, R^2 = 0.28, F_{(1,2,152)} = 833.43, p = 0.00$
Elaboration	0.57	$R = 0.57, R^2 = 0.32, F_{(1,2,152)} = 1014.1, p = 0.00$
Setting minimal demands	0.04	$R = 0.04, R^2 = 0.001, F_{(1,2,152)} = 2.98, p = 0.08$
Academic achievement	0.29	$R = 0.29, R^2 = 0.08, F_{(1,2,152)} = 191.51, p = 0.00$

assessments, students still perceive teacher encouragement of SRL to be lower. This is also supported by other research (Dignath-van Ewijk et al., 2013). Furthermore, it has been shown that students and teachers agree in terms of the sequence of components of SRL encouragement (Šimić Šašić et al., 2023b). Interestingly, according to student assessments, teachers primarily encourage effort investment and metacognitive monitoring of learning. This is not surprising considering that teachers perceive SRL as autonomous/self-directed learning and independence in learning (Šimić Šašić et al., 2023a), with

similar findings also having been reported by Callan and Callan and Shim (2019). Metacognition is a key component of learning self-regulation, and encouraging metacognitive skills helps students become self-regulated learners (Karlen et al., 2023). In this context, the teachers were found to primarily encourage metacognitive strategies by Rosenthal et al. (2023). Therefore, it appears necessary to develop teacher competencies in the field of SRL, as the first step in effective SRL teaching is for teachers to have a clear understanding of what constitutes SRL and how they can encourage it in students.

The conducted research revealed differences in students' perception of teacher encouragement of SRL based on gender, grade level, and type of school attended. Female students assess that teachers encourage SRL to a greater extent, particularly in terms of metacognitive monitoring of learning, understanding, and effort investment. Secondary school students perceive that teachers promote SRL more than primary school students. It appears that teachers encourage grammar school students to use more complex strategies such as elaboration and evaluation, while vocational school students are encouraged to use simpler strategies such as effort investment and learning planning and organization strategy (although differences in the latter case are not statistically significant). Differences based on grade level indicate a similar conclusion, as it seems that, according to students' assessments, teachers predominantly encourage SRL in 4th-grade secondary school students, along with 5th-grade primary school students and 2nd-grade secondary school students. It is possible that in the 5th grade, the encouragement of SRL is slightly higher due to the transition from classroom to subject-specific teaching, where students need to adapt to a new system involving more subjects and different teachers. On the other hand, the lower ratings of teacher encouragement of SRL in final (7th and 8th) grades of primary school are rather concerning. Peeters et al. (2016) found that some teachers consider encouragement of SRL as a privilege that is to be given to more successful students, expressing the belief that others should first master the necessary learning content. Similarly, teachers perceive that this teaching approach is to be reserved only for advanced students (Zohar and Barzilai, 2015) and those who can

be allowed to work independently, whereas when working with below-average students, they more often adopt a teacher-directed approach. Overall, teachers believe that younger students are not capable of self-regulated learning, and that SRL is poorly encouraged at the primary school level (de Boer et al., 2012). It is possible that teachers in our study perceive the “more successful” students, whom they can encourage in self-regulated learning, predominantly as female students, students in higher grades (especially seniors), and secondary school students (especially grammar school students), and that students agree in this perception, thereby providing such assessments. This teacher attitude is entirely erroneous because research shows that students with low achievement benefit from explicit instructions in SRL strategies in particular (Zohar and Ben David, 2008; Zohar and Peled, 2008).

Teaching students how to self-regulate their learning and engaging them in work within a stimulating environment enhances their performance (Brenner, 2022; Conesa et al., 2023; de Boer et al., 2012; Dignath and Büttner, 2008). These findings are supported by research results that have tested the effectiveness of interventions in encouraging SRL among teachers. However, research in educational practice shows contradictory results. Some studies show a positive relationship (Depaepe et al., 2010), while others found either negative or no correlation at all (Heirweg et al., 2021; Karlen, 2016). Such outcomes may result from the use of different measurement instruments to assess the encouragement of SRL and SRL in students, variations in the duration of interventions to promote SRL, differences in the perception of SRL encouragement by teachers, students, observers, various contextual factors, etc. (Rosenthal et al., 2023). The results of our research in practice indicate a moderate correlation between students' perception of teacher encouragement of SRL and the use of SRL strategies. When students perceive a higher level of SRL encouragement from teachers, they are more likely to use proactive SRL strategies. In such cases, students have higher general control beliefs, more positive motivational beliefs (self-efficacy and knowledge mastery orientation), employ more effective motivational strategies (goal setting and effort regulation), and utilize both metacognitive (monitoring and control of learning processes) and cognitive (organization and elaboration) strategies, all of which reflect better academic performance as well. Defensive self-regulation strategies, such as avoiding work, self-handicapping, and setting minimal requirements, are weakly associated with the encouragement of SRL, and when this happens, the relationship tends to be mostly negative, indicating that higher perceptions of SRL encouragement remain linked to lower use of defensive strategies. Along these lines, the encouragement of SRL contributes most to explaining proactive self-regulation strategies. Students' assessments of higher teacher encouragement of SRL primarily explain students' motivational beliefs, such as self-efficacy and mastery goals, but also motivational strategies (goal setting and effort regulation) and learning strategies encompassing metacognitive (monitoring and control of learning processes) and cognitive strategies (elaboration and organization). These findings are consistent with the findings of authors who discuss a positive relationship between the encouragement of SRL and students' self-regulated learning (Depaepe et al., 2010). It is necessary to emphasize the absence of connection and contribution of SRL encouragement in the explanation of setting minimum demands, i.e., low level of cognitive effort investment in learning. When working

with below-average students, teachers use a more teacher-centred approach, believing that if they allowed students to self-regulate their learning, they would not achieve the necessary teaching goals (Peeters et al., 2016). However, research shows that it is precisely low-achieving students who particularly benefit from SRL encouragement, especially when it comes to explicit instruction in SRL strategies (Zohar and Ben David, 2008; Zohar and Peled, 2008).

The conducted research contributes to understanding the encouragement of SRL from the students' perspective and underscores the importance of students' assessments of SRL encouragement. Despite the potential drawbacks tied to data collection techniques and the lack of simultaneous student assessments of both SRL encouragement and SRL, student ratings are based on a larger sample of teacher behaviours accumulated over a greater number of teaching hours. De Jong and Westerhof (2001) argue that student perceptions shape their behaviour and therefore bear a greater impact on student learning than external observations. Similarly, Seidel and Prenzel (2006) consider student perceptions of learning conditions to be among the most relevant factors mediating between teaching quality and students' use of learning opportunities, while Newmann et al. (1996) suggest that teaching methods are less important than the quality of students' educational experiences. Dignath-van Ewijk et al. (2013) found that student and observer assessments have greater predictive value for student self-regulation than teacher assessments, thus indicating that student assessments appear to be an important source of information about teacher encouragement of SRL. The results of the present study support the possibility of teacher encouragement of SRL in everyday teaching from the students' perspective, and point towards the existence of a relationship with student self-regulated learning. The findings also indicate the need for enhancing teacher competencies in fostering self-regulated learning, understanding SRL, and methods of its encouragement. It is particularly important to emphasize the need for SRL encouragement among young students, those in lower grades, or elementary school students. Future research should continue to investigate students' perceptions of teachers' encouragement of SRL in class and the factors that influence it. Research should also focus on clarifying the relationship between the encouragement of specific self-regulation strategies during teaching and student self-regulated learning.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Ethics Committee of the University of Zadar and Approval of the Ministry of Science and Education of the Republic of Croatia according to the positive opinion of the Education Agency. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

SŠ: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Writing – original draft, Writing – review & editing. MA: Data curation, Formal analysis, Writing – original draft, Writing – review & editing.

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Conflict of interest

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Enhancing academic engagement through students' perceptions of teacher expectations: the mediating role of intentional self-regulation in middle school

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In the context of evolving educational standards, enhancing students' academic engagement has emerged as a critical factor in mitigating the risks of school aversion among middle school students. This study examines the longitudinal effect of middle school students' perceptions of teacher expectations on their academic engagement, as well as the mediating role of intentional self-regulation in this dynamic. A six-month longitudinal survey was conducted with 702 Chinese middle school students through three waves of questionnaires. The results showed that students' perception of teacher expectations significantly predicted their academic engagement, with higher perceived teacher expectations leading to increased academic engagement. Furthermore, the study revealed that intentional self-regulation played a pivotal mediating role in the relationship between students' perceptions of teacher expectations and academic engagement. Students' perceptions of teacher expectations at Time 1 positively influenced their intentional self-regulation at Time 2, which subsequently enhanced their academic engagement at Time 3. These findings highlight the crucial impact students' perceptions of teacher expectation on adolescents' academic motivation and provide guidance for educators to implement proactive strategies that enhance students' academic development.

KEYWORDS

academic engagement, teacher expectation, intentional self-regulation, cross-lagged analyses, adolescent development

1 Introduction

Academic engagement plays a vital role in students' positive academic adjustment, especially during the critical period of early adolescence (Lawson and Lawson, 2013; Wang and Eccles, 2013). It refers to a positive psychological state that individuals maintain throughout their learning process (Schaufeli et al., 2002). This state reflects not only active participation in learning tasks but also integrates aspects of students' psychological well-being and positive character traits (Wang and Eccles, 2012; Tayama et al., 2019), both of which are fundamental to their overall psychological development. For educators, assessing students' academic engagement is essential as it significantly predicts their academic achievement, learning satisfaction, and adaptability to school life (Appleton et al., 2006; Li et al., 2022). Furthermore, academic engagement serves as a protective factor by promoting mental health, enhancing well-being, and reducing learning burnout and dropout rates (Carmona-Halty et al., 2021; Abreu Alves et al., 2022).

In China's fundamental education system, the middle school stage represents a critical transitional period marked by a significant escalation in academic difficulty compared to elementary school. Consequently, the issue of behavioral disengagement among middle school students has become an urgent problem to address. In this context, research on academic engagement is of considerable significance. With the rise of positive psychology, more researchers are focusing on student academic engagement as a constructive state to combat school refusal behavior (Solomon and Croft, 2016; Abreu Alves et al., 2022; Widlund et al., 2023).

Middle school adolescents are at a critical juncture of both educational and psychological growth. Their academic engagement is largely shaped by the surrounding environment and significant individuals who influence their academic experiences (Carmona-Halty et al., 2021; McKellar and Wang, 2023). Within this context, teachers emerge as pivotal figures in the school setting, having a lasting and profound influence on students' attitudes and behaviors toward learning (Goetz et al., 2021). Over half a century ago, Rosenthal and Jacobson (1968) concluded that a teacher's belief in and expectations for a student's potential could lead to self-fulfilling prophecies. Conversely, low expectations from teachers can negatively impact students' motivation by limiting learning opportunities and creating a negative learning environment (Weinstein, 2002). It is important to recognize that the impact of teacher expectations is primarily realized through students' perceptions. Once these perceived expectations are internalized, they significantly influence students' motivation and academic performance (Johnston et al., 2023). This underscores the necessity of focusing on how students interpret and internalize teacher expectations in educational research and practice.

Meanwhile, the internal factors also play an important role in the interplay between their perception of teacher expectations and academic engagement. Meanwhile, students' internal factors can play an important role in the interplay between their perception of teacher expectations and academic engagement. Grounded in the situated expectancy-value theoretical framework (Wigfield and Eccles, 2000; Eccles and Wigfield, 2020), intentional self-regulation can be viewed as a comprehensive process in which students re-evaluate and adjust their academic-related cognitive structures and expectations, and adopt corresponding adjustment strategies after perceiving the beliefs and behaviors of others (Eccles and Wigfield, 2020; Gestsdóttir and Lerner, 2008; Zhong et al., 2022). This process, in turn, drives their subsequent academic outcomes. Longitudinal research has also shown that intentional self-regulation can positively impact student academic engagement over time (Stefansson et al., 2018). Thus, when students perceive and internalize their teachers' expectations, their self-regulation may lead to the adjustment of short-term learning goals, influencing their subsequent academic engagement.

To gain a more in-depth understanding of these dynamic influences, this study focuses on middle school students, employing a three-wave longitudinal survey to explore the impact of teacher expectations on their academic engagement from the students' perspective and the role of intentional self-regulation in this process.

1.1 Students' perceptions of teacher expectations and academic engagement

In recent years, the effect of teacher expectations on student academic engagement has received significant attention in the field of

educational psychology (Wang et al., 2018; Neuenschwander et al., 2021). Teachers' beliefs and attitudes play an important role in determining students' motivation and their learning behaviors. This influence can manifest through explicit expressions, subtle behaviors, and feedback, with students typically adjusting their learning behaviors in response to these cues (Jussim and Harber, 2005; Rubie-Davies et al., 2020; Hornstra et al., 2023). Rosenthal and Jacobson's (1968) study first identified that teacher expectations can significantly elevate student performance, a phenomenon later known as the "Pygmalion effect." Subsequent studies have delineated the mechanisms of this effect, demonstrating the nuanced ways in which teacher expectations enhance student learning outcomes. Despite criticisms of these experimental methods, researchers have consistently acknowledged the existence of teacher expectation effects (Gentrup et al., 2020; Hollenstein et al., 2024). For instance, Hornstra et al. (2018) argued that one prerequisite for forming learning motivation is the perception of positive expectations from teachers, which in turn affects their engagement in learning. Another study found that teachers who hold high expectations are inclined to provide more challenging tasks, give positive feedback regularly, and directly enhance student academic engagement and motivation (Rubie-Davies et al., 2012). These teachers offer more choices in learning activities, apply teaching methods that foster motivation, track students' educational progress continuously, and encourage independent learning (Rubie-Davies et al., 2006; Rubie-Davies, 2007; Hornstra et al., 2018; Johnston et al., 2022). Conversely, teachers with low expectations are more likely to use direct instruction, offer limited choices to students, provide less feedback, and tend to group students rigidly by ability. Such practices may lead to a decline in students' interest in learning and a decrease in adopting behaviors that enhance learning (Rubie-Davies, 2007; Johnston et al., 2022).

Drawing on the concept of the teacher expectation effect, existing research has illuminated the significant impact that both actual and perceived teacher expectations can exert on students' psychological well-being and academic performance (Wang et al., 2018). Nonetheless, it is important to acknowledge that the subjective expectations held by teachers do not spontaneously engender self-fulfillment in students (Rubach et al., 2023). Teacher expectations can subtly permeate classroom interactions, manifesting in spoken words, nonverbal gestures, vocal inflections, and feedback on student assignments (Johnston et al., 2023). As certain researchers have pointed out, the activation of the teacher expectation effect is predicated upon the students' recognition and interpretation of these communicated signals (Weinstein, 2002; Johnston et al., 2023; Rubach et al., 2023). Although students are the primary subjects affected by these expectations, much of the research has predominantly been through the lens of teachers and other professionals in the field. Only a few recent studies have examined the actual impact of teacher expectations from the students' own perspective (Hornstra et al., 2018; Rubie-Davies et al., 2020; Johnston et al., 2023). In reality, the impact of teacher behavior on students' learning largely depends on how students perceive those behaviors, which may not always align with the teachers' intentions (Johnston et al., 2023). Studies have also shown that students modulate their academic behaviors in response to the expectations they discern from teachers, aiming to fulfill these anticipations and receive positive feedback (Lavy and Naama-Ghanayim, 2020). When students perceive strong signals of expectations, they tend to experience increased support from their

teachers, leading to improved academic performance (Gaspard et al., 2023; Johnston et al., 2023). Therefore, this study aimed to explore teacher expectations from students' perspective, examining the impact of these perceived expectations on student academic engagement. In this study, students' perception of teacher expectations are defined as their interpretation of predictive beliefs about their academic achievement inferred from teachers' everyday actions and attitudes.

Moreover, students' perceptions of teachers expectations may vary according to their achievements and developmental progress (Hughes and Kwok, 2006; Timmermans et al., 2021; Hao et al., 2022). This dynamic suggests that the academic engagement and successes of students may conversely shape their perceptions of teacher expectations, thus fostering a reciprocal relationship. Nevertheless, scant research has delved into the dynamics or causal relationships between perceived teacher expectations and academic engagement (Kelly and Carbonaro, 2012; Timmermans et al., 2021), with the existing studies primarily utilizing cross-sectional approaches that captured a momentary, static correlation (An et al., 2023). Therefore, this research employed a longitudinal approach to investigate the relationship between student's perception of teacher expectations and academic engagement among middle school students, aiming to provide robust theoretical support and practical guidance for educational practice.

1.2 The mediating role of intentional self-regulation

The situated expectancy-value theory provides a comprehensive framework for understanding how students' perceptions of teacher expectations can impact their academic engagement (Eccles and Wigfield, 2020). This model proposes a sequential process: students' perceptions of others beliefs and behaviors affect their general self-schemata, leading to changes in their expectations of success, and ultimately impacting achievement-related choices and performance (Wigfield and Eccles, 2000; Eccles and Wigfield, 2020). Within this context, perceived teacher expectations constitute a significant external factor, shaping students' academic self-schemata, learning goals, and expectations for success, positively affecting their academic engagement (Diemer et al., 2016; Han et al., 2022; Rubach et al., 2023).

From a dynamic perspective, the process of intentional self-regulation involves students adjusting their cognition and behavior to coordinate their perceived teacher expectations with their own academic goals. This comprehensive process, spanning from students modifying their general self-schemata to establishing specific academic goals and success expectations, essentially reflects the process of students' intentional self-regulation. Intentional self-regulation encompasses the active management of behaviors, emotions, and cognitions in pursuit of personal goals (Gestsdóttir and Lerner, 2008; Zimmerman et al., 2008). It is particularly crucial during adolescence, a critical period for self-regulation development, where adolescents must proactively apply strategies to balance their needs and resources in different situations (Gestsdóttir and Lerner, 2008; Tian et al., 2015). Freund and Baltes (2002) proposed the SOC model based on the nature of intentional self-regulation functions during adolescence. It posits that students can allocate resources or adjust their learning behaviors to align with their goals and competencies by employing three strategies: Selection (S), Optimization (O), and Compensation (C) (Gestsdóttir and Lerner,

2007; Moghimi et al., 2017). Studies have shown that intentional self-regulation is not only highly related to students' academic engagement (Larson and Tran, 2014; Stefansson et al., 2018) but also significantly enhances their attentiveness to educational activities (Gestsdóttir et al., 2023). This, in turn, contributes to a deeper level of involvement in their learning process (Larson and Tran, 2014; Zhou et al., 2021; Gestsdóttir et al., 2023). Therefore, based on the situated expectancy-value theoretical framework, this study conceptualizes intentional self-regulation as a comprehensive process ranging from goals and general self-schemata to the formation of success expectations. Through this dynamic and active self-regulation, students can continuously adjust their internal cognition and motivation by integrating external resources, thus forming a constantly updated dynamic relationship between teacher expectations and academic engagement.

Existing research has illuminated that intentional self-regulation bridges the enduring relationship between internal and external learning resources (Gestsdóttir et al., 2011; Chang et al., 2020). This implies that students' perceptions of teacher expectations, seen as an external resource, and student academic engagement, an internal resource, are interconnected not just through direct association but also via an indirect pathway by shaping intentional self-regulation (Xu et al., 2017). Intentional self-regulation can be regarded as an evolving variable responsive to alterations in environmental contexts. The study carried out by Bowers et al. (2016) has shown that mentoring relationships can affect adolescents' intentional self-regulation. Given their pivotal role in students' lives, perceived teacher expectations can directly influence or indirectly shape student behavior through the mediation of the students' own self-expectations. A longitudinal study of Asian-American high school students in the United States revealed that higher perceived teacher expectations positively correlated with students' success expectations and academic achievements (Cherng and Liu, 2017). Moreover, Intervention and interview studies have also indicated that students who have a clear understanding of their teachers' expectations demonstrate improved intentional self-regulatory behaviors (Vattøy, 2020; Wahman and Anderson, 2021).

Grounded in both theoretical frameworks and empirical findings, there appear to be pairwise correlations among students' perceived teacher expectations, intentional self-regulation, and academic engagement. Thus, the longitudinal relationship between students' perceptions of teacher expectations and student academic engagement is likely mediated by intentional self-regulation. In other words, students' perceptions of teacher expectations initially affect students' intentional self-regulation, which in turn impacts their academic engagement (Larson and Tran, 2014; Stefansson et al., 2018; Xu et al., 2017; Yerdelen and Sungur, 2019). Furthermore, the variables of students' perceptions of teacher expectations, self-regulation, and academic engagement in middle school are inherently dynamic, adapting progressively in concert with environmental shifts (Bowers et al., 2016; Quin, 2017; Vattøy, 2020; Wahman and Anderson, 2021). Hence, this study posits that intentional self-regulation could serve as a mediator between middle school students' perceptions of teacher expectations and academic engagement, fostering a dynamic interplay over time.

1.3 The present study

Although perceived teacher expectations act as a critical catalyst for middle school students' academic engagement, uncovering the

mechanisms by which students leverage this catalyst remains paramount. Prior research has explored the association between students' perceptions of teacher expectations and academic engagement (Yerdelen and Sungur, 2019; Lavy and Naama-Ghanayim, 2020), and has begun to consider cognitive factors in internalizing these expectations (Cherng and Liu, 2017; Quin, 2017). However, a nuanced understanding remains to be developed regarding how students engage in intentional self-regulation to navigate the influence of internalized perceived teacher expectations on their academic engagement. To further elucidate this complex relationship, the present study integrated the concept of intentional self-regulation into the expectancy-value theoretical framework to examine its impact on the interplay between teacher expectations and the academic engagement of middle school students.

Teachers' expectations of their students are adaptable and subject to alterations driven by external factors. Concurrently, students are gradually aware of their perceptions of these expectations and modify their behavior in response, constituting an ongoing interaction between teachers and students (Cherng and Liu, 2017; Quin, 2017). Intentional self-regulation serves as a pivotal adjustment mechanism that enables students to swiftly adapt to the changes in their perceptions of teacher expectations, affecting their academic engagement. Consequently, this investigation employed cross-lagged panel modeling techniques to examine the relationship between students' perceptions of teacher expectations and student academic engagement within a middle school setting. Furthermore, it scrutinized the mediation effect of intentional self-regulation on the interplay between these variables through longitudinal mediation analysis. The conceptual model, depicted in Figure 1, posits two primary hypotheses: (1) Students' perceptions of teacher expectations exert a positive influence on academic engagement; and (2) Intentional self-regulation acts as a longitudinal mediator in the relationship between students' perceptions of teacher expectations and academic engagement.

2 Materials and methods

2.1 Participants and procedure

The present study was conducted employing a longitudinal design over a six-month period, involving 788 middle school students sourced from three educational institutions within Jilin Province, selected through convenience sampling methodology. Data collection ensued at three distinct junctures, each demarcated by a three-month interval. This procedure encompassed the administration of three sequential waves of questionnaire surveys to the participants: the initial wave at the beginning of the spring semester (Time 1), followed by a subsequent wave at the end of the spring semester (Time 2), and the final wave at the beginning of the fall semester (Time 3). Considering Chinese middle schools include grades 7 to 9, and ninth graders graduating at the end of the spring semester, our study focused exclusively on seventh and eighth graders from Time 1.

In the matching and screening process of the three questionnaire datasets, we initially omitted students who were unable to continue due to illness, transfer, or dropout. To protect privacy and improve the survey quality, an anonymous approach was adopted, collecting only essential identifiers: students' school identification numbers, grades,

classes, age, and gender. This information facilitated the precise matching of each participant's responses across questionnaires. The preliminary screening focused on the duration of response time and the completeness of the questionnaires. The R package *careless* was utilized to detect instances of inattentive responses, yielding a final effective sample size of 702 individuals. This reflects a total attrition rate of 10.91% by Time 3. Within this valid sample, there were 313 males (44.59%) and 389 females (55.41%), comprising 387 seventh graders (55.13%) and 315 eighth graders (44.87%). The age of participants ranged from 12 to 16 years, with a mean age of 14.18 ± 0.91 .

An independent sample *t*-test was implemented to assess biases arising from participant attrition. Specifically, participants who completed all three questionnaires were coded as 1, and those with incomplete responses were coded as 0. The test results indicated no statistically significant disparities in academic engagement ($t = -0.36$, $p > 0.05$), teacher expectation ($t = 1.24$, $p > 0.05$), or intentional self-regulation ($t = -0.24$, $p > 0.05$) between the groups with complete and incomplete datasets.

The study was executed within classroom settings, utilizing paper-based questionnaires. Administration was conducted by psychology master's students who had undergone specialized training to fully comprehend the testing procedures and requirements before the survey deployment. The instruments used for all three waves were consistent. The study adhered to the principles laid out by the research ethics committee and received approval from the principals of the participating schools. Participants were informed about the study purpose, the voluntary basis of their participation, and their right to withdraw from the survey at any time. Informed consent was obtained from all participants and their guardians prior to their inclusion in the study.

2.2 Measures

Data collection in this study was based on self-reported assessments. Although Cronbach's alpha (α) has long been the standard for reliability assessment, recent literature advocates for McDonald's omega (ω) as a more robust measure of internal consistency (Hayes and Coutts, 2020). In alignment with this contemporary viewpoint, this study utilized Jamovi 2.2.5 to compute the McDonald's ω coefficient, thereby serving as the reliability index for adopted questionnaires. Confirmatory factor analysis (CFA) was performed using Mplus 8.3 to verify the structural validity of the survey instruments.

2.2.1 Students' perceptions of teacher expectations questionnaire

The present study employed Zhang's (2009) Student Perception of Teacher Expectancy Questionnaire, a robust tool featuring the response options on a Likert scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The questionnaire encompasses 15 items across three dimensions: teacher support (e.g., "The teacher always cares about me"), instructional interaction (e.g., "The teacher held me to higher academic standards than my other classmates"), and academic feedback (e.g., "When I ask the teacher for help, he/she usually explains things to me patiently"), with aggregate scoring reflecting the intensity of a student's perception of teacher expectations. The questionnaire was

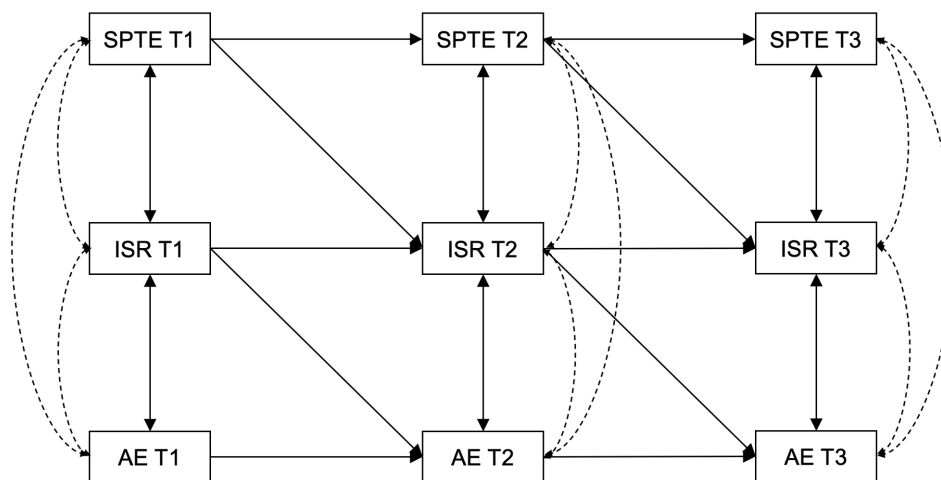


FIGURE 1

Hypothesized mediated cross-lagged model. SPTE, students' perceptions of teacher expectations; ISR, intentional self-regulation; AE, academic engagement; T1, T2, T3, Time 1, Time 2, Time 3.

specifically tailored to align with the Chinese educational framework, distinguished by its classroom-based instruction approach, wherein homeroom teachers play a crucial role in overseeing the students' comprehensive academic performance. Reflecting this emphasis, the current study specifically targeted the perceived expectations held by homeroom teachers. The questionnaire demonstrated high internal consistency across three measurement waves, with McDonald's ω coefficients of 0.92, 0.91, and 0.91, respectively. Confirmatory factor analysis (CFA) yielded good fit indices, with χ^2/df ranging from 3.08 to 3.58, CFI between 0.96 and 0.97, TLI from 0.95 to 0.96, and RMSEA consistently at 0.06, indicating a well-fitting model for the questionnaire.

2.2.2 Intentional self-regulation index

The Adolescent Intentional Self-Regulation Index, created by Gestsdóttir and Lerner (2007), was used to measure participants' intentional self-regulation. The questionnaire consists of 9 items across three dimensions: goal selection (e.g., "When I decide upon a goal, I stick to it."), goal optimization (e.g., "I keep trying as many different possibilities as are necessary to succeed at my goal"), and goal compensation (e.g., "For important things, I pay attention to whether I need to devote more time or effort"). Participants rated these items on a 7-point Likert scale (1 = "strongly disagree," 7 = "strongly agree"), with higher total scores indicating a higher level of intentional self-regulation. The McDonald's ω coefficients for the questionnaire across three measurements were 0.89, 0.90, and 0.89. The confirmatory factor analysis (CFA) fit indices were favorable, with χ^2/df ranging from 2.66 to 4.74, CFI from 0.97 to 0.99, TLI from 0.96 to 0.99, and RMSEA from 0.05 to 0.07.

2.2.3 Academic engagement scale

Student academic engagement was measured using The Utrecht Work Engagement Scale for Students (Schaufeli et al., 2002). The scale consists of 17 items that are divided into three dimensions: vigor (e.g., "When I get up in the morning, I feel like going to class"), dedication (e.g., "I am enthusiastic about my studies"), and

absorption (e.g., "When I am studying, I forget everything else around me"). Participants responded to this scale on a 7-point Likert scale, ranging from 1 ("never") to 7 ("always"), where a higher cumulative score indicated a greater level of academic engagement. The scale demonstrated high reliability, with McDonald's ω coefficients consistently at 0.93 across three measurements. Confirmatory factor analysis (CFA) showed good fit indices, with χ^2/df between 3.20 and 3.38, CFI ranging from 0.96 to 0.97, TLI at 0.96, and RMSEA at 0.06, indicating a well-fitting model for the questionnaire.

2.3 Data processing

The study utilized SPSS 26.0 and Mplus 8.3 for data analysis. The initial step involved conducting descriptive statistics and computing correlation coefficients to assess the stability and interrelationships of students' perceptions of teacher expectations, intentional self-regulation, and academic engagement across different measurement points. This preliminary analysis aimed to identify any significant trends or consistencies within the data, establishing the foundation for further in-depth analysis.

Informed by the correlational analysis findings, a cross-lagged model was developed to explore the relationships between teacher expectations and academic engagement over time. This step examined the directionality and strength of the relationships. The model fitting process, which included examining the fit indices, was executed in Mplus 8.3 to ascertain the model's suitability and better capture the underlying dynamics.

After confirming the validity of the model, a longitudinal mediation analysis was implemented to elucidate the pathways through which students' perceptions of teacher expectations influence their academic engagement, specifically focusing on the mediating role of intentional self-regulation. The mediation analysis provided a comprehensive understanding of the indirect effects,

thereby providing insights into the intricate interplay of the studied variables.

3 Results

3.1 Common method bias test

Given that all variable measurements in this study were based on self-reports by subjects, there was a potential risk of common method bias. To assess this potential bias, we employed Harman's single-factor test (Podsakoff et al., 2012). The results of the exploratory factor analysis indicated that the variance explained by the principal factor at Time 1 (T1), Time 2 (T2), and Time 3 (T3) was 30.41, 31.45, and 25.06%, respectively. Each percentage was below the 40% critical threshold, which suggested that common method bias was not a significant concern in this study.

3.2 Descriptive statistics and correlational analysis

The results of descriptive statistics, correlational analyses, t-tests, and ANOVA for all variables in the study are presented in Table 1. Significant positive correlations were observed among students' perceptions of teacher expectations, intentional self-regulation, and academic engagement at each of the three measurement intervals, indicating the temporal stability of these variables within the middle school population. Within the same measurement points, significant positive relationships were consistently observed between students' perceptions of teacher expectations, intentional self-regulation, and academic engagement. Moreover, across different measurement points, students' perceptions of teacher expectations and intentional self-regulation at T1 exhibited a significant positive correlation with academic engagement at T2. Similarly, students' perceptions of teacher expectations and intentional self-regulation at T2 were also significantly associated with academic engagement at T3. Analysis of variance (ANOVA) results indicated no significant differences attributable to age across the variables. Likewise, t-test analyses confirmed the absence of significant gender disparities across all measured variables.

3.3 Cross-lagged analysis between students' perceptions of teacher expectations and academic engagement

Building on the correlational analyses and controlling for age, this study constructed a cross-lagged model between students' perceptions of teacher expectations and academic engagement across three waves (Model 1, see Figure 2). The model exhibited fit indices of $\chi^2/df = 3.90$, RMSEA = 0.06, CFI = 0.99, and TLI = 0.95, demonstrating a satisfactory fit, thereby justifying the acceptance of the model's results (see Table 2). Figure 2 illustrates the regression coefficients for each pathway.

In the cross-lagged analysis examining the relationship between students' perceptions of teacher expectations and academic engagement, students' perceptions of teacher expectations at T1 and T2 were found to positively predict academic engagement at subsequent time points. Conversely, while students' academic engagement at T1 positively predicted their perceived teacher expectations at T2, academic engagement at T2 did not significantly influence students' perceptions of teacher expectations at T3. Notably, students' perceptions of teacher expectations at T1 were significant predictors of academic engagement at T3. In addition, students' perceptions of teacher expectations at T1 were found to predict students' perceptions of teacher expectations at T3, and academic engagement at T1 predicted academic engagement at T3. These results indicated a delayed predictive effect of middle school students' perceptions of teacher expectations on academic engagement, and highlighted cross-temporal stability for both constructs. The findings thus validate Hypothesis 1 and set the stage for subsequent longitudinal mediation effect analysis.

3.4 Longitudinal analysis of intentional self-regulation as a mediator

Expanding upon the findings from the cross-lagged analysis between students' perceptions of teacher expectations and academic engagement, and incorporating age as a covariate, this investigation developed three distinct models to examine the bidirectional mediation of intentional self-regulation in the relationship between students' perceptions of teacher expectations and academic engagement. The first model probed the process by which students' perceptions of teacher expectations might affect their academic

TABLE 1 Descriptive statistics, analysis of variance, T-test, and correlation analysis for the variables.

Variables	M ± SD	F	t	1	2	3	4	5	6	7	8
1 SPTE (T1)	3.55 ± 0.94	0.676	−1.470	1							
2 SPTE (T2)	3.56 ± 0.78	1.781	−0.475	0.478**	1						
3 SPTE (T3)	3.60 ± 0.74	1.038	0.623	0.333**	0.297**	1					
4 ISR (T1)	4.45 ± 1.58	0.737	1.952	0.423**	0.265**	0.135**	1				
5 ISR (T2)	4.51 ± 1.29	1.045	−0.546	0.617**	0.526**	0.283**	0.426**	1			
6 ISR (T3)	4.54 ± 1.17	1.202	0.909	0.398**	0.476**	0.320**	0.359**	0.477**	1		
7 AE (T1)	4.64 ± 1.40	1.346	−1.533	0.304**	0.233**	0.149**	0.262**	0.263**	0.192**	1	
8 AE (T2)	4.45 ± 1.34	0.949	−0.488	0.200**	0.348**	0.103**	0.412**	0.359**	0.302**	0.285**	1
9 AE (T3)	4.34 ± 0.91	1.712	−0.614	0.497**	0.432**	0.423**	0.367**	0.600**	0.535**	0.358**	0.393**

The F value denotes the results of the age variance analysis, and the t value signifies the outcomes of gender different test; ** $p < 0.01$. SPTE, Students' Perceptions of Teacher Expectation; ISR, Intentional Self-regulation; AE, Academic Engagement; T1, T2, T3, Time 1, 2, and 3, respectively.

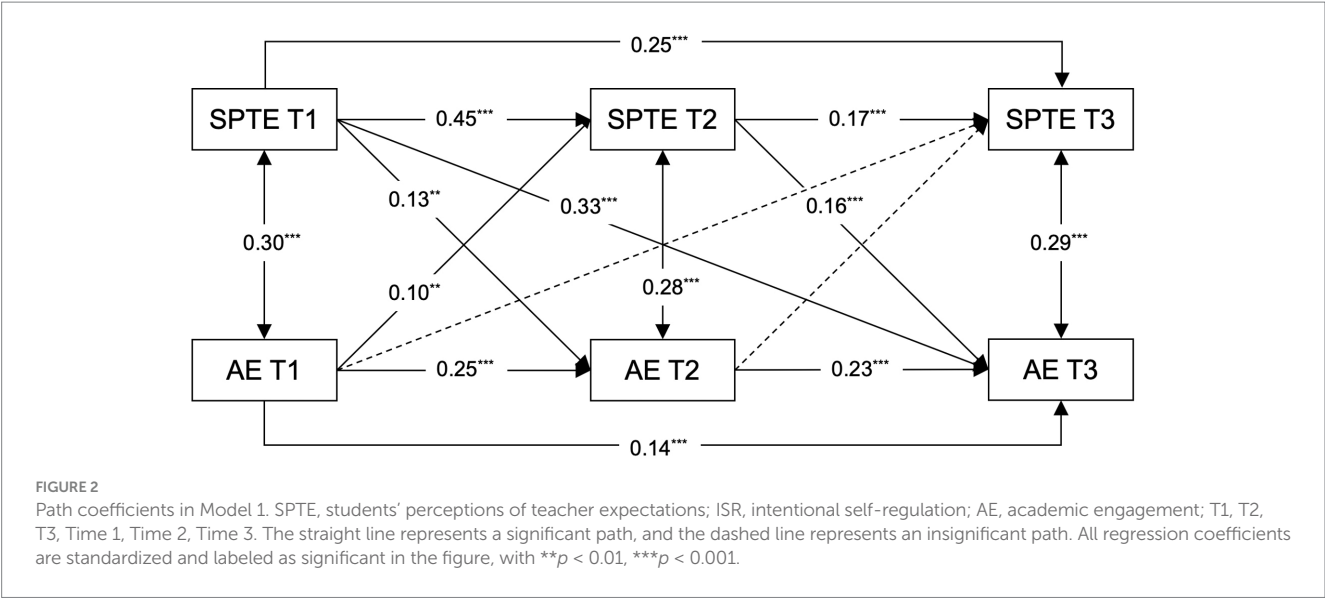


TABLE 2 Fit indices for cross-lagged panel models.

	χ^2	df	CFI	TLI	RMSEA	SRMR
Model 1	3.895	1	0.996	0.950	0.064	0.013
Model 2	30.842	13	0.990	0.975	0.044	0.033
Model 3	642.625	13	0.648	0.106	0.263	0.167
Model 4	16.185	8	0.995	0.981	0.038	0.018

engagement through intentional self-regulation (Model 2, see Figure 3). The second model explored the reverse pathway, analyzing how student academic engagement could influence their perceptions of teacher expectations through intentional self-regulation (Model 3, see Figure 4). The third model encompassed all potential cross-lagged paths among the studied variables (Model 4, see Figure 5). As shown in Table 2, both Models 2 and 4 demonstrated a good fit, whereas Model 3 did not align well with the empirical data. A comparative analysis of the χ^2 values for Models 2 and 4 indicated a superior fit for Model 2 ($\Delta\chi^2 = 14.297$, $\Delta df = 5$, $p < 0.05$). Therefore, Model 2 was selected as the final mediation model for further cross-lagged analysis.

The results revealed significant pathways within the mediation model: Students' perceptions of teacher expectations at T1 positively predicted intentional self-regulation at T2 ($\beta = 0.54$, $p < 0.001$), and similarly, students' perceptions of teacher expectations at T2 positively influenced intentional self-regulation at T3 ($\beta = 0.29$, $p < 0.001$). In the subsequent phase of the mediation pathway, intentional self-regulation at T1 positively predicted academic engagement at T2 ($\beta = 0.36$, $p < 0.001$), and intentional self-regulation at T2 positively predicted academic engagement at T3 ($\beta = 0.39$, $p < 0.001$).

Intentional self-regulation significantly mediated the relationship between students' perceptions of teacher expectations and academic engagement. This mediation effect was evidenced by a significant indirect effect of 0.212 and a 95% confidence interval of [0.156, 0.252] (not including 0, $p < 0.001$), accounting for 54.78% of the total effect. This finding highlight the important role of intentional self-regulation in the relationship between students' perceptions of teacher expectations and academic engagement, in line with Hypothesis 2.

Table 3 details the direct, indirect, and total effects within the established mediation model (Model 2).

4 Discussion

This study aimed to explore the relationship between students' perceptions of teacher expectations and academic engagement among middle school students, examining the mediating role of intentional self-regulation. Utilizing data collected over three waves and employing cross-lagged and longitudinal mediation analyses, our findings illuminate the predictive effect of students' perception of teacher expectations on students' academic engagement. Significantly, this research highlights the mediating role of intentional self-regulation, emphasizing its importance in the interaction between students' perception of teacher expectations and academic engagement. Furthermore, our analysis revealed a unidirectional influence from students' perceptions of teacher expectations to academic engagement, confirming the significant role of perceived teacher attitudes and behaviors in shaping student outcomes. Overall, these findings not only demonstrated a clear temporal progression but also affirmed a significant relationship among the studied variables, deepening our comprehension of how students' perceptions of teacher expectations relate to student academic outcomes over time.

4.1 The impact of students' perceptions of teacher expectations on academic engagement

This study employed a cross-lagged analysis to investigate the interactive relationship between students' perceptions of teacher expectations and their academic engagement. The results revealed a significant positive predictive relationship between middle school students' perceptions of teacher expectations and their subsequent academic engagement. This finding aligns with and extends previous research across intervention, interview, and cross-sectional studies (An

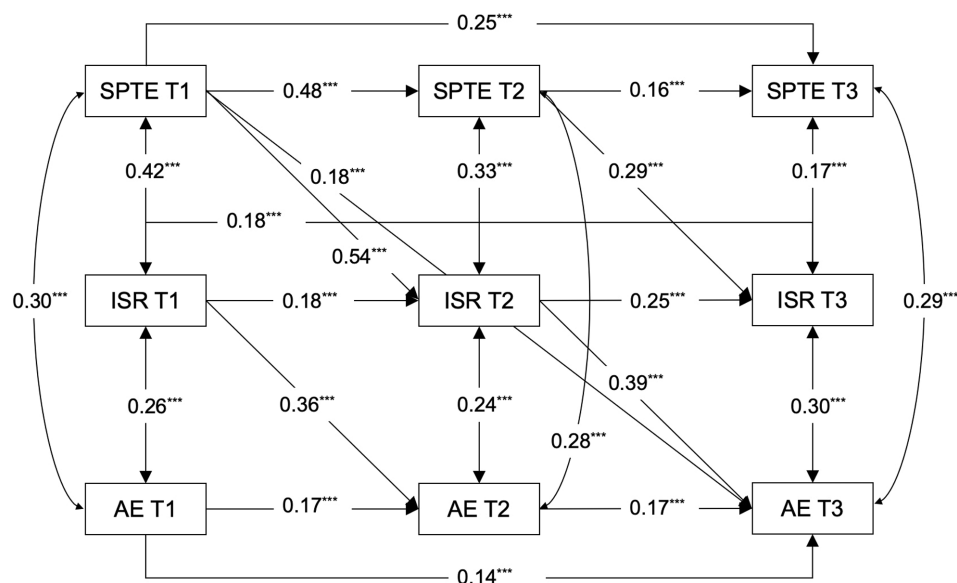


FIGURE 3

Path coefficients in Model 2. SPTE, students' perceptions of teacher expectations; ISR, intentional self-regulation; AE, academic engagement; T1, T2, T3, Time 1, Time 2, Time 3. The straight line represents a significant path, and the dashed line represents an insignificant path. All regression coefficients are standardized and labeled as significant in the figure, with *** $p < 0.001$.

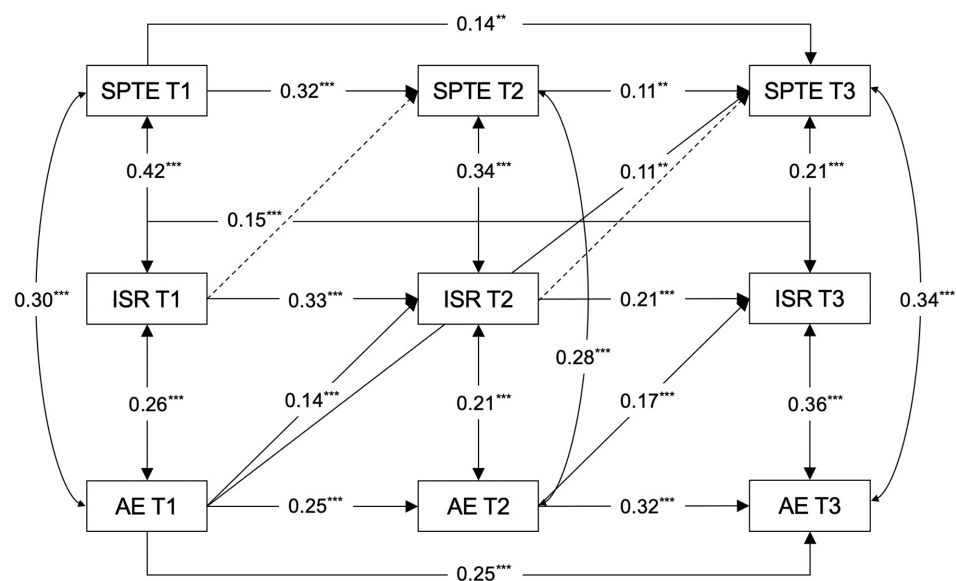


FIGURE 4

Path coefficients in Model 3. SPTE, students' perceptions of teacher expectations; ISR, intentional self-regulation; AE, academic engagement; T1, T2, T3, Time 1, Time 2, Time 3. The straight line represents a significant path, and the dashed line represents an insignificant path. All regression coefficients are standardized and labeled as significant in the figure, with ** $p < 0.01$, *** $p < 0.001$.

et al., 2023; Gaspard et al., 2023; Johnston et al., 2023), thereby supporting Hypothesis 1. Our longitudinal approach further offered compelling evidence of the directional influence of students' perceptions of teacher expectations on academic engagement over time, emphasizing the enduring importance of positive teacher expectations.

Specifically, students who reported perceiving higher expectations from their teachers also demonstrated higher levels of academic engagement. While our study focused on students'

perceived expectations rather than directly measured teacher expectations, this observed trend aligns with the core principles of teacher expectation effects in the context of academic engagement. The similarity in the direction of influence—from teacher expectations (in our case, students' perceptions of teacher expectations) to student outcomes—parallels the fundamental mechanism proposed by the Pygmalion effect, albeit with our specific focus on students' perceptions. This finding enriches the discourse

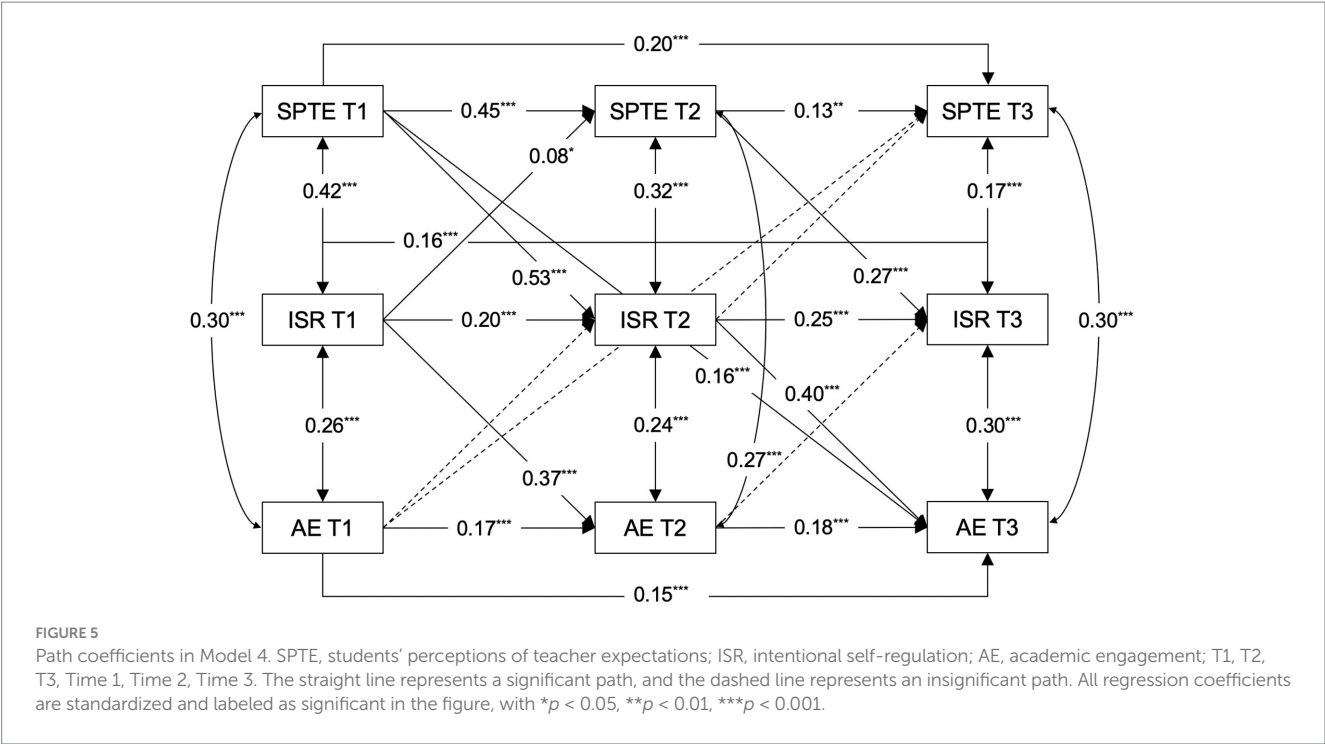


TABLE 3 Path coefficient analysis of mediation model.

Path	Effect	SE	95%CI	
			LLCI	ULCI
Total effect	0.387	0.033	0.292	0.438
Specific indirect	0.212	0.023	0.156	0.252
Direct	0.175	0.039	0.063	0.237

established by various research methodologies, underscoring the importance of sustained, positive teacher expectations in a broader view, showcasing their pivotal role not just in immediate student responses, but in shaping academic engagement trajectories over more extended periods.

Academic engagement, reflecting the degree of a student's absorption, vigor, and dedication in the learning process (Schaufeli et al., 2002), was examined as an outcome potentially influenced by students' perceptions of teacher expectations. Consistent with prior research, our study underscored that these perceptions are instrumental in positively affecting student academic engagement (Johnston et al., 2022). Crucially, the influence of teacher expectations on students largely depends on how students perceive these expectations (Rubach et al., 2023).

Teachers express their expectations through specific actions, including academic guidance, learning support, and attention to students' attitudes and performance. The emotional support inherent in teachers' expectations becomes a critical factor in this process. Research by Yin et al. (2023) illustrated that the emotional components, such as love, trust, and respect, inherent in teacher expectations collectively foster a nurturing teacher-student relationship. This relationship is fundamental, as students who perceive these positive emotions are more likely to adopt proactive behaviors and attitudes

toward learning. Such perceptions inspire them to elevate their academic standards and enhance their engagement in learning activities.

Moreover, middle school students are in a pivotal phase where external evaluations significantly influence their self-esteem (Dan et al., 2014; Gong et al., 2023). In this context, teachers play a crucial role in shaping their students' academic experiences. Teachers' high expectations and emotional investment, evident in heightened classroom challenges, extended problem-solving opportunities, and enriched teacher-student interactions, can persistently stimulate and unlock students' potential. When students perceive and internalize these high expectations and supportive practices from their teachers, they become inherently motivated to confront challenges, engage in active exploration, and tailor personalized learning strategies. These positive perceptions of teacher expectations significantly enhances their overall learning experience (An et al., 2023).

Our study demonstrated the significant impact of middle school students' perceptions of teacher expectations on their academic engagement, a finding complemented by Reeve et al.'s (2019) research showing that enhancing teachers' motivating styles can improve these perceptions and, consequently, increase engagement. These findings align well with the situated expectancy-value theory (Wigfield and Eccles, 2000; Eccles and Wigfield, 2020), which posits that students' perceptions of their social environment, including teacher expectations, shape their academic beliefs and outcomes. However, the relationship between perceived teacher expectations and academic engagement is not likely to be direct. Rather, it may operate through various internal processes that students undergo as they interpret and respond to their perceived environment. In the situated expectancy-value theoretical framework, students' perceptions of teacher expectations influence their academic engagement through processes involving intentional adjustments to their self-schemata and expectancies for success. One key process that warrants further exploration is intentional self-regulation, which may serve as a crucial mediating mechanism in this relationship.

4.2 The mediating role of intentional self-regulation

Through longitudinal mediation analysis, this study confirms Hypothesis 2 by revealing how middle school students' perceptions of teacher expectations affect their academic engagement through intentional self-regulation. The results extend our understanding of the situated expectancy-value theory (Wigfield and Eccles, 2000; Eccles and Wigfield, 2020) by demonstrating the pivotal mediating role of intentional self-regulation in this process.

Intentional self-regulation, as an active regulatory process, can be elucidated through the progression from "general self-schemata" to "expectations of success" within the expectancy-value theory model, fundamentally embodying the core characteristics of intentional self-regulation. Specifically, when students perceive high expectations from teachers, they adjust their self-schemata, including self-concept and beliefs about their own abilities. This process entails re-evaluating and reorganizing self-related information, which is central to intentional self-regulation. Through this self-regulation, students establish new learning goals, modify success expectations, and ultimately influence their learning behaviors and engagement. This goal-oriented regulatory mechanism enables individuals to reassess their abilities and objectives when perceiving others' beliefs, and to adopt corresponding adaptive behaviors, thereby enhancing learning engagement (Gestsdóttir and Lerner, 2008; Eccles and Wigfield, 2020; Li et al., 2022). Concurrently, intentional self-regulation, through Selection, Optimization, and Compensation (SOC) strategies (Freund and Baltes, 2002), inherently involves students adjusting their success expectations and aligning these expectations with their perception of teacher expectations and personal goals. Students with high levels of intentional self-regulation can adeptly align their academic goals with perceived teacher expectations and continuously adopt adaptive learning strategies to overcome challenges (Gestsdóttir et al., 2009). They possess the ability to reevaluate their learning strategies and adjust their behaviors, transforming perceived teacher expectations into a catalyst for academic engagement (Cherng and Liu, 2017; Vattøy, 2020; Wahman and Anderson, 2021).

Through intentional self-regulation, students not only internalize their perceptions of teacher expectations but also actively monitor and regulate their learning processes. This proactive self-regulatory process facilitates the transformation of external teacher expectations into intrinsic learning motivation, thereby promoting increased levels of academic engagement (Bowers et al., 2016; Rubie-Davies et al., 2020).

Our research extends the application of situated expectancy-value theory by introducing intentional self-regulation as a mediating variable in understanding the impact of perceived teacher expectations on student learning engagement. The longitudinal mediation analysis reveals a partial mediating effect of self-regulation in the relationship between students' perceptions of teacher expectations and their learning engagement. This finding suggests that intentional self-regulation play a role in how students' perception of teacher expectations influence their academic engagement. While this partially supports the theoretical pathway from external influences to internal cognition and subsequent behavioral changes, it also indicates that other factors may be involved. The results contribute to our understanding of the complex dynamics in student learning processes,

highlighting the interplay between perceived external expectations and internal regulatory mechanisms (Wigfield and Eccles, 2000; Han et al., 2022).

4.3 Limitations and future directions

This study has further validated and deepened the investigation of its thematic focus. However, several limitations remain to be addressed. Firstly, given that the study's subjects were Chinese middle school students, it focused on exploring how students' perceptions of homeroom teacher expectations influence their overall academic engagement. Future research could delve into a more detailed analysis of how students' perceptions of expectations from specific subject teachers affect their academic engagement in those respective subjects. Secondly, the sample did not include ninth-grade students due to the structure of the middle school system. Subsequent research could investigate whether the perceptions of middle school teachers' expectations have a lasting impact as students transition into high school. Thirdly, this study primarily focused on students' perceptions. While this approach provided valuable insights, incorporating teachers' perspectives could offer a more comprehensive view of the dynamics at play. Future research might benefit from integrating both student and teacher viewpoints to explore the Pygmalion effect more thoroughly. Lastly, the study focused on the effects of teacher factors. However, family dynamics, peer interactions, and academic achievements may also shape student academic engagement (Chase et al., 2014; Harris et al., 2020; McKellar and Wang, 2023). Future research should take a more holistic view of these external environmental factors, exploring how they interact with intentional self-regulation and their consequent effect on the academic development of middle school students.

5 Conclusion

This research enhances our comprehension of students' perceptions of teacher expectations effect by exploring its influence on academic engagement and uncovering the underlying mechanisms. Employing a longitudinal design grounded in a robust methodological approach and well-developed theoretical context, the study explores the dynamics between students' perceptions of teacher expectations and academic engagement among Chinese middle school students, emphasizing the mediating role of intentional self-regulation. Through cross-lagged panel analysis, the study revealed that (a) Middle school students' perceptions of teacher expectations have a positive effect on student academic engagement, confirming their role as a significant factor in sculpting student academic engagement. (b) Middle school students' perceptions of teacher expectations can positively predict students' intentional self-regulation over time, which subsequently positively affects their academic engagement. (c) The mediation analysis further verified that intentional self-regulation serves as a significant longitudinal mediator in the relationship between middle school students' perceptions of teacher expectations and academic engagement. These findings not only underscore the pivotal influence of students' perceptions of teacher expectations on

educational outcomes but also highlight the role of intentional self-regulation as a key intrinsic mechanism through which perceived teacher expectations impact middle school students' academic engagement.

The implications of these findings advocate for a shift from traditional, logic-based teaching methods to a more emotion-centered approach. By tailoring expectations and instructional strategies to students' needs and implementing diverse assessment methods, teachers can enhance students' perception of support and understanding, thereby motivating students' interest and determination in learning. This approach encourages students to embrace challenges and sustain a positive engagement with their studies.

Furthermore, it is imperative for students, schools, and families to develop strategies for intentional self-regulation. This involves guiding students in accurately evaluating their needs against available resources, setting realistic goals, and employing effective strategies to achieve these objectives, which in turn promotes optimal personal development.

Data availability statement

The datasets presented in this article are not readily available because the data presented in this study are available on request from the corresponding author. These data are not publicly available because they are part of an ongoing study, which requires maintaining confidentiality and integrity to ensure the validity of future, more in-depth research findings. Requests to access the datasets should be directed to wanghy178@nenu.edu.cn.

Ethics statement

The studies involving humans were approved by Academic Ethics Committee of the College of Psychology of Northeast Normal University (protocol code 2022028). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

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HW: Conceptualization, Funding acquisition, Methodology, Project administration, Supervision, Writing – review & editing. YS: Conceptualization, Formal analysis, Methodology, Software, Validation, Writing – original draft, Writing – review & editing. XZ: Data curation, Investigation, Resources, Writing – original draft. WW: Data curation, Writing – review & editing. JX: Visualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Development of a causal model of self-regulated learning by students at Loei Rajabhat University

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Introduction: Self-regulated learning is an active process in which learners employ self-directed behaviors, thoughts, and actions to attain learning objectives. It is essential for students as it can result in improved academic achievement, task completion, and the acquisition of life skills. The objectives of this research were to examine the congruence between a causal model of self-regulated learning and empirical data and to investigate the direct and indirect effects of the model on a sample of 660 students from Loei Rajabhat University.

Methods: The data were analyzed using structural equation modeling. The results indicate that the causal model of self-regulated learning aligns with the empirical data.

Results: The study showed that self-efficacy, achievement motive, and learning by imitation variables had a favorable impact on self-regulated learning. The achievement motive and learning by imitation have indirect impacts on self-regulated learning through the self-efficacy variable. The findings suggest an increase in self-efficacy, achievement motive, and learning by imitation. Increasing self-efficacy, achievement motive, and learning by imitation among students may be an effective strategy for enhancing the efficiency of self-regulated learning.

Discussion: This research suggests that teachers should organize teaching and learning activities that promote achievement motivation and develop self-efficacy, and they should be good role models for students. All parties, including administrators, should implement policies that promote and develop activities to create incentives for achievement. Self-efficacy and learning by imitation are necessary for students to practice self-regulated learning in the future.

KEYWORDS

self-regulated learning, causal model, self-efficacy, achievement motive, learning by imitation

1 Introduction

In the Twelfth National Economic and Social Development Plan B.E. 2,560–2,564 (2017–2021), Strategy 1 on the potential promotion and development of human capital in Thailand sets the goal of people of all ages possessing skills, knowledge, and ability as a basis for national development through lifelong learning. This is because education is a mechanism for developing people's quality of life so that they can live happily in society under the prevailing and rapidly advancing economic, environmental, social, and technological conditions.

Moreover, most behavioral psychologists view the act of learning as being different from learning according to social cognitive theory, which focuses on the internal behavior of a person. For instance, the learning theory of Bandura (1986) assumes that people learn through observation, modeling, and reinforcement; this theory is rooted in social perception theory, focusing on social factors in human behavioral development.

The theory of *self-regulated learning* (SRL) focuses on the involvement of an individual learner in three processes: (i) Cognition is the learner's mental process of perceiving, processing, and storing new data, involving aspects such as memory and problem-solving; (ii) metacognition is the learner's perception and control of their strengths and weaknesses, ability to plan and monitor their learning, and ability to reflect on their own learning experience, involving aspects such as planning, examination, and evaluation; (iii) motivation is an internal and external factor affecting the learner's involvement, effort expenditure, and persistence in learning, involving aspects such as goal-setting, self-efficacy, and self-determination (Zimmerman, 1990). SRL is not a static process but is instead constantly changing and dynamic and can be improved by training or instruction (Zimmerman, 2002). SRL is behavior that is based on the concepts of self-regulation and learning in social cognitive theory. Self-regulation is the process of a person using various strategies to regulate thoughts, behaviors, and emotions to learn different skills through their own motivation and actions (Schunk and Zimmerman, 1994). Self-regulation has three causes: person, environment, and behavior, all of which have interdependent effects that change with each factor (Zimmerman, 1989). The process of self-regulation involves three steps. (i) Self-observation helps a person to perceive their actions; this is important because successful self-regulation partly results from clear, regular, and accurate observation. Therefore, self-regulation enables a person to accurately diagnose conditions and express or adjust their behaviors. (ii) Self-judgment uses information obtained from self-observation, where comparisons are made with certain criteria before making a judgment to change one's behavior. It affects behavioral change when the outcome is valuable enough and concerns one's ability and actions. (iii) Self-reaction is a process that depends on each person's decision benchmark and obtained outcome; for example, if a person achieves a specified standard, then they will reward themselves; in contrast, if they do something below a specified standard, then they usually react by punishing themselves. In addition, self-reaction can be either observable (e.g., working harder) or unobservable (e.g., a sense of pride). Therefore, SRL is an important behavior for learners in the 21st century because it can regulate and guide learners to continue studying outside of class to develop their knowledge, understanding, and skills. In an age with quick access to information without time and place limitations, learners can study using technological media (Jongjaisurathum et al., 2015). Learners without SRL usually face both academic and behavioral problems in school (Chianchana et al., 2010).

It is essential to study the background or causes of self-regulation; thus, the present study focuses on SRL by reviewing previous research that included variables that affect self-regulation. Many researchers have studied the relationship between different variables and SRL. For example, Aldridge and Rowntree (2022), Koshkouei et al. (2016), Milyavskaya and Werner (2018), and Zimmerman (2002) studied the relationship between achievement motive (MOT) and SRL, finding that MOT had a significant effect on SRL. Meanwhile, Azari Noughabi and Amirian (2021), Chung (2000), and Ha (2021) studied

self-efficacy (SEE) and SRL, finding that SEE had a significant effect on SRL. Also, Bandura et al. (1961), Schunk and Hanson (1985), and Choeysuwan (2013) studied learning by imitation (LIM) and SRL, finding that LIM had a significant effect on SRL. Thus, these studies demonstrate that students who have a high level of MOT, SEE, and LIM will have a high level of self-regulation in their learning.

Against the above background, the present authors were interested in developing a causal model of SRL by students at Loei Rajabhat University (LRU) to obtain data to guide the development of student potential. It is hoped that teachers and administrators will use the model as a guideline for developing students' SRL, leading to students' professional development in their future occupations, as well as benefiting society and the country more broadly. The research objectives were as follows: (i) to examine the congruence between the model and empirical data; (ii) to investigate the direct and indirect impacts of achievement incentive, SEE, and LIM on SRL according to the model. We put forward the following research hypotheses:

H1: SEE has a significant effect on SRL.

H2: MOT has a significant effect on SRL.

H3: LIM has a significant effect on SRL.

H4: MOT has a significant indirect effect on SRL through the mediating variable of SEE.

H5: LIM has a significant indirect effect on SRL through the mediating variable of SEE.

2 Literature review

2.1 Self-regulated learning

The foundation of self-regulation is social cognitive theory, which offers multiple interpretations of self-regulation based on core beliefs. Bandura (1994) defined self-regulation as the influence an individual has over their own motivation, cognitive processes, emotional states, and behavioral patterns. Various scholars have extensively studied SRL during the past three decades. The consensus among most writers is that the process is cyclical, consisting of many stages and areas that partially overlap (Panadero, 2017). Examining previous research on SRL models, Panadero (*Ibid.*) highlighted a three-phase framework established by Puustinen and Pulkkinen (2001). The three fundamental stages found in nearly all models, however occasionally referred to by other names, are preparation, performance, and appraisal. Similar to the stages, various models can differ in the domains of SRL, typically identifying three or four phases. While certain aspects of SRL may occasionally need more focus, it is crucial to address all of them since they are significant and should not be overlooked. The OECD (2013) has recognized self-regulation as a crucial skill for the twenty-first century and a significant factor in achieving success. Developing self-regulation abilities in learning is

essential since undergraduate students are required to have the ability to autonomously manage their academic objectives. Several studies have confirmed that to succeed and improve their performance in learning, students must develop self-regulation skills (Kizilcec et al., 2017; Greene et al., 2018). The current study builds upon previous research on self-regulated learning by developing a specific causal model for students at Loei Rajabhat University. This model offers new insights and practical implications for promoting self-regulated learning in this particular setting. Researchers have concluded that SRL refers to students' self-regulation in class and extracurricular activities. It involves choosing problem-solving learning methods, planning studies to achieve good learning outcomes, and succeeding according to expectations or objectives. Social cognitive theory identifies three subprocesses of SRL (Bandura, 1986): (i) Self-Observation (SEO): If individuals do not observe their behavior, they have no control over their actions. Self-regulation requires awareness of actions. This process requires clarity, consistency, self-observation, precision, and self-recording. Bandura stressed the importance of self-observation factors such as actions, consistency, similarity, and precision. (ii) Self-Judgment (SEJ): If individuals cannot assess whether self-observation data meets their needs, it will have little impact on their behavior. Personal standards learned through direct instruction must be applied. Evaluating social reactions to behavior and observing model behavior help in the transmission of process standards. Another important factor in judgment is social, self, and group comparisons with the social reference group. (iii) Self-Reaction (SER): Setting assessment and decision-making standards in the previous step causes self-reaction.

2.2 Self-efficacy

Self-efficacy (SEE), as a psychological concept, relies heavily on Bandura's (1977) social-cognitive theory as a crucial framework for comprehending SEE. SEE refers to an individual's self-assessment of their capacity to complete a task or their confidence in their skills to do a task (Pintrich et al., 1991). Personal beliefs, judgments, and convictions influence SEE, making a single comprehensive exam an inaccurate measure (Bandura, 1977). The measurement of SEE depends on the specific environment and activities involved. Instead, it defers to SRL. Bandura (1997) and Schunk (1995) concur that SEE beliefs have an impact on effort, task selection, perseverance, resilience, and accomplishment. Contemporary comprehension of SEE encompasses metacognition and motivational processes (Zimmerman and Campillo, 2003; Zimmerman and Moylan, 2009). In addition, Winne (2011) explores the cognitive and metacognitive elements of SRL based on the Information Processing Theory. These elements include (i) task definition (comprehension of the task), (ii) goal setting and planning (establishing objectives and determining how to achieve them), (iii) implementing study tactics and strategies (executing a set of actions), and (iv) metacognitive adaptation of studying (making long-term changes in motivation, strategies, and beliefs) (Panadero, 2017). The models highlight SEE as a vital SRL process (Panadero, 2017). Eroglu and Ozbek (2018) regard SRL as one of the most significant individual talents of our time. Researchers have synthesized and categorized the components of SEE based on theories and research on SEE, designating them as follows: (i) Choice Behavior (CHO): decision-making about behavior and learning based on one's

abilities in specific situations; (ii) Effort Expenditure and Persistence (EEP): the determination and perseverance in learning to achieve success; and (iii) Thought and Emotion Reaction (TER): the cognitive processes and emotional responses that influence learning.

2.3 Achievement motive

The achievement motive refers to the desire to excel and to experience a sense of accomplishment when pursuing specific objectives, as well as experiencing anxiety in the face of failure (McClelland, 1961). Weiner (1972) explained how high- and low-achievers differ. People with high achievement motives work harder, handle failures better, and enjoy challenges. They take the initiative, start many activities, and take more pride in their achievements than those with weak achievement motives. Achievement motive, sometimes referred to as achievement goals, have an important influence on SRL (Nurudin et al., 2023). Students who have mastery- and performance-approach objectives demonstrate more regulation effort in all aspects of SRL (Paz-Baruch and Hazema, 2023). This highlights the significance of these goals in influencing learning behaviors. Moreover, there is a notable impact of learning motivation on SRL, as evidenced by a positive connection between these two characteristics (Greisel et al., 2023). Essentially, SRL closely connects accomplishment goals and learning motivation, influencing students' learning strategies and outcomes. Based on these findings, researchers have synthesized and streamlined the components of achievement motivation, identifying the following three important elements: (i) Energetic (ENE): works hard, whether mentally or physically, to feel important and have a sense of accomplishment. (ii) Individual Responsibility (IND): strives for personal fulfillment and success without praise; prefers intellectual and behavioral autonomy. (iii) Ambition (AMB): exhibits a strong desire to learn, exerts great effort to accomplish objectives regardless of how simple or difficult the tasks are, and strives for success. Individuals with strong achievement motives are intrinsically motivated, overcoming obstacles to accomplish their goals and achieve success.

2.4 Learning by imitation

Bandura (1986) defined learning by imitation as the process of observing, imitating, or emulating the behavior of others as a guide for one's actions. Bandura (1977) suggested that environmental interactions cause behavior. In an ongoing process, learners imitate models by observing response patterns, diverse reactions, and environmental indicators. When observation is a factor, students can demonstrate novel behaviors or replicate model behaviors without making mistakes. As social development progresses, learners imitate those closest to them and grow beyond them. Imitators observe and remember the behaviors of esteemed models, but their motivation determines whether they emulate them. Imitation by learning entails instructing an agent to exhibit behavior by replicating expert demonstrations (Masaki, 2023; Parveen et al., 2023). SRL is a cognitive process in which learners actively manage and control their learning activities (Teng, 2023). While imitation through learning involves replicating actions, SRL stresses learners assuming responsibility for their learning process. Both approaches entail acquiring knowledge

through the act of seeing and engaging in practical activities, although they vary in terms of the degree of independence and self-guidance. Imitation by learning relies on external supervision, whereas SRL enables individuals to autonomously control their learning. Gaining a comprehension of the relationship between imitation by learning and SRL can offer valuable insight into how individuals gain new abilities by integrating the process of learning through observation with tactics for self-regulation, ultimately leading to improved learning outcomes. Based on the theories and research on learning by imitation, researchers have synthesized, defined, and appropriately named the components of learning by imitation. There are two factors: peer imitation (PIM) and teacher imitation (TIM). Peer imitation refers to the process of observing, imitating, or emulating peers in various aspects, such as studying, playing, reviewing lessons, managing study time, pursuing additional knowledge, and engaging in activities. Teacher imitation is the process of observing, imitating, or emulating instructors in areas such as punctuality, work planning, effort, pursuing additional information, and participation in activities.

3 Methodology

3.1 Population and sample

This study investigates the students of Loei Rajabhat University in particular, given the substantial influence that the COVID-19 pandemic has had on the learning behaviors of students in virtual learning environments. Despite efforts to create conducive learning environments through online systems that facilitate efficient learning, online learning still impacts students. For instance, diminished academic performance and increased procrastination are consequences of perceived deficiencies in self-regulatory skills. We, as educators and researchers at Loei Rajabhat University, acknowledge the significance of identifying the variables that impact the self-regulation of learning among university students. Therefore, we conducted this study using students currently enrolled at Loei Rajabhat University. This survey research was a descriptive investigation of a causal model of SRL by LRU students. The study population comprised 12,279 undergraduate students from five faculties at LRU in the 2022 academic year, and the sample size was estimated using the LISREL software package. Schumacker and Lomax (2015) suggested the rule of thumb of using a sample size of 10–20 per estimated parameter; in the present study, the estimation involved 29 parameters, so the authors determined the sample size using the ratio of 20 participants per parameter and obtained a sample size of no fewer than 580 participants. Proportional stratified random sampling was then used to select undergraduate students at LRU in the 2022 academic year. Based on the sample size and the population in each stratum, the number of participants in each group was calculated proportionally. An extra 20% of participants were chosen from each faculty to make up for non-respondents who did not fill out the survey and to ensure sufficient data coverage for the analysis. Consequently, the final sample comprised 660 undergraduate students: 219 were male (33.20%) and 441 were female (66.80%). Within the sample, 173 respondents were from the Faculty of Education (26.20%), 142 were from the Faculty of Science and Technology (21.50%), 151 were from the Faculty of Humanities and

Social Sciences (22.90%), 171 were from the Faculty of Management Science (25.90%), and 23 were from the Faculty of Industrial Technology (3.50%).

3.2 Research framework

Based on the SRL literature and a review of prior research that incorporated variables that influence self-regulation, the current study concentrates on SRL. Numerous researchers have investigated the correlation between SRL and various variables. They were then put together in a framework based on Bandura's social cognitive learning to create the current causal model of SRL by LRU students. In the causal model, SEE, MOT, and LIM have direct effects on SRL, while MOT and LIM have indirect effects on SRL by transmission through SEE. The conceptual framework is shown schematically in Figure 1.

3.3 Instrument for data collection

The instrument for data collection was a three-part questionnaire about the SRL of students at LRU: Part 1 covered basic data on the respondents in terms of gender, educational level, and faculty; Part 2 covered SRL; and Part 3 covered the variables affecting SRL, i.e., SEE, MOT, and LIM. Five experts tested the questionnaire's content validity using a five-level rating scale (1 = minimum, 5 = maximum). The results showed that all items had an item-level content validity index (CVI) higher than 0.78, and the scale-level CVI was 0.91, higher than the specified criterion of no less than 0.90 (Polit and Beck, 2012). The questionnaire contained 58 items in total: three on basic respondent data, such as gender, education level, and faculty; 15 on SRL in three aspects; 15 on SEE in three aspects; 15 on MOT in three aspects; and 10 on LIM in two aspects. After validation, the questionnaire was revised and improved before being tested on another group of 100 students similar to the sample, i.e., 20 students from each faculty. The results were used to examine the quality of the instrument by calculating the corrected item-total correlation (CITC) with Pearson's correlation coefficient; the criterion for selection was a discrimination power of 0.20–1.00. The reliability was then calculated to find the Cronbach's alpha coefficient; according to George and Mallery (2021), the reliability should be moderate (0.70) or higher. The questionnaire was classified according to each variable as follows:

3.3.1 SRL

This part of the questionnaire included 15 items with a discrimination power of 0.623–0.789 and a reliability value of 0.946. It contained three factors, each of which comprised five items: (i) SEO (e.g., A student always plans to study all subjects in advance. A student sets learning goals) with a discrimination power of 0.617–0.717 and a reliability value of 0.864; (ii) SEJ (e.g., A student can make his or her own study decisions. A student self-checks his or her study) with a discrimination power of 0.609–0.819 and a reliability value of 0.874; (iii) SER (e.g., A student is satisfied with academic results that meet his or her goals. A student can correct his or her learning deficiencies to achieve the goals) with a discrimination power of 0.790–0.844 and a reliability value of 0.913.

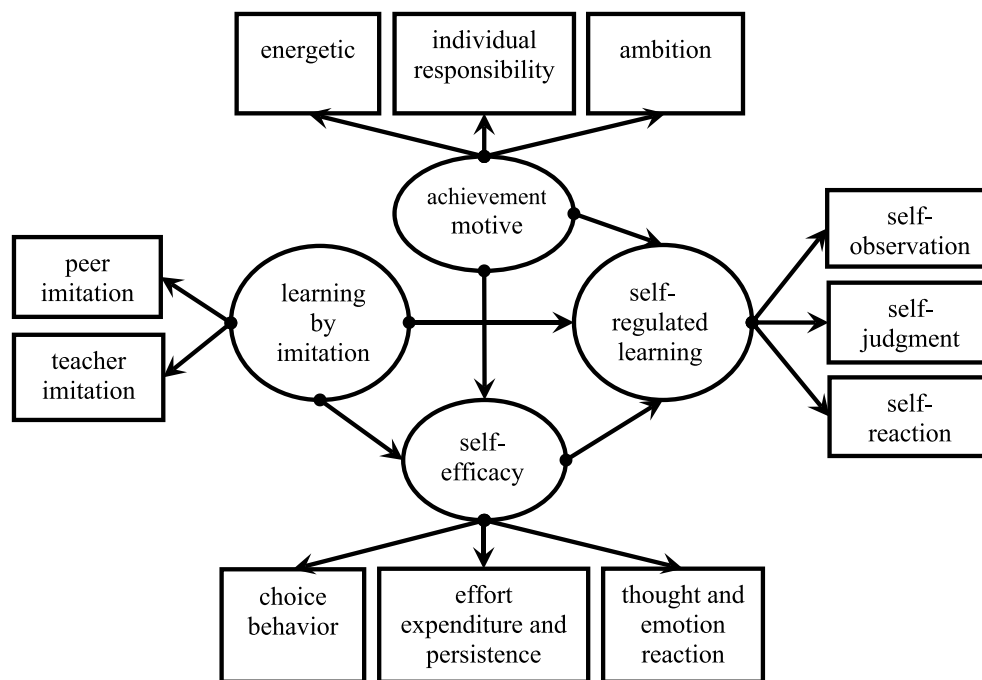


FIGURE 1

Conceptual framework of a causal model of self-regulated learning (SRL) by students at Loei Rajabhat University (LRU).

3.3.2 SEE

This part of the questionnaire included 15 items with a discrimination power of 0.530–0.751 and a reliability value of 0.925. It contained three factors, each of which comprised five items: (i) CHO (e.g., A student can choose learning activities on his or her own. A student believes that the learning activities chosen are suitable for his or her abilities) with a discrimination power of 0.580–0.809 and a reliability value of 0.884; (ii) EEP (e.g., A student can solve any problem that occurs while studying. If a student sees that learning is too complicated and confusing, he or she will never try to do it again) with a discrimination power of 0.429–0.750 and a reliability value of 0.799; (iii) TER (e.g., A student enjoys learning in class. A student feels proud when he or she achieves academic goals) with a discrimination power of 0.523–0.773 and a reliability value of 0.859.

3.3.3 MOT

This part of the questionnaire included 15 items with a discrimination power of 0.655–0.790 and a reliability value of 0.949. It contained three factors, each of which comprised five items: (i) ENE (e.g., A student will do their best on his or her assignments. A student will never abandon assignments and will do the best he or she can) with a discrimination power of 0.685–0.830 and a reliability value of 0.908; (ii) IND (e.g., When a student is given any assignments, he or she will complete them before the due date. A student is determined to work to achieve their goals) with a discrimination power of 0.850–0.891 and a reliability value of 0.951; (iii) AMB (e.g., A student wants to be a leader among his or her classmates. A student is likely to have higher academic expectations than his or her classmates, which will push him or her to compete with themselves and others) with a discrimination power of 0.566–0.933 and a reliability value of 0.924.

3.3.4 LIM

This part of the questionnaire included 10 items with a discrimination power of 0.528–0.787 and a reliability value of 0.911. It contained two factors, each of which comprised five items: (i) PIM (e.g., A student follows the learning practices of classmates who study hard. A student follows classmates who review lessons in their free time) with a discrimination power of 0.658–0.777 and a reliability value of 0.883; (ii) TIM (e.g., A student follows teachers in that he or she will not give up if not successful. A student follows teachers in researching knowledge from the library and the internet) with a discrimination power of 0.732–0.887 and a reliability value of 0.938.

3.4 Data analysis

The scores of the scale were examined against the criteria, with the analysis using the basic statistics of mean, standard error, standard deviation, minimum and maximum, normal distribution considering skewness and kurtosis, and the multicollinearity test. Pearson's correlation coefficient was then used to test the congruence between the hypothesized model and empirical data, and the fitness index was used in the LISREL software package for the data analysis. The criterion values for the model fit coefficients were as follows: $0.05 < p \leq 1.00$; $0 < \chi^2 / df \leq 2$; $0.95 \leq GFI \leq 1.00$; $0.95 \leq AGFI \leq 1.00$; $0 < RMSEA \leq 0.05$; $0 < SRMR \leq 0.05$; $0.95 \leq NFI \leq 1.00$; $0.97 \leq CFI \leq 1.00$; $CN \geq 200$ (Diamantopoulos and Siguaw, 2000). In addition, the path coefficient was analyzed in the causal model to examine the direct effect (DE), indirect effect (IE), and total effect (TE) of different variables in the model to study the direct and indirect effects on SRL by LRU students.

4 Results

4.1 Descriptive statistical analysis of variables

The means (M) of the latent variables were between 3.484 and 3.795. The highest mean was for SEE ($M=3.795$), followed by MOT, SRL, and LIM ($M=3.746$, 3.672, and 3.484). The standard deviation (S) ranged from 0.647 to 0.733. Examining the coefficient of variation (CV) of the variables, it was determined that LIM variables had the greatest CV . The MOT variable had the greatest degree of data dispersion ($CV=21.032$), the SRL variable was ranked second ($CV=17.904$), and the SEE variable had the lowest distribution coefficient ($CV=17.058$). Considering the skewness (Sk) of the variables, all variables were left-skewed. Since there was a statistically significant negative value at the 0.01 level, most students had a higher opinion level of the variable than the average. In terms of kurtosis (Ku), all variables had positive kurtosis with statistical significance at the 0.05 and 0.01 levels. The distribution characteristics of the variables were curved higher than normal (leptokurtic), showing that the students had a high degree of agglutination behavior. Pearson product-moment correlations between the SRL, SEE, MOT, and LIM variables ranged from small to moderate (0.276–0.653). These values (see Table 1) were lower than the criterion for concerns about multicollinearity (*correlations between the independent variables* < 0.80; Preacher and Hayes, 2004).

4.2 Correlation coefficients between variables observed in the model

Pearson's correlation coefficient analysis between all 52 pairs of observed variables found that none of the correlation coefficients was greater than 0.800. All variables were significantly correlated at the

0.01 level, with correlation coefficients ranging from 0.276 to 0.747. These results are given in Table 1.

4.3 Data analysis according to research objectives

Examination of the causal model of SRL by LRU students showed that the model was not congruent with the empirical data ($\chi^2=107.615$, $df=38$, $p=0.000$, $GFI=0.971$, $AGFI=0.950$, $RMSEA=0.053$, $SRMR=0.024$, $NFI=0.989$, $CFI=0.993$, $CN=359.801$). The model was then adjusted by the researchers to be compatible with the empirical facts, taking into account its applicability and theoretical feasibility. The researchers changed the values in the THETA-DELTA (TD) and THETA-DELTA-EPS (TH) matrices as follows: TD (3,2) TD (4,3) TH (2,5) TH (4,1) TH (4,3) TH (2,1) TH (3,4). This was done one by one according to the program's instructions until the model agreed with the empirical data and showed that the model was congruent with the empirical data ($\chi^2=38.404$, $df=31$, $p=0.169$, $GFI=0.990$, $AGFI=0.978$, $RMSEA=0.019$, $SRMR=0.015$, $NFI=0.996$, $CFI=0.999$, $CN=882.315$). The reliability of the 11 observed variables ranged from 0.484 to 0.859, with TIM having the highest reliability ($R^2=0.859$), ENE ranked second ($R^2=0.796$), and AMB having the lowest reliability ($R^2=0.484$). The values for SRL and SEE for the forecasting coefficient (R^2) in the structural equation of the latent variables were 0.736 and 0.721, respectively. This means that LIM and MOT could explain 73.60 and 72.10% of the variance in SRL and SEE, as shown in Figure 2. The results for the sizes of the direct and indirect effects among the studied variables are described below.

4.3.1 Self-efficacy (SEE)

Regarding the direct effects on SEE, the study found that MOT and LIM had direct effects on SEE at a statistical significance of 0.01.

TABLE 1 Pearson correlation-coefficient matrix, mean, and standard deviation between variables observed in the research model.

Variables		SRL			SEE			MOT			LIM	
		SEO	SEJ	SER	CHO	EEP	TER	ENE	IND	AMB	PIM	TIM
SRL	SEO	1										
	SEJ	0.747**	1									
	SER	0.610**	0.639**	1								
SEE	CHO	0.542**	0.594**	0.518**	1							
	EEP	0.531**	0.537**	0.495**	0.648**	1						
	TER	0.524**	0.543**	0.488**	0.665**	0.632**	1					
MOT	ENE	0.607**	0.637**	0.530**	0.615**	0.618**	0.611**	1				
	IND	0.581**	0.653**	0.516**	0.531**	0.521**	0.551**	0.739**	1			
	AMB	0.463**	0.536**	0.448**	0.485**	0.440**	0.444**	0.616**	0.631**	1		
LIM	PIM	0.419**	0.411**	0.337**	0.276**	0.327**	0.283**	0.391**	0.328**	0.394**	1	
	TIM	0.465**	0.501**	0.411**	0.430**	0.423**	0.430**	0.477**	0.421**	0.411**	0.715**	1
M		3.712	3.677	3.628	3.837	3.754	3.794	3.870	3.708	3.659	3.427	3.541
S		0.737	0.753	0.748	0.751	0.740	0.728	0.758	0.760	0.807	0.790	0.792

Bartlett's test of sphericity $\chi^2=4519.193$ ($p=0.000$), $KMO=0.915$. SRL, self-regulated learning; SEO, self-observation; SEJ, self-judgment; SER, self-reaction; SEE, self-efficacy; CHO, choice behavior; EEP, effort expenditure and persistence; TER, thought and emotion reaction; MOT, achievement motive; ENE, energetic; IND, individual responsibility; AMB, ambition; LIM, learning by imitation; PIM, peer imitation; TIM, teacher imitation. ** $p < 0.01$, * $p < 0.05$.

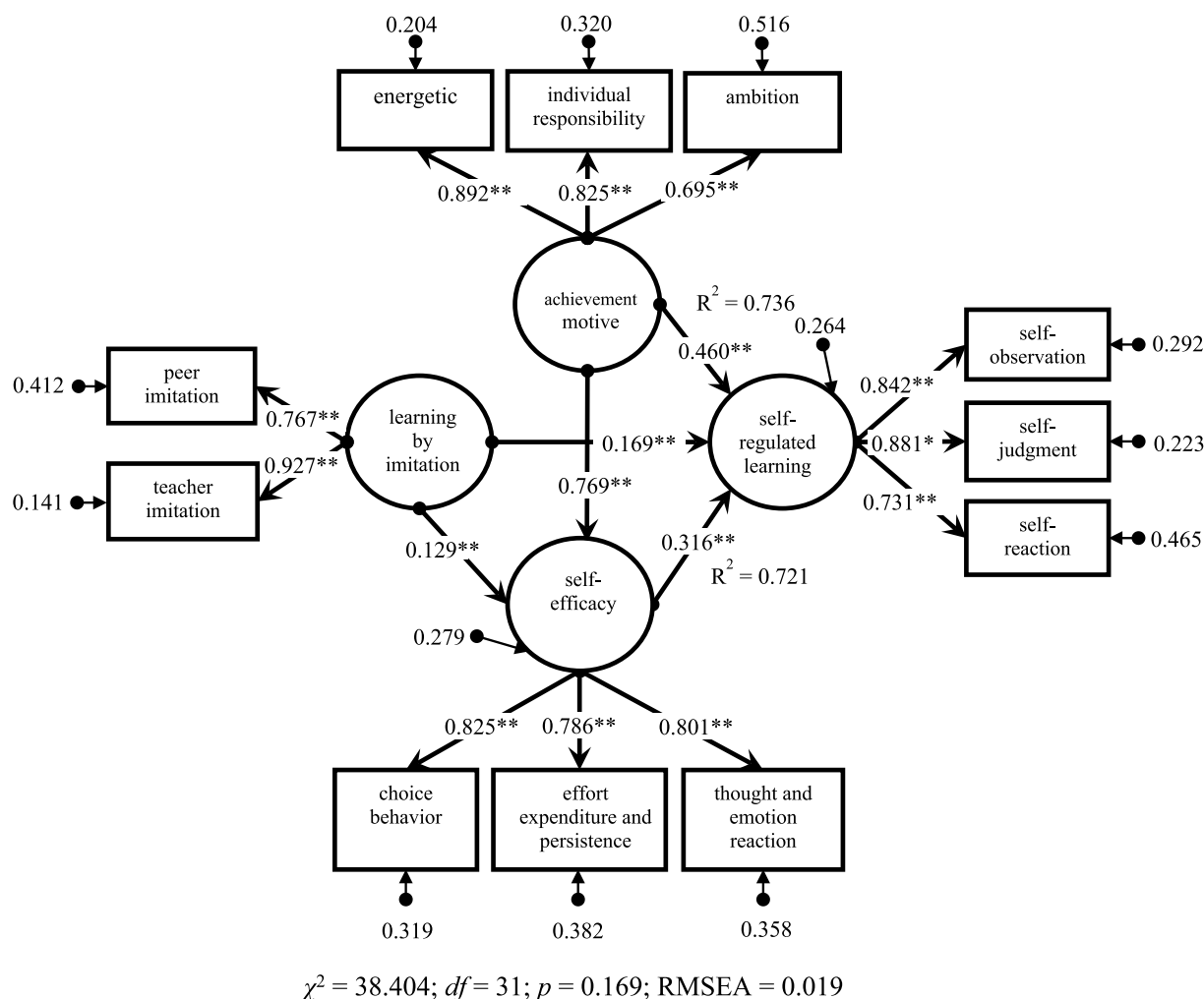


FIGURE 2

Parameter values in the SRL model with causal effects of self-efficacy (SEE), achievement motive (MOT), and learning by imitation (LIM). * $p < 0.05$, ** $p < 0.01$.

MOT had a positive effect on SEE with an effect value of 0.769, higher than the direct effect of LIM with a positive effect of 0.129. This indicates that students with high MOT and LIM also had high SEE.

4.3.2 Self-regulated learning (SRL)

Regarding the direct and indirect effects on SRL, the study found that SEE, MOT, and LIM had direct effects on SRL at a statistical significance of 0.01 with effect sizes of 0.316, 0.460, and 0.169, respectively, indicating that students with high SEE, MOT, and LIM had high SRL in terms of SEO, SEJ, and SER. Moreover, MOT also had an indirect effect on SRL at a statistical significance of 0.01 with an effect size of 0.243 by transmission through SEE, and LIM had an indirect effect on SRL at a statistical significance of 0.01 with an effect size of 0.041 by transmission through SEE. Comparing the direct and indirect effects on SRL, the direct effect of MOT (0.460) was higher than its indirect effect (0.243), and the direct effect of LIM (0.169) was higher than its indirect effect (0.041). These results are given in Table 2.

5 Discussion

The study results are discussed separately according to the study objectives below; the following two issues are of relevance.

5.1 Issue 1

Without adjustment, the causal model of self-regulated learning by LRU students was not congruent with the empirical data. Therefore, the authors modified the model by adjusting the error terms of the observed variables to partly correlate with one another so that the adjusted model was congruent with the empirical data. Furthermore, it aligns with the conceptual framework of this study. Researchers have also investigated the correlation between self-regulated learning and various variables. According to these studies, students with a high achievement motive, self-efficacy, and learning by imitation will demonstrate high self-regulation in their learning.

TABLE 2 Statistical results for a causal model of SRL by students at LRU.

Dependent variables	Independent variables								
		LIM			MOT			SEE	
	TE	IE	DE	TE	IE	DE	TE	IE	DE
SEE	0.129** (0.043)		0.129** (0.043)	0.769** (0.044)		0.769** (0.044)			
SRL	0.210** (0.040)	0.041** (0.017)	0.169** (0.038)	0.704** (0.041)	0.243** (0.051)	0.460** (0.051)	0.316** (0.073)		0.316** (0.073)
Statistical values									
$\chi^2 = 38.404$, $df = 31$, $p = 0.169$, GFI = 0.990, AGFI = 0.978, RMSEA = 0.019, SRMR = 0.015, NFI = 0.996, CFI = 0.999, CN = 882.315									
Variables		SEO	SEJ	SER	CHO	EEP	TER		
Reliability		0.708	0.777	0.535	0.681	0.618	0.624		
Variables		ENE	IND	AMB	PIM	TIM			
Reliability		0.796	0.680	0.484	0.588	0.859			
Variables in Structural Equation			SRL			SEE			
R^2			0.736			0.721			
Matrix of correlation among latent variables									
Latent Variables		SRL		SEE		MOT		LIM	
SRL		1.000							
SEE		0.801		1.000					
MOT		0.824		0.843		1.000			
LIM		0.613		0.569		0.572		1.000	

T, total effect; IE, indirect effect; DE, direct effect; bold numbers—effect in form of standardized scores; numbers in brackets—standard error; SRL, self-regulated learning; SEO, self-observation; SEJ, self-judgment; SER, self-reaction; SEE, self-efficacy; CHO, choice behavior; EEP, effort expenditure and persistence; TER, thought and emotion reaction; MOT, achievement motive; ENE, energetic; IND, individual responsibility; AMB, ambition; LIM, learning by imitation; PIM, peer imitation; TIM, teacher imitation. ** $p < 0.01$, * $p < 0.05$.

5.2 Issue 2

Apart from the congruence of the causal model of self-regulated learning by LRU students with the empirical data, some other interesting issues are discussed below.

(1) The research findings concerning the constituents of self-regulated learning indicated that the standardized component score weights for the observed variables of self-regulation learning varied between 0.731 and 0.881. Self-judgment (0.881) had the highest weighted standard deviation of any component, signifying that it assessed problem-solving in learning, decisive decision-making, and reasoned decision-making. This was followed closely by self-observation (0.842). This component encompasses the use of organized learning tools, effective time management for assignments and homework, strict adherence to school regulations, thorough task verification, and punctuality. Finally, self-reaction (0.731) comprises activities such as self-reward, self-reflection on performance, and error-related adjustments and corrections. These findings are consistent with those of Chianchana et al. (2010), and Jongjaisurathum et al. (2015). This indicates that educators should encourage self-judgment, self-reaction, and self-observation to foster self-regulated learning.

(2) According to energetic, individual responsibility, and ambition measurements, achievement motive (0.460) had the

greatest direct impact on self-regulated learning for LRU students, and energetic had the highest weight of importance. Individual responsibility and ambition were the next two most important factors. These findings indicate that to achieve good achievement motive, energetic is the main factor that stimulates students to study diligently, work, and pay full attention to assignments. Despite dealing with hard work and demanding mental and physical effort, students attempt to accomplish tasks and obtain a sense of achievement. Compared to students with low achievement motive, those with high achievement motive pay better attention to studying and assignments, are more patient when faced with failures, prefer complex tasks, initiate different things from their ideas, and are proud to deal with difficult work, leading to an effect on self-regulated learning by LRU students. These findings are consistent with those of Aldridge and Rowntree (2022), Koshkouei et al. (2016), and Milyavskaya and Werner (2018), who found that achievement motive affected students' self-regulated learning. Therefore, helping students possess achievement motive helps them perform self-regulated learning.

In addition, achievement motive had a positive direct effect on self-efficacy (0.769), which reflects the fact that students' achievement motive affects their self-efficacy. This accords with Bjørnebekk et al. (2013), González Fernández et al. (2020), and Turner et al. (2021), who found that achievement motive affects self-efficacy.

Regarding indirect effects, achievement motive also had an indirect effect on self-regulated learning for LRU students through self-efficacy. This finding reflects the fact that to enhance students' self-regulated learning, achievement motive alone is not enough, and self-efficacy is also needed.

(3) The next variable with a direct effect on self-regulated learning by LRU students was self-efficacy (0.316) as measured by choice behavior, effort expenditure, persistence, and thought and emotion reaction; the factor with the most weight of importance was choice behavior, followed by thought and emotion reaction, and then effort expenditure and persistence. These findings indicate that if students have a choice behavior, then they will decide to perform some behaviors and do some learning activities according to their ability in particular situations, demonstrating effort and persistence to learn successfully through the process of thought and emotion reaction. Consequently, these students obtain good self-efficacy, which has an effect on self-regulated learning by LRU students. These findings are consistent with those of [An et al. \(2021\)](#), [Azari Noughabi and Amirian \(2021\)](#), [Ha \(2021\)](#), [Aldridge and Rowntree \(2022\)](#), [Lu et al. \(2022\)](#), and [Truong \(2022\)](#), who noted that self-efficacy affects students' self-regulated learning. Therefore, helping students to acquire self-efficacy helps them to apply self-regulated learning.

(4) The last variable with a direct effect on self-regulated learning by LRU students was learning by imitation (0.169), as measured by peer imitation and teacher imitation; the factor with the most weighted importance was teacher imitation, followed by peer imitation. Teacher imitation involves imitating teachers' good practices such as punctuality, work planning, persistence, additional research, and activity participation, while peer imitation involves imitating friends in terms of study, play, lesson review, time management for study, knowledge-seeking, and activity participation. Such imitation enables students to achieve learning by imitation, resulting in self-regulated learning by LRU students. These findings are consistent with those of [Bandura et al. \(1961\)](#), [Schunk and Hanson \(1985\)](#), and [Choeysuwan \(2013\)](#), who noted that learning by imitation affects students' self-regulated learning. Therefore, helping students learn through good imitation helps them apply self-regulated learning.

Moreover, learning by imitation also had a positive direct effect on self-efficacy (0.129), which reflects the fact that if students learn by good imitation, then their self-efficacy will also be positively affected.

In terms of indirect effects, learning by imitation had an indirect effect on self-regulated learning for LRU students through self-efficacy. This finding reflects the fact that to enhance students' self-regulated learning, learning by imitation alone is not enough, and self-efficacy is also needed.

5.3 Research suggestions for implementation

There are two areas in which research recommendations can be made: (i) suggestions for using the research results, and (ii) suggestions for future research.

(i) Suggestions for using the research results.

According to the results on the causal model of self-regulated learning by LRU students, self-efficacy, achievement motive, and learning by imitation had direct effects on students' self-regulated

learning. The following are recommendations for teachers and administrators on how to use the research results:

Teachers should arrange learning activities and activities for developing desirable student characteristics both inside and outside classes to promote and develop students' self-regulated learning. They should arrange activities for students to practice goal-setting, determining desirable behaviors, methods for behavior modification, and self-monitoring. Teachers should record the students' performance to assess their ability to meet targets, improve weaknesses, and achieve goals. They should train students to use decision-making processes and self-assessment to assess if their behaviors align with the target; reward themselves if changes are in line with the target; or review outcomes to adjust their behavior if not. These activities would help train students to develop self-regulated learning according to its factors.

The researchers found that self-efficacy, achievement motive, and learning by imitation significantly influenced students' self-regulated learning. Therefore, teachers should use teaching methods that enhance self-efficacy, such as activities to promote mastery experience, modeling, verbal persuasion, and emotional arousal. Moreover, teachers should promote students' achievement motive, such as by showing admiration or giving a reward when students succeed in learning activities or other activities that require full effort to accomplish. Furthermore, the teaching methods used should promote students' self-efficacy, resulting in better self-regulated learning.

Administrators should set policies for promoting the arrangement of activities and the development of self-regulated learning by using teaching methods that enhance students' self-efficacy and achievement motive. Administrators should also train teachers to be good role models for students by participating in courses or projects.

(ii) Suggestions for future research.

Further investigation is warranted in the form of longitudinal studies that scrutinize the enduring impacts of self-regulated learning, achievement motive, self-efficacy, and learning by imitation. Studies should also examine the ramifications of cultural differences and the efficacy of technology-facilitated interventions. Researchers should investigate how peers and instructors impact achievement motivation and learning through imitation, as well as how interpersonal relationships and classroom dynamics influence these abilities. In addition, to promote achievement motive and self-efficacy among at-risk student populations, interventions should be customized. The purpose of these suggestions is to augment students' self-regulated learning.

6 Conclusion

The causal model of self-regulated learning by LRU students matched actual evidence and self-efficacy achievement motive, and learning by imitation directly affected self-regulated learning. Transmission through self-efficacy, achievement motive, and learning by imitation indirectly affected self-regulated learning. The research guides teachers and administrators on how to support self-regulated learning. To encourage self-regulated learning, teachers should plan learning and character development activities within and outside the class. Students should practice goal-setting, identifying desired behaviors, behavior adjustment, and self-monitoring. Administrators should use educational strategies to improve students' self-efficacy and achievement motive and promote self-regulated learning and activity

organization. Administrators should also train teachers to be role models and integrate activities into courses, activities, and projects.

7 Limitations of the study

This study used a sample comprising only LRU students. Future studies should investigate developing the self-regulated learning of students at other universities to test whether the results of the present causal model of self-regulated learning are confirmed or confounded. Also, the present results should be examined further in future research by studying a learning activity package for developing students' self-regulated learning in self-development and the development of knowledge and necessary skills, as well as students' potential and learning achievement.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

This study was approved by the Loei Rajabhat University Ethics Committee for Human Research based on the Declaration of Helsinki and the ICH Good Clinical Practice Guidelines (Approval No.386 HE 016/2563, certificated on August 28, 2020). Written informed consent for participation in the study was not required from the participants in accordance with the national legislation and institutional requirements.

Author contributions

AK: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration,

Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. PK: Writing – review & editing. CP: Writing – review & editing. JS: Writing – review & editing. CI: Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Antecedents and consequences of academic help-seeking in online STEM learning

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Introduction: College students often encounter challenges or ambiguity in online learning, which they cannot overcome independently, and therefore, require help. However, relatively little is known about how academic help-seeking can be supported in online contexts and about its potential benefits. The present study investigated the role of academic help-seeking in online STEM learning and its contextual antecedents.

Methods: A total of 213 college students, enrolled in an introductory Engineering course, completed an online survey. Their survey responses and academic record data were analyzed.

Results: Results of path analysis indicated that adaptive help-seeking was positively related to retention intention, whereas expedient help-seeking was negatively related to the choice of future courses. In addition, avoidant help-seeking was negatively related to retention intention and major declaration status and positively to disorganized studying. Results also showed that sense of belonging and environmental fixed mindset served as significant predictors of academic help-seeking.

Discussion: Findings indicate that academic help-seeking is related to successful online STEM learning. Therefore, fostering online learning contexts in which students perceive more sense of belonging and less environmental fixed mindset is crucial.

KEYWORDS

academic help-seeking, online learning, sense of belonging, environmental fixed mindset, STEM education

Introduction

Despite the significant contribution of Science, Technology, Engineering, and Mathematics (STEM) to our daily lives, the dropout rate in STEM education has been considerably high for the past several decades (Glass et al., 2013; Seymour and Hewitt, 1997; van den Hurk et al., 2019). Numerous studies have attempted to identify factors influencing students' persistence and academic performance in STEM fields. However, most of these studies have focused on face-to-face learning, and surprisingly little is known about STEM learning in online contexts. At least two reasons suggest the necessity of investigating online STEM learning. First, online learning has increasingly become an important component of higher education, particularly during the coronavirus disease 2019 (COVID-19) pandemic. Second, online learning differs from face-to-face learning in that it requires greater degrees of self-regulation with increased autonomy, as the less structured nature of online environments demands that students independently manage their learning activities, such as goal-setting, time management, and

seeking assistance (Broadbent and Poon, 2015; Dabbagh and Kitsantas, 2004). Therefore, it is essential to understand how STEM students learn in online environments.

The present study focuses on academic help-seeking, a critical self-regulated learning strategy (Karabenick and Berger, 2013; Karabenick and Gonida, 2018). Specifically, we postulate that academic help-seeking could play a pivotal role in online STEM learning. Considering the repeatedly reported difficulty of STEM learning itself (Koenig et al., 2012; Seymour and Hewitt, 1997), seeking assistance in their learning seems critical for students. Notably, academic help-seeking is a socially mediated strategy involving other social figures. One key difference between online and face-to-face learning is the presence of an instructor and other students and how they interact and communicate (Broadbent and Lodge, 2021; Kitsantas and Chow, 2007). Although prior work has well documented the importance of academic help-seeking in face-to-face settings (e.g., Karabenick, 2003, 2004), this difference makes it difficult to draw any solid conclusions and further calls for research evaluating its importance in online settings. We thus investigate the utility of academic help-seeking in predicting students' choice, retention intentions, and performance in online STEM learning.

This study also examines sense of belonging and environmental entity theory as two antecedents of academic help-seeking and educational outcomes in online STEM learning. Sense of belonging has been linked to students' retention and achievement (e.g., Hausmann et al., 2009; Lewis and Hodges, 2015). Environmental entity theory (i.e., environmental fixed mindset), recently introduced by researchers (Good et al., 2012) and particularly pervasive in STEM fields (Lytle and Shin, 2020), has also been found to be associated with students' retention intentions and achievement in STEM fields (Good et al., 2012). Students' perceptions of their instructors and peers may promote or hinder their decision to ask for help. Hence, the present study investigates if sense of belonging and environmental fixed mindset could predict students' choices, retention intentions, and performance in online STEM learning directly and indirectly via academic help-seeking.

Literature review

Academic help-seeking

Given the increased complexity of learning materials in postsecondary education, students inevitably face insurmountable challenges or ambiguity, which can interfere with their optimal learning. To seek help and assistance in such circumstances, students should be able to monitor their understanding, recognize their needs for seeking help, and translate this recognition into action (Karabenick and Berger, 2013). In other words, academic help-seeking consists of students' cognition, motivation, and behavior regulation. Accordingly, it has been consistently conceived of as a self-regulated learning strategy, which enables students to perform a more active and constructive role in their learning (Karabenick, 2003; Karabenick and Berger, 2013; Karabenick and Dembo, 2011; Karabenick and Gonida, 2018; Newman, 2000; Ryan et al., 2001). Indeed, there is compelling evidence that academic help-seeking is conducive to academic success (Fong et al., 2023). Specifically, college students' *adaptive help-seeking*, asking for hints or explanations necessary for learning and task

mastery, has been linked to greater cognitive and behavioral engagement, less anxiety, and better academic performance (e.g., Karabenick, 2003, 2004; Karabenick and Knapp, 1991; Kitsantas and Chow, 2007; Micari and Calkins, 2021).

However, it should be noted that students do not always ask for help to improve their knowledge and skills (Butler, 1998; Karabenick, 2003, 2004; Newman, 2000; Ryan et al., 2005). A theoretical distinction has been drawn between adaptive help-seeking and expedient help-seeking as suggested by Nelson-Le Gall (1985). Unlike adaptive help-seeking, which can ultimately facilitate learning, in *expedient help-seeking*, students attempt to minimize their efforts in completing their academic tasks by simply asking for solutions to problems without explanation or requesting others to perform the tasks. Prior research has provided empirical evidence indicating that expedient help-seeking is detrimental to academic success (Fong et al., 2023). Specifically, college students' expedient help-seeking was positively linked to anxiety and negatively linked to academic performance (Karabenick, 2003). Similar findings have been consistently reported in prior work investigating adolescent populations (e.g., Cheong et al., 2004; Ryan et al., 2005; Ryan and Shim, 2012).

Furthermore, although college students are generally able to monitor their learning processes and recognize gaps in their skills or knowledge, some students are reluctant to ask for much-needed help from their instructors and peers (Collins and Sims, 2006; Karabenick and Knapp, 1991). Asking for help may be regarded as a sign of personal inadequacy and overdependence, leading to embarrassment and loss of self-esteem (Nelson-Le Gall, 1985). More importantly, it has been claimed that by avoiding help-seeking when needed, students place themselves in a disadvantageous position for academic success (Ryan et al., 2001). Consistent with this claim, prior research documented that college students' *avoidant help-seeking* was related to their lower exam performance and higher anxiety (Karabenick, 2003). Similarly, Karabenick (2004) showed that college students' avoidant help-seeking was negatively related to academic performance. These findings are broadly consistent with those from previous research on adolescent students. Adolescent students' avoidant help-seeking has been negatively associated with test scores and grade point average and positively with anxiety (Ryan et al., 2005; Ryan and Shin, 2011).

Academic help-seeking in online learning

Academic help-seeking has been primarily investigated in traditional, face-to-face learning contexts. The role of help-seeking in online learning has not been extensively investigated, thus, representing a notable gap in the literature. Compared to face-to-face learning, students are generally expected to plan, organize, and control their learning much more under their own direction. Furthermore, students have fewer opportunities to interact with their instructors and peers directly. To ask for help from their instructors, students typically send emails or chat messages or post help requests on online forums (e.g., Cheng et al., 2013), which is different from academic help-seeking in face-to-face settings. Considering its different nature, it is critical to evaluate academic help-seeking and its importance for academic success in online learning settings.

As observed in face-to-face contexts (e.g., Karabenick, 2003, 2004), a few studies have demonstrated that students could benefit from academic help-seeking in online learning. For instance, academic

help-seeking was positively associated with college students' participation in online learning activities and test scores (Schworm and Gruber, 2012). Similarly, the combination of academic help-seeking and flipped learning intervention successfully increased college students' self-efficacy and course involvement (Chyr et al., 2017). Additionally, Liu (2017) reported that preservice teachers' online help-seeking was positively related to their engagement in self-regulated learning. These studies have provided informative insights, yet several notable shortcomings in the studies make it difficult to draw any firm conclusions concerning the role of academic help-seeking in online learning. Specifically, these studies tested academic help-seeking in the context of blended learning, which consists of both face-to-face and online learning (Chyr et al., 2017; Schworm and Gruber, 2012), and focused only on adaptive help-seeking (Chyr et al., 2017; Liu, 2017). Furthermore, one study manipulated both academic help-seeking and flipped learning simultaneously, making it impossible to evaluate the effect of academic help-seeking only (Chyr et al., 2017). These shortcomings along with the paucity of studies point to a need for research examining the role of academic help-seeking in online learning contexts.

Furthermore, due to the COVID-19 pandemic, a rapid transition to online learning was required, presenting numerous challenges to students (Hensley et al., 2022). It became more difficult to understand learning materials and complete tasks, making it necessary for students to seek assistance or additional explanations for learning and task mastery. Simply looking for solutions to problems without fully understanding them or avoiding help-seeking altogether could hinder their learning. Consequently, academic help-seeking could play a key role in helping students overcome these challenges and achieve their academic goals. Therefore, we investigated this among college students taking online courses during the pandemic, particularly those majoring in STEM fields.

Academic help-seeking in STEM learning

Due to the considerably high attrition rates in STEM fields, understanding factors influencing students' STEM-related choices has received significant attention (Lykkegaard and Ulriksen, 2019; Miller and Wai, 2015; van den Hurk et al., 2019). Various individual and contextual factors have been found to contribute to STEM dropout (e.g., Ball et al., 2017; Graham et al., 2013; Seymour and Hewitt, 1997; van den Hurk et al., 2019). Amidst such factors, academic difficulties, including inadequate preparation, language barriers, and the nature of conceptual difficulties, act as barriers keeping students from achieving STEM degrees. As such, academic help-seeking could likely promote STEM retention. By requesting assistance, students can avert possible failure, maintain engagement, successfully progress in their program, and ultimately attain a degree (Newman, 2002). Indeed, students' engagement in self-regulated learning has been broadly linked to their retention in the program (e.g., Patterson et al., 2014; Peck et al., 2018; Reparaz et al., 2020).

Despite its potential importance in STEM fields, little attention has been paid to STEM college students' academic help-seeking. A few studies that examined the association between help-seeking strategies and academic performance in math or science consistently documented the adaptive nature of academic help-seeking

(Horowitz et al., 2013; Szu et al., 2011). Specifically, Horowitz et al. (2013) found that strategic help seekers performed better in chemistry than those who avoided help-seeking. Similarly, Szu et al. (2011) reported that higher achieving students demonstrated more engagement in help-seeking behaviors earlier in the semester than lower achieving students in organic chemistry. However, these studies have mostly focused on academic performance concerning academic help-seeking. Thus, the relation between students' academic help-seeking and their choice or persistence in STEM fields remains unclear.

The present study investigated whether STEM students' academic help-seeking strategies can be used to understand their choice and retention intentions in STEM fields. Specifically, we examined the role of adaptive, expedient, and avoidant help-seeking in predicting not only students' academic performance but also their choice of courses and retention intentions in STEM fields. It should be noted that students often experience confusion and uncertainty in online learning. In addition to students' course grades and major declaration status, we tested if academic help-seeking was related to students' disorganization (i.e., perceptions of not knowing what to do or how to study for the course; Elliot et al., 1999) as another indicator of their academic performance.

Sense of belonging and environmental fixed mindset

College students do not always utilize available resources and assistance provided by their postsecondary institutions or use them appropriately (Karabenick, 2003). Hence, instructors and administrators are particularly interested in encouraging students to fully utilize such resources and assistance. To address this issue, students' academic help-seeking should be understood within the academic and social contexts in which they function, as suggested by models of self-regulated learning (Pintrich and Zusho, 2007; Zimmerman, 1989, 1995, 2000). In particular, academic help-seeking involves other social figures from whom students request and receive help and assistance (Newman, 2000). However, little is known about online learning contexts that can promote college students' adaptive help-seeking and reduce their expedient and avoidant help-seeking. We focused on sense of belonging and environmental fixed mindset as two potential predictors of students' adaptive, expedient, and avoidant help-seeking in online settings.

Sense of belonging refers to the extent to which students feel accepted by their instructors and peers and perceive themselves as a valuable part of their learning environment (Goodenow, 1993; Osterman, 2000). While sharing some commonalities with social support and positive relationships with instructors and peers, sense of belonging differs in that it reflects perceived social membership within the school community rather than individual relationships. It is likely that students' sense of belonging plays a critical role in academic help-seeking for two reasons. First, sense of belonging is closely associated with social and emotional adjustment. Specifically, college students are more likely to be socially accepted and less likely to feel anxious or lonely when they perceive a strong sense of belonging (e.g., Gummadam et al., 2016; Ostrove and Long, 2007). With the reduced anxiety and increased security from being accepted by their community members, including instructors and peers, students would

feel more comfortable asking for help. Second, sense of belonging facilitates students' adoption of the ideals and values shared within their school or community, such as the importance and utility of learning (Goodenow, 1993; Goodenow and Grady, 1993). The internalization of the importance and utility of STEM learning, as shared within the STEM community, is likely to encourage STEM students' academic help-seeking. Indeed, one recent study reported that college students' sense of belonging was positively related to adaptive help-seeking, whereas it was not related to expedient help-seeking (Won et al., 2021). Although not specifically for academic help-seeking, several studies have also provided relevant evidence showing that sense of belonging is related to students' engagement in self-regulated learning (Kennedy and Tuckman, 2013; Won et al., 2018). In sum, prior work has indicated that college students' sense of belonging could inform if and how they seek help with their learning.

The present study also focused on students' perceptions of environmental fixed mindset. Environmental fixed mindset refers to the extent to which students perceive an entity-oriented learning environment (Good et al., 2012). Unlike self-theories of intelligence that focus on students' own beliefs about the fixedness or malleability of their ability or intelligence, environmental fixed mindset focuses on how students perceive people around them with regard to their views on intelligence or ability. It also differs from instructors' fixed mindset in that it encompasses the fixed mindset of both instructors and peers, reflecting a broader perspective on the collective views of intelligence within the students' environment. Previous research has shown that these perceptions of entity views in one's environment can play a pivotal role in motivation and learning (Good et al., 2012; Rattan et al., 2012). We postulated that students' perceptions of how the STEM community views intelligence or ability would serve as another critical contextual factor predicting their help-seeking in online STEM learning.

Although the role of environmental fixed mindset has not yet been examined in predicting academic help-seeking, it can be inferred from previous work on individual-level fixed mindset (i.e., the self-theories of intelligence). Prior studies have consistently reported that when students hold an entity view of intelligence (i.e., the belief that intelligence is a fixed trait, and they cannot do much to change it), they are less likely to seek adaptive forms of help and more likely to engage in help-avoidance behaviors (Mihlon, 2010; Shih, 2007).

Indeed, given the inherently social nature of academic help-seeking, it is likely that not only students' own beliefs on intelligence but also their perceptions of how instructors and peers, whom they ask for needed assistance, view intelligence could promote or hinder their academic help-seeking. If students perceive that their community sees intelligence as a fixed trait, they may avoid asking questions or seeking help out of fear of appearing incompetent. In contrast, when students believe that their community members deem intelligence a malleable trait, they may be less worried about looking incompetent and more likely to engage in adaptive help-seeking. That is, when students believe their learning environment emphasizes growth and development, they are more likely to view help-seeking as a natural part of the learning process, fostering greater academic engagement and success. As noted in the literature on help-seeking, students' competence concerns are among the primary factors contributing to help-seeking avoidance (Ryan et al., 2001). Indeed, it should also be noted that fixed views on intelligence or ability are particularly prevalent in STEM learning

contexts (Lytle and Shin, 2020). Therefore, environmental fixed mindset is likely to play a pivotal role in explaining STEM students' academic help-seeking.

Based on these findings, we investigated sense of belonging and environmental fixed mindset as two determinants of college students' help-seeking in online STEM learning. Notably, sense of belonging and environmental fixed mindset have been linked to students' academic performance and retention (e.g., Good et al., 2012; Hausmann et al., 2009; Lewis and Hodges, 2015). Thus, we further examined whether students' academic help-seeking would serve as a pathway through which sense of belonging and environmental fixed mindset relate to choice, retention intentions, and academic performance.

The present study

The primary goal of this study was to investigate the role of academic help-seeking in online STEM learning by addressing three research questions. First, to what extent does undergraduate STEM students' academic help-seeking predict their choice, retention intentions, and performance (disorganization, course grades, major declaration status) in online STEM learning? Drawing on prior research investigating face-to-face learning (e.g., Karabenick, 2003; Kitsantas and Chow, 2007), we expected that adaptive help-seeking would positively predict students' choice, retention intentions, and performance, whereas expedient and avoidant help-seeking would show null or negative relations.

Second, to what extent do sense of belonging and environmental fixed mindset predict academic help-seeking in online STEM learning? Consistent with existing evidence (e.g., Won et al., 2021), we hypothesized that students' sense of belonging in their STEM community would positively predict their use of adaptive help-seeking and negatively predict their expedient and avoidant help-seeking. On the contrary, we expected that students' perceptions of an entity-oriented STEM environment would negatively predict their adaptive help-seeking and positively predict their expedient and avoidant help-seeking.

Third, does academic help-seeking mediate the relations of sense of belonging and environmental fixed mindset with STEM choice, retention intentions, and performance? We hypothesized that students' academic help-seeking would serve as pathways linking sense of belonging and environmental fixed mindset to students' choice, retention intentions, and performance. Specifically, sense of belonging would be positively associated with choice, retention intentions, and performance via increased adaptive help-seeking and decreased expedient and avoidant help-seeking. The opposite pattern was expected with environmental fixed mindset.

Method

Participants and procedure

A total of 213 students ($M_{\text{age}} = 19.0$, $SD_{\text{age}} = 1.96$) were recruited from an introductory Engineering course (13 sections) at a large public university located in Western Canada. This course was fully offered online during the spring term of 2021 due to the COVID-19

pandemic and consisted of asynchronous lectures and synchronous labs. In general, students engaged with course material through asynchronous lectures, where they independently learned key concepts at their own pace. During the synchronous labs, students applied theoretical knowledge and completed exercises. Most undergraduate courses were also offered online during this semester. This was not the students' first encounter with online learning environments, as many had experienced online coursework during previous terms as part of the adjustments to pandemic-related restrictions. Notably, this introductory course is mandatory for first-year Engineering students to declare specific Engineering programs (e.g., computer science and biomedical engineering). The majority of the students were male (70.9%) and in their first year at the university (83.1%).

An online survey was administered toward the end of the spring term of 2021, and academic record data were obtained after the semester ended. Specifically, the online survey assessed students' sense of belonging, environmental fixed mindset, academic help-seeking, disorganization, and retention intentions, whereas their course grades and major declaration status were obtained from the academic records. The university's Institutional Review Board approved the protocol for this study.

Measures

All constructs were measured at a domain-specific level, and students were directed to respond to items specific to the domain of Engineering and the introductory Engineering course in which they were enrolled. The Cronbach's α s obtained from the current study are reported in Table 1.

Sense of belonging

We adopted the sense of belonging scale from Bollen and Hoyle (1990). The scale consisted of three items assessing students' sense of belonging to the Engineering community (e.g., "I see myself as a part of the Engineering community"). Students responded to the items using a 6-point Likert scale, ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Prior work using this scale has documented its good internal consistency and positive relation to college

students' persistence (e.g., Hausmann et al., 2007; Hurtado and Carter, 1997).

Environmental fixed mindset

We assessed environmental fixed mindset using the four-item scale derived from Good et al. (2012). This scale measured the extent to which students perceive people in engineering to have a fixed mindset (e.g., "People in Engineering believe that people have a certain amount of engineering intelligence, and they cannot really do much to change it"). Students responded to the items using a 5-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). This scale has demonstrated acceptable reliability and its negative relation to students' intentions to pursue math in prior research (Good et al., 2012; Rattan et al., 2012).

Academic help-seeking

Academic help-seeking was assessed using the Students' Help-Seeking measure developed by Ryan and Shim (2012) and Ryan et al. (2009). A total of 18 items measured students' *adaptive help-seeking* (six items; e.g., "If there is something I do not understand, I ask someone for help so I can learn it"), *expedient help-seeking* (six items; e.g., "If I do not understand something, I usually want someone to just give me the answer"), and *avoidant help-seeking* (six items; e.g., "If my coursework is too hard for me, I just do not do it rather than asking for help") in the introductory Engineering course they were taking. The focus of this measure is primarily on seeking assistance related to learning, understanding course content and materials, and completing academic tasks. Students completed the measure using a 5-point Likert scale, ranging from 1 (*not at all true*) to 5 (*very true*). In previous research, this scale has shown acceptable reliability and theoretically consistent relations to students' behavior and emotional engagement and academic performance (e.g., Shim et al., 2016).

Choice

Students' choice of future Engineering courses was measured using the scale from Wolters (2004). This scale consisted of four items (e.g., "I look forward to taking more Engineering courses in the future"), and students responded to the items using a 7-point Likert scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Responses to negatively

TABLE 1 Descriptive statistics for observed variables.

Variable	<i>M</i>	<i>SD</i>	Variance	Skewness	Kurtosis	Min. observed	Max. observed	α
Sense of belonging	4.07	1.07	1.14	−0.27	−0.07	1.00	6.00	0.93
Environmental fixed mindset	2.52	0.86	0.74	0.38	−0.07	1.00	5.00	0.88
Adaptive help-seeking	3.75	0.72	0.51	−0.72	0.81	1.00	5.00	0.80
Expedient help-seeking	2.12	0.77	0.59	0.74	0.37	1.00	5.00	0.82
Avoidant help-seeking	2.16	0.75	0.56	0.49	−0.40	1.00	4.33	0.80
Choice	5.42	1.13	1.27	−0.33	−0.74	2.00	7.00	0.66
Retention intentions	5.27	0.85	0.72	−1.36	1.48	1.83	6.00	0.83
Disorganization	3.96	1.62	2.61	−0.11	−0.92	1.00	7.00	0.93
Course grade	90.49	4.69	22.00	−0.34	1.23	72	100	–
Major declaration status	0.74	0.44	0.19	−1.08	−0.83	0	1	–

N = 213. Min., minimum; Max., maximum.

worded items were reverse coded such that high values indicated higher intentions to take more Engineering courses in the future. Prior research using the scale has documented acceptable reliability and its positive relations to motivation and retention intentions (e.g., Wu et al., 2020).

Retention intentions

As an indicator of persistence, students' retention intentions in their Engineering major were measured using the scale developed by Perez et al. (2014). Students responded to six items (e.g., "At the present time, I am likely to switch to a major that is not in an Engineering field") using a 6-point Likert scale, ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Responses to negatively worded items were reverse coded such that higher values represented higher intentions to remain in the Engineering major. This scale has shown its good reliability and positive relations to academic achievement in prior research (e.g., Hiltz et al., 2018).

Disorganization

We measured students' perceived disorganization in the introductory Engineering course by adopting the five-item scale from Elliot et al. (1999). Students responded to the items (e.g., "I'm not sure how to study for this online course") using a 7-point Likert scale, ranging from 1 (*not at all true of me*) to 7 (*very true of me*). The scale has been adopted in prior work and demonstrated good reliability and its positive relations to procrastination and avoidance intentions and negative relation to academic performance (e.g., Jiang et al., 2018).

Course grades

Students' grades for the introductory Engineering course were obtained from the academic records. The course grades could range from 0 to 100.

Major declaration status

Students' specific Engineering major declaration status was collected from the academic records. To qualify for the major declaration, students were required to complete 24 credits and achieve the minimum grade point average of C+ with no course grade less than C.

Overview of analysis

Descriptive statistics and correlations were computed using SPSS 24. Then, path analysis was conducted to address our three research questions using Mplus 7.31 (Muthén and Muthén, 1998–2012). A diagonally weighted least square estimator (WLSMV) was utilized given that one of the outcomes, students' major declaration status, was binary (Muthén and Muthén, 1998–2012). As such, probit regression coefficients were reported for the paths related to major declaration status, whereas linear regression coefficients were reported for all the other paths.

We specified a path model in which academic help-seeking was postulated as a pathway linking perceived academic contexts to educational outcomes. Given the predominance of male students, a common occurrence in STEM majors, we included gender as a covariate in the path model. Additionally, academic year was included as another covariate. Despite the introductory course being mandatory primarily for first-year students, it was also open to students in other academic years.

To test the indirect effects of perceived academic contexts on educational outcomes via academic help-seeking, a bootstrap procedure with 1,000 bootstrapping samples and 95% bias-corrected confidence intervals were utilized (MacKinnon et al., 2007; Williams and MacKinnon, 2008). Model fit was evaluated based on several fit indices. Besides the chi-square statistics (χ^2), we used the Tucker–Lewis Index (TLI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA) based on the recommendation by Hu and Bentler (1999).

Results

Descriptive statistics and correlations

Descriptive statistics for all major variables are presented in Table 1. Most of the mean scores fell near the middle of the response scale, except for choice ($M = 5.42$) and retention intentions ($M = 5.27$), which were somewhat higher. The mean score for adaptive help-seeking ($M = 3.75$ on a 5-point scale) indicates a tendency for students to engage in effective help-seeking behaviors, slightly above the midpoint of the scale. In contrast, the mean scores for expedient ($M = 2.12$) and avoidant help-seeking ($M = 2.16$) suggest that students were relatively less engaged in these forms of help-seeking compared to adaptive help-seeking. Additionally, the mean score for sense of belonging ($M = 4.07$ on a 6-point scale) was above the midpoint, indicating a slightly positive sense of connection to the engineering community. The mean course grade was 90.5, and approximately 73.7% of students successfully declared their specific Engineering major at the end of the term. Skewness and kurtosis statistics indicated that all observed variables approximate a normal distribution. All scales showed acceptable degrees of internal consistency ($0.80 \leq \alpha \leq 0.93$), except for the choice scale. The reliability was somewhat low ($\alpha = 0.66$), and we suspected that it was due to the two reverse-worded items of the four-item scale. Missing rates ranged from 0 to 0.9%, which were minimal.

As presented in Table 2, sense of belonging was positively correlated with adaptive help-seeking ($r = 0.16$), whereas environmental fixed mindset was positively correlated with expedient help-seeking ($r = 0.22$). Adaptive help-seeking showed a positive correlation with retention intentions ($r = 0.24$). In contrast, expedient help-seeking was positively correlated with disorganization ($r = 0.23$) and negatively with retention intentions ($r = -0.22$). Similarly, avoidant help-seeking was positively correlated with disorganization ($r = 0.36$) and negatively with retention intentions ($r = -0.35$), course grade ($r = -0.15$), and major declaration status ($r = -0.27$).

Path model

We examined a path model with students' gender and academic year as covariates. The model fit the data well, $\chi^2(6, N = 213) = 2.581$, $p = 0.859$ (CFI = 1.000, TLI = 1.000, RMSEA = 0.000). As presented in Figure 1, students' gender was not related to any of the outcomes, whereas students' academic year significantly predicted their final course grades ($b = -3.95$, $\beta = -0.32$, $p < 0.001$) and major declaration status ($b = -0.65$, $\beta = -0.24$, $p = 0.019$). That is, first-year students were less likely to perform well in the introductory online Engineering course and declare specific Engineering majors.

TABLE 2 Bivariate correlations for observed variables.

Variable	1	2	3	4	5	6	7	8	9	10
1. Sense of belonging	–									
2. Environmental fixed mindset	0.07	–								
3. Adaptive help-seeking	0.16*	0.10	–							
4. Expedient help-seeking	–0.07	0.22**	0.08	–						
5. Avoidant help-seeking	–0.13	0.08	–0.28***	0.46***	–					
6. Choice	0.16*	–0.13	0.10	–0.29***	–0.24***	–				
7. Retention intentions	0.20**	–0.14*	0.24***	–0.22**	–0.35***	0.44***	–			
8. Disorganization	–0.12	0.10	0.01	0.23***	0.36***	–0.26***	–0.26***	–		
9. Course grade	0.09	0.02	0.08	–0.05	–0.15*	0.16*	0.16*	–0.18*	–	
10. Major declaration status	0.02	–0.05	–0.03	–0.11	–0.27***	0.03	0.22**	–0.23***	0.32***	–

N=213. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

As expected, sense of belonging was significant in predicting academic help-seeking. Specifically, sense of belonging positively predicted adaptive help-seeking ($b = 0.10$, $\beta = 0.15$, $p = 0.021$) and negatively predicted avoidant help-seeking ($b = -0.10$, $\beta = -0.14$, $p = 0.027$). However, sense of belonging was not significant in predicting expedient help-seeking. Additionally, sense of belonging was directly associated with retention intention ($b = 0.11$, $\beta = 0.14$, $p = 0.013$) and choice ($b = 0.13$, $\beta = 0.12$, $p = 0.043$). The opposite predictive pattern emerged with environmental fixed mindset. Environmental fixed mindset was predictive of expedient help-seeking ($b = 0.20$, $\beta = 0.23$, $p < 0.001$). However, environmental fixed mindset failed to predict adaptive or avoidant help-seeking and any indicators of choice, retention intentions, and performance.

Consistent with our hypotheses, adaptive help-seeking positively predicted retention intention ($b = 0.20$, $\beta = 0.17$, $p = 0.003$), whereas expedient help-seeking negatively predicted choice ($b = -0.33$, $\beta = -0.22$, $p < 0.001$). Avoidant help-seeking negatively predicted retention intention ($b = -0.26$, $\beta = -0.23$, $p < 0.001$) and major declaration status ($b = -0.55$, $\beta = -0.41$, $p < 0.001$) and positively predicted disorganization ($b = 0.77$, $\beta = 0.36$, $p < 0.001$). Neither adaptive, expedient, nor avoidant help-seeking, however, significantly predicted course grades.

Indirect effects

Based on the path analysis results, we evaluated the indirect effects of sense of belonging and environmental fixed mindset via academic help-seeking. Table 3 presents all significant indirect effects based on a bootstrap procedure with 1,000 bootstrapping samples and 95% bias-corrected confidence intervals. In general, results support our hypotheses that students' perceptions of social contexts were related to their choice, retention intentions, and academic performance not only directly but also indirectly via academic help-seeking.

Specifically, the indirect effects of sense of belonging on retention intention were significant via both adaptive help-seeking and avoidant help-seeking. In addition, the indirect effects of sense of belonging on disorganization and major declaration status were significant through avoidant help-seeking. Lastly, the indirect effect of environmental fixed mindset on choice was also significant via expedient help-seeking.

Discussion

In the present study, we examined the antecedents and consequences of students' academic help-seeking within the context of online STEM learning. The results revealed that college students' academic help-seeking was related to their choice, retention intentions, and academic performance in STEM fields. Furthermore, we found that sense of belonging and environmental fixed mindset could be used to understand students' academic help-seeking in online learning.

Academic help-seeking in online STEM learning

Our results show that academic help-seeking relates to students' choice and retention intentions. Specifically, students' adaptive help-seeking was positively related to their retention intentions in STEM fields, and their avoidant help-seeking was negatively related to their intentions. That is, the more students reportedly asked for hints or explanations necessary for learning and task mastery or the less students avoided necessary help, the more they demonstrated their intentions to remain in STEM fields. Interestingly, adaptive help-seeking and avoidant help-seeking were not predictive of choice. In contrast, expedient help-seeking emerged as a significant predictor of students' choice. Specifically, students who reportedly asked for solutions to problems without explanation or requested others to do their tasks were less likely to take more Engineering courses in the future. These findings indicate that students' attempts to minimize their effort in learning or completing academic tasks could be further manifested in refraining from taking non-mandatory courses.

In prior work, the importance of academic help-seeking has been typically supported by its relations to academic performance (e.g., Karabenick, 2003; Micari and Calkins, 2021). Our findings extend prior work and provide insights into the role of academic help-seeking in promoting students' choice and retention intentions, particularly within STEM fields. Due to the inherently difficult and conceptually complex nature of STEM courses (Koenig et al., 2012; Seymour and Hewitt, 1997), a substantial proportion of students drop out or switch to non-STEM majors (Glass et al., 2013; van den Hurk et al., 2019).

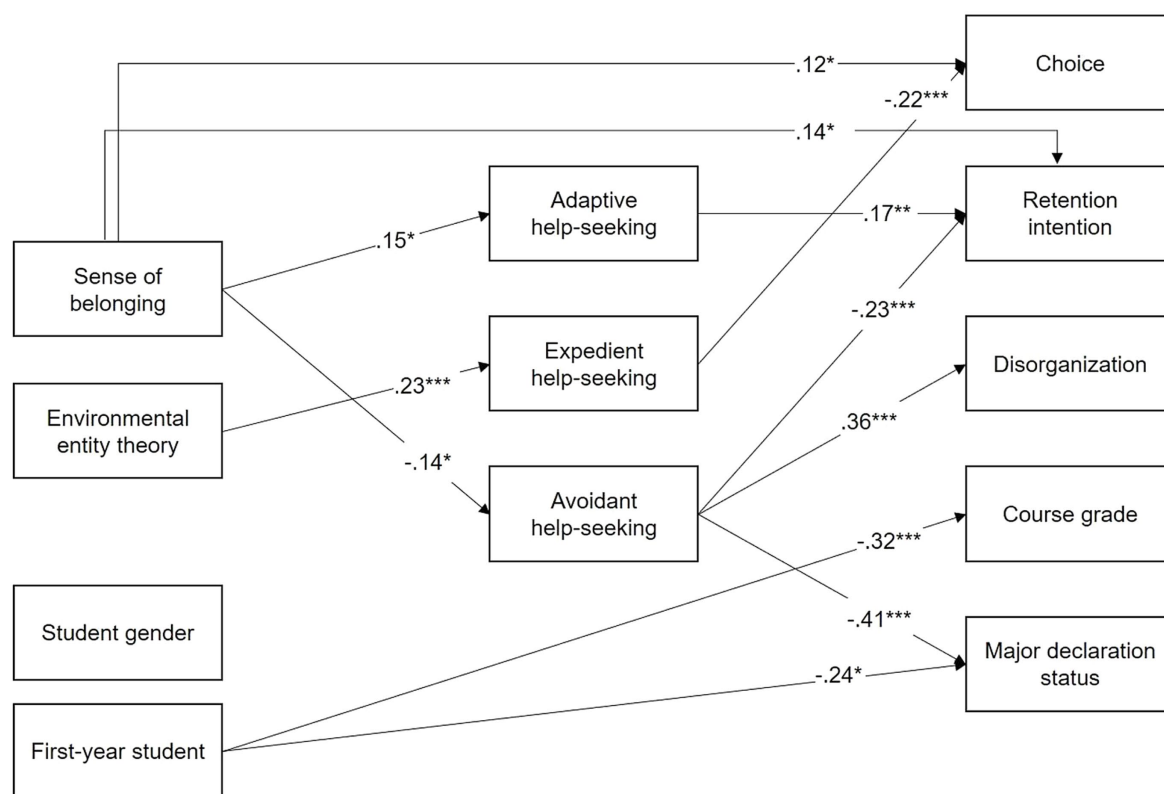


FIGURE 1

Standardized path coefficients from the path model. Only statistically significant paths at $p < 0.05$ are presented. Error terms and residual covariances are omitted for clarity. First-year student (others = 0, first-year student = 1). * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

This issue is further compounded in online environments, where limited instructor interaction and less structured coursework present additional challenges. Given the increasing shift toward online learning in higher education, our findings are particularly promising. Helping students adopt more effective approaches to these learning challenges could promote their choice of courses and retention intentions in STEM fields. Greater focus on the potential role of academic help-seeking in STEM retention is clearly one important direction for future research.

Our findings concerning the relations between students' academic help-seeking and academic performance were somewhat mixed. We examined three different aspects of students' academic performance, including disorganized studying, course grades, and major declaration status. On the one hand, the three types of academic help-seeking did not predict students' course grades. This result stands in contrast to other studies in which academic help-seeking has been found to predict students' course grades (e.g., Micari and Calkins, 2021). On the other hand, students' avoidant help-seeking was positively related to their disorganized studying (i.e., not knowing how to study effectively and what to study for the online Engineering course) and negatively related to their major declaration status. Put differently, students who showed help-seeking avoidance were more likely to report difficulties in studying for the online course and less likely to meet the requirements (i.e., minimum course credits and cumulative GPA) to declare a specific Engineering major.

There are several possible reasons for the mixed pattern of results. First, help-seeking behavior may not have been necessary for success

in a particular course. As noted in prior research, specific course characteristics (e.g., course difficulty, grading) could moderate the relations between help-seeking and academic performance (Credé and Phillips, 2011). Indeed, a meta-analysis study showed that compared to individual course grades, students' use of learning strategies in general had stronger correlations with GPA, which can be deemed a more holistic representation of college students' academic performance (Credé and Kuncel, 2008). Providing support for this speculation, academic help-seeking was significantly associated with students' major declaration status, determined based on their cumulative GPA and course credits, in the present study. Second, as documented in several studies (Credé and Phillips, 2011; Roszkowski, 2013), there might be a curvilinear relationship between academic help-seeking and course grades. Specifically, very high- or low-achieving students are less likely to seek assistance in their learning (Credé and Phillips, 2011; Fong et al., 2023), which might not have been captured in our analysis. Third, the institution's grading policies during the data collection could also have contributed to the mixed findings. Due to the pandemic and students' increased academic stress, the institution switched to a more lenient grading system, which could have masked the differences in students' academic performance. Relatedly, students' avoidant help-seeking was positively related to their disorganized studying. That is, students who avoided seeking help reported more difficulties and ambiguity in their course learning, but the course grades based on the lenient grading system may not have accurately captured them.

Overall, this study provides empirical evidence supporting the pivotal role of academic help-seeking in online STEM learning.

TABLE 3 Estimates of indirect effects.

			β	<i>b</i>	95% bias-corrected bootstrapped CI	
					Lower 2.5%	Upper 2.5%
Sense of belonging	→ Adaptive help-seeking	→ Retention intentions	0.025	0.020	0.002	0.056
	→ Avoidant help-seeking	→ Retention intentions	0.033	0.026	0.002	0.068
		→ Disorganization	−0.050	−0.077	−0.184	−0.004
		→ Major declaration status	0.058	0.055	0.003	0.127
Environmental fixed mindset	→ Expedient help-seeking	→ Choice	−0.050	−0.065	−0.141	−0.022

Specifically, the different types of academic help-seeking related to various aspects of educational outcomes, including students' choice of future courses, retention intentions, disorganization, and major declaration status. Our findings support the conclusion that discouraging help-seeking avoidance could be as important as promoting adaptive help-seeking for students' academic success and retention in STEM fields. To our knowledge, this is the first empirical study to evaluate the three different types of academic help-seeking and link them to students' STEM choice and retention intentions in online learning settings. It is also noteworthy that the present study evaluated the importance of academic help-seeking by utilizing not only students' self-reported responses but also their course grades and major declaration status obtained from academic records at the end of the semester. This use of objective data enhanced the rigor of the findings, providing a more reliable evaluation of academic help-seeking and its significance.

Sense of belonging and environmental fixed mindset as predictors of academic help-seeking

Students' sense of belonging was positively associated with their reported use of adaptive help-seeking. That is, when students perceived that they were an essential part of the Engineering community and were accepted and supported by the community members, they were more likely to ask for assistance or explanation that could ultimately promote their understanding of course material. This finding is consistent with one recent study showing the positive link between sense of belonging and adaptive help-seeking (Won et al., 2021) and, more broadly, prior work documenting the relations of teacher support and classroom peer climate (Ryan et al., 2005; Ryan and Shim, 2012; Shim et al., 2013), as well as instructor relatedness and peer relatedness (Oh et al., 2024), with adaptive help-seeking. In contrast, sense of belonging was negatively related to students' avoidant help-seeking. The more students perceived sense of belonging in their Engineering community, the less they reportedly avoided asking for help when needed. This finding adds to prior work showing that students with higher levels of avoidant help-seeking reported lower levels of teachers' academic and emotional support (Ryan et al., 2005) and lower peer relatedness (Oh et al., 2024), which is necessary for building sense of belonging (Allen et al., 2018).

In addition to sense of belonging, this study also found the significant role of environmental fixed mindset in predicting college students' expedient help-seeking. When students perceived that their instructors and peers in the Engineering community view Engineering

intelligence or ability as a fixed trait, they were more likely to ask for solutions to problems without explanation or ask others to do their tasks. This finding could be explained by the well-established associations between threat to self-esteem and help-seeking reported by prior research (Arbreton, 1993; Karabenick and Knapp, 1991; Newman and Schwager, 1993). For students who perceived high levels of environmental fixed mindset, asking for help from others could be attributed to a lack of ability (Blackwell et al., 2007; Hong et al., 1999), which they view as a threat to their self-esteem. This attribution leads students to concentrate on external indicators of success, focusing on completing tasks rather than developing a deeper understanding of the material (Dweck and Leggett, 1988). Thus, these students may prioritize expedient work completion, such as obtaining answers from others when they do not understand their tasks and need assistance.

Notably, students' environmental fixed mindset was not associated with their avoidant help-seeking, which was a somewhat unexpected finding. We suspected that similar to performance goal structure, environmental fixed mindset may have led students to adopt performance goals. When students perceive performance goal structure, an emphasis on abilities, grades, or social comparisons, they tend to focus more on getting good grades rather than on learning and task mastery (Meece et al., 2006). Under such a circumstance, avoiding help-seeking does not help as they still need to obtain answers and complete their work. Considering the positive associations between performance goals and students' engagement in surface learning reported in prior research (Dupeyrat and Marine, 2005; Elliot et al., 1999; Greene and Miller, 1996), students with high environmental fixed mindset could still care about completing their task but not necessarily actual learning. Therefore, environmental fixed mindset may not contribute to students' avoidance of help-seeking. Prior research has documented the relations between perceived performance goal structure and expedient help-seeking (Karabenick, 2004; Ryan et al., 1998), yet our speculation should be examined in future research.

Sense of belonging and environmental fixed mindset and their relations to adaptive, expedient, and avoidant help-seeking lend support to the conclusion that students' perceptions of learning contexts could inform if and how they seek help in their learning. As researchers pointed out (Karabenick and Berger, 2013; Ryan et al., 2001), students' cognitive capabilities to monitor and reflect on their performance alone cannot explain students' decision to ask for help or not. Academic help-seeking is a socially mediated self-regulated learning strategy in which students use other social figures as a resource to secure necessary assistance for their optimal learning. Our findings highlight the importance of academic and social contexts in

which students are situated for understanding their academic help-seeking.

More broadly, our findings align with prior work indicating that sense of belonging and environmental fixed mindset could facilitate students' engagement in self-regulated learning. Specifically, sense of belonging has been linked to students' motivation and their use of self-regulatory strategies (e.g., Goodenow, 1993; Goodenow and Grady, 1993; Kennedy and Tuckman, 2013; Won et al., 2018), both of which are major components of self-regulated learning (Pintrich and Zusho, 2007). Our findings contribute to the literature by demonstrating the role of sense of belonging in academic help-seeking. Similarly, research has shown that individuals' growth mindset is positively associated with adaptive patterns of motivation and self-regulatory strategies (Blackwell et al., 2007; Burnette et al., 2013; Yeager and Dweck, 2012), as it encourages students to embrace challenges and persist in the face of difficulties. This study extends this line of research by revealing that students' perceptions of their instructors' and peers' mindsets could also play a role in shaping self-regulated learning.

Another noteworthy contribution of this study is to evaluate the role of sense of belonging and environmental fixed mindset within online learning contexts. Specifically, our findings are the first to link sense of belonging and environmental fixed mindset to academic help-seeking in online learning settings. A few studies have explored contextual factors predicting students' academic help-seeking in online learning contexts. Guided by achievement goal theory (Meece et al., 2006), for instance, Er (2016) provided valuable insights into the importance of fostering mastery goal structures for students' academic help-seeking in online learning. The present study extends this line of work by documenting that sense of belonging and environmental fixed mindset could serve as additional critical contextual factors promoting or hindering students' strategic engagement in online learning.

Our findings also contribute to the literature on STEM education. As noted in prior work, a fixed mindset is particularly pervasive in STEM fields (Leslie et al., 2015; Lytle and Shin, 2020). There are common stereotypes, such as pursuing STEM requires innate abilities, or innate talent is necessary for success in STEM fields. As such, students in STEM fields are more likely to perceive that their instructors and classmates endorse such beliefs (i.e., environmental fixed mindset), which possibly leads them toward expedient help-seeking strategies by focusing only on copying answers and completing tasks but not understanding learning materials or task mastery. Our findings suggest that these pervasive stereotypes in STEM fields might be one factor contributing to the high dropout rate and require intervention to promote students' retention and choice in STEM education.

Mediating role of academic help-seeking

Consistent with our expectations, academic help-seeking served as a mediator linking sense of belonging to retention intentions, disorganization, and major declaration status. That is, students' perceived belongingness to their Engineering community was related to greater adaptive help-seeking and lesser avoidant help-seeking, and this pattern of academic help-seeking was, in turn, associated positively with students' retention intentions in STEM fields and

successful progression in engineering programs and negatively with disorganized studying. Prior research has consistently shown that sense of belonging plays a pivotal role in college students' choice, persistence, and academic performance (e.g., Hausmann et al., 2007; Lewis and Hodges, 2015; Pittman and Richmond, 2007). Indeed, several studies have documented the importance of sense of belonging in STEM retention (Good et al., 2012; London et al., 2011). Our findings provide insights into one possible mechanism explaining the relations between sense of belonging and STEM retention.

Academic help-seeking also significantly mediated the relations between perceived environmental fixed mindset and students' choices of future Engineering courses. Specifically, when students perceived that their Engineering instructors and peers deemed Engineering intelligence a fixed entity that is difficult to change or develop, they were more likely to minimize the effort required to increase their understanding and task mastery by asking for answers to problems without explanation or asking others to perform the task instead. In turn, the minimized effort in course learning was further linked to minimized effort in taking future Engineering courses. Students reportedly avoided taking more Engineering courses, particularly if they were not mandatory. These findings are partially supported by prior research reporting the indirect effects of environmental fixed mindset on college students' intent to pursue math in the future (Good et al., 2012).

In sum, our findings suggest that academic help-seeking could be one possible pathway through which sense of belonging and environmental fixed mindset promote or hinder students' choice, retention intentions, and academic performance. More broadly, our findings also fit models of self-regulated learning well. In most models of self-regulated learning rooted in social cognitive theory, social and contextual factors are assumed to influence educational outcomes through self-regulatory processes (Pintrich and Zusho, 2007). Consistent with this theoretical assumption, several studies have provided empirical evidence showing the mediating role of self-regulatory processes. Specifically, perceived instructional practices and teacher support have been linked to students' academic success via their use of various self-regulatory strategies (e.g., Wang and Holcombe, 2010). Our findings support and extend this mediating role of self-regulatory processes by showing that academic help-seeking could be used to understand the indirect effects of sense of belonging and environmental fixed mindset on students' choice, retention intentions, and academic performance in STEM fields.

Our findings also offer practical implications for STEM educators. First, to encourage students to seek assistance when needed, instructors may consider focusing on cultivating students' sense of belonging. Specifically, STEM instructors could adopt teaching practices that encourage mutual respect, caring, and fairness, which help students feel accepted and connected (Allen et al., 2018), to promote students' academic help-seeking and ultimately their academic success. In addition, instructors could aim to enhance students' perceptions of teacher presence, which is considered important for developing positive relationships with teachers and peers in online settings (Rapanta et al., 2020). Second, addressing STEM students' beliefs about their peers' and instructors' mindset may be another lever for promoting help-seeking strategies. As noted, stereotypical beliefs that STEM ability and intelligence are innate are

common in STEM fields (Lytle and Shin, 2020). Thus, STEM instructors could consider fostering environmental growth mindset by communicating growth-oriented messages and providing instructional practices that encourage students to take on challenges and embrace mistakes as part of the learning process (Yeager and Dweck, 2020).

Limitations and future directions

Our findings and conclusions should be understood within the context of at least three limitations. First, one limitation of the present study is the correlational and cross-sectional nature of the data. Although we postulated the predictive relations and the ordering of the constructs in the path model based on theory and prior findings, the opposite direction of predictive relations remains a plausible possibility. For instance, students who had already had high levels of intentions to remain in STEM fields might have asked for assistance necessary for learning. As such, our findings need to be replicated and strengthened by future research using experimental or longitudinal data.

Second, we relied on students' self-report to assess academic help-seeking. Although widely used in assessing diverse aspects of self-regulated learning (Wolters and Won, 2017), criticisms of using self-report instruments and concerns over their validity are not uncommon (Karabenick and Zusho, 2015). It is also noteworthy that several different methods have been developed and introduced to assess self-regulated learning, including observing and recording students' self-regulatory behaviors in classroom settings and recording traces of students' self-regulatory behaviors in technology-enhanced learning environments (Azevedo and Gašević, 2019). Examining the reported relations using such observation or trace data represents an obvious path for future research.

Third, it should be noted that the sample size in our study was relatively small, and as a result, we had to perform path analyses. Due to the number of parameters that need to be estimated (Kline, 2011), we were unable to conduct structural equation modeling, which has several notable advantages, such as using latent variables and accounting for measurement errors. Relatedly, participants were recruited from a single course, which may limit the generalizability of our findings. Although all Engineering major students are required to take this introductory first-year course, it is possible that students may exhibit different patterns of help-seeking in other courses. Therefore, future research with larger, more representative samples is needed to conduct a more rigorous test using structural equation modeling and to generalize our findings.

Conclusion

Despite these limitations, the present study offers initial insights as a preliminary investigation that focuses on the role of academic help-seeking, particularly in online STEM learning. The present study provides empirical evidence suggesting that students' academic help-seeking could play a significant role in online STEM learning. In particular, this study expands the existing knowledge by showing its potential for promoting STEM choice, retention

intentions, and major declaration. Additionally, our findings suggest that students' social membership in their Engineering community and their perceptions of the community members' views on Engineering intelligence and ability could inform if and how students ask for help and assistance in their learning. This study also revealed a pathway through which sense of belonging and environmental fixed mindset are related to students' choice, retention intentions, and academic performance in STEM fields. However, given the presence of non-significant results and some hypotheses that were not supported, further research is needed to strengthen these findings and explore their broader implications. Overall, our findings support the conclusion that academic help-seeking could be considered among the growing array of factors that are increasingly recognized as critical influences on students' online learning and STEM retention, and therefore a critical area of continued research.

Data availability statement

The data presented in this article are not available due to privacy concerns and the lack of participant consent for public sharing. Further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by the Human Research Ethics Board (HREB) at the University of Victoria. The studies were conducted in accordance with local legislation and institutional requirements. Written informed consent was obtained from the participants themselves, but not from their legal guardians or next of kin, in accordance with the national legislation and institutional requirements, as the University of Victoria's guidelines permit competent youth aged 17 to 18 to consent to their participation in research studies without parental or guardian approval.

Author contributions

SW: Writing – original draft, Writing – review & editing, Conceptualization, Data curation, Formal analysis. YC: Writing – original draft, Writing – review & editing, Conceptualization.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Peer assessment to promote self-regulated learning with technology in higher education: systematic review for improving course design

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Peer assessment is one of the approaches to develop self-regulation of learning. When evaluating the work of peers, metacognitive strategies of critical reflection are employed. They improve their own learning especially if evaluative feedback and/or suggestions for modification are provided. The aim of this systematic review is to learn how technology can facilitate self-regulation of learning, using peer assessment activities. We focus on higher education. To achieve the objective, we searched WoS and Scopus, obtaining 15 publications that concatenate the four search terms: self-regulated learning, peer assessment, higher education, and technology. These four terms must appear in the title, abstract or keywords. In this way, we ensure that the topic to be reviewed is central to the publication. The results are analyzed using the model for systematic review, which has three phases: description, synthesis, and critique. A proposal has been made to improve the design of courses in virtual classrooms, focusing on Moodle, and to include peer evaluation to improve self-regulated learning. It highlights the possibility of virtual classrooms to configure a rubric to guide the evaluation, together with the request for mandatory comments to justify the evaluation. This helps the student reflect on what is wrong and why, and how to improve. It also highlights the facility to randomly assign a specific number of tasks per reviewer or per task, and to make the whole process completely anonymous. The technology allows short deadlines for submission and review times to be maintained for instant feedback, as it can be configured with a single click. Finally, and related to this, Moodle can reopen the submission phase, to send an improved version based on feedback, and the evaluation phase, to check that the proposed improvements have been made. This helps to a greater extent to apply metacognitive strategies.

KEYWORDS

peer assessment, self-regulated learning, higher education, Moodle, technology

1 Introduction

Lifelong learning has been included as one of the Sustainable Development Goals (SDGs) (United Nations, 2023) to face the complex context in which we find ourselves in the 21st century. To this end, the European Commission proposed the Learning to Learn competence to achieve lifelong learning (Hoskins and Fredriksson, 2008). And, as Lluch and Portillo (2018) state, self-regulated learning (SRL) is essential to develop it in higher

education. SRL is a process composed of thoughts, emotions and planned actions aimed at achieving a personal goal, that is, a set of strategies that students can activate when working toward their goals (Zimmerman, 2002). Thus, SRL enables students to manage their own learning process.

One of the ways of working on SRL is through Peer Assessment (PA), which refers to the analysis and assessment of the quality of a peer's product or performance, through a process of critical reflection (Roberts, 2006; Topping, 2009). The level of reflection will depend on whether the peer assessment consists only of proposing a score on the quality of the work. This is known as summative PA, or if it includes feedback derived from that reflection, formative PA. Feedback is no longer seen only as a process of transmitting information. Thus, we now also find a new focus on learning (Winstone et al., 2022). Black and Wiliam (2009) propose feedback in formative assessment as the information that enables students to advance in their learning. Considering that feedback is a key element in instruction because of its high effectiveness, different approaches have been proposed to study how to deal with feedback in the classroom.

Thus, adopting a formative approach to PA enables students to develop metacognitive skills, helping each other to identify strengths and weaknesses, and to plan and guide their learning (Topping, 2009). Metacognition includes knowledge, related to process evaluation, and metacognitive skills, related to feedback mechanisms that facilitate action planning and performance evaluation (Veenman et al., 2006). Metacognition has been shown to be a fundamental component of self-regulated learning, including processes such as goal setting, planning, progress monitoring and reflection (Azevedo and Gašević, 2019).

Peer feedback in these activities refers mainly to the performance of the task, but also to the process and even formal aspects of writing. This leads to improvements in the task and in future learning (Ion et al., 2016). Therefore, most studies tend to assume a formative PA (Alqassab et al., 2023). In this case, feedback becomes feedforward, which can be positive or negative, and, if negative, must be accompanied by proposals for improvement (Topping, 2018).

This results in students employing advanced-level metacognitive strategies to provide feedback during peer assessment, especially if they are asked to provide evaluative comments and/or suggestions for modification on the assessed work (Liu and Lin, 2007). Furthermore, Van Helden et al. (2023) have been able to conclude that, in many cases, PA promotes a better understanding of the assessment criteria. Consequently, this improves judgement and quality of feedback comments. Thus, students can learn from the feedback provided by their peers, but also through metacognitive reflection by having to justify what they have done (Liu and Carless, 2006).

For this reason, the application of metacognitive strategies during feedback facilitates SRL (Butler and Winne, 1995; Winne, 1996). Moreover, this reflection will be enhanced if it is implemented together with a backward evaluation process, which consists of the evaluated student assessing the feedback received from his or her reviewer. This helps the student to reflect on their work and use it to improve the assessed product (Misiejuk and Wasson, 2021).

At this point, the design of PA activities must take into account the results found so far in the literature. On the one hand, Van Zundert et al. (2010) have seen how the training and experience that students had when carrying out PA influenced the quality of the activities, so that some kind of training is necessary to be successful in this type of activities. In order to improve feedback processes, it is necessary to develop more effective processes based on teacher feedback literacy. With teacher feedback literacy, an approach based on shared responsibility between teachers and learners can be achieved (Carless and Winstone, 2023). This is the only way to develop feedback literacy in students, so that they are able to deal adequately with task assessment.

Students' feedback literacy involves developing the ability to take advantage of feedback opportunities by actively participating in feedback processes (Malecka et al., 2022). To this end, these authors propose three mechanisms to be taken into account in the curriculum: eliciting, processing, and enacting feedback. For example, it has been shown to be important for students to manage their perceptions and attitudes, as well as to have greater confidence and agency in the feedback process (Little et al., 2024). One technique to achieve this is the co-assessment of examples that would help students develop feedback literacy (Carless and Boud, 2018).

On the other hand, Panadero and Alqassab (2019) have concluded that, according to the studies reviewed, anonymous PA improves students' perception of the value of the learning provided through PA. This is because feedback is more critical and tends to lead to higher achievement, especially in higher education. If, in addition, authors are paired with reviewers with similar performance, self-regulation will be more effective (Zhang and Schunn, 2023).

All this should have an impact on the improvement of the activity, not only for students to learn through the help they receive from their peers. The useful activity should be used for metacognitive reflection. This means asking what they need to learn in order to apply it to the activity, what is important, how they should apply it, why it can be useful to them, and so on. At this point, it is important to consider the possibilities of PA to improve the self-regulation of their own learning, so we will focus on reviewing the literature on PA as a resource for improving SRL.

Currently, technology can be a great ally for the use of PA, as different tools can be used such as dedicated web-based PA system, Learning Management Systems (LMS), social media or mobile application (Zheng et al., 2019). LMSs, such as Moodle, are widely used in online university courses (Gamage et al., 2022), but can be applied to any modality that wants to benefit from a virtual classroom. Although originally used as after-class tools, technology-facilitated PA activities are increasing within the classroom (Fu et al., 2019).

Therefore, to ensure the benefits of PA, and to provide the necessary scaffolding, as Goh et al. (2019) argue, the Moodle workshop activity allows all these elements to be incorporated, by introducing examples in the workshop itself. It also provides assessment guidelines, such as the use of rubrics, which include the possibility of adding feedback comments with a formative approach. In addition, it facilitates the distribution of work among many students in a random and anonymous way.

In addition, to facilitate SRL, technology has enabled the development of the Open Learner Model (OML) (Hooshyar et al., 2020). This design facilitates the organization, monitoring, and regulation of learning in virtual environments, thanks to internal feedback through self-assessment of their learning. And, additionally, through external feedback such as from the teacher or peers (Chou and Zou, 2020). This is important because one of the weaknesses of higher education students in virtual environments is knowing how to identify the knowledge of objectives and assessment criteria (Ortega-Ruipérez and Castellanos-Sánchez, 2023), which is necessary to provide good feedback in PA activities.

Good technology design can also help in improve the quality of skills such as argumentative writing, according to Noroozi et al. (2023). This is because, if PA feedback is presented in an appropriate way, it can facilitate reflection to improve original work in situations with the backward assessment process (Misiejuk and Wasson, 2021).

This systematic review aims to account for how technology can facilitate SRL, that is, the ability to reflect on tasks, through PA activities. For this reason, the research questions that define the focus of the research are related to how technology can support PA to facilitate SRL in higher education. Firstly, a question is posed about the current state of research on the topic, as we intend to focus solely on virtual environments. Secondly, we aim to collect and provide guidelines to guide the design of PA activities to facilitate SRL in technological environments.

2 Materials and methods

It is a systematic review because it follows a specific protocol, uses an explicit and reproducible method, and attempts to critically appraise and synthesize the subject matter. Specifically, this review includes a narrative synthesis, an approach to systematic review that attempts to synthesize the findings of multiple studies (Popay et al., 2006). As confirmed by these authors, a systematic review with a narrative synthesis usually contains a limited number of publications, unlike other approaches such as meta-analysis. The possibility of focusing on a smaller number of publications makes it possible to select only those that best address the topic for a more adequate critical analysis. For this systematic review of the most relevant literature on the topic addressed, a five-stage analysis protocol was followed, similar to that of other systematic reviews on educational innovation topics (Ramírez and Lugo, 2020; Gros and Cano, 2021).

In phase 1 the research questions have been posed, concerning the analysis of how technology can support PA to facilitate SRL in higher education. Firstly, a question is posed about the current state of research on the topic, and secondly, a question is posed to answer with appropriate guidelines to guide the design of PA activities to facilitate SRL.

RQ1: what is the state of the literature on how peer assessment facilitates self-regulated learning?

RQ2: what design guidelines for peer assessment activities can we follow for our students to enhance their self-regulated learning?

In phase 2, the search process was established. Using the Web of Science and Scopus databases, the search was limited to articles from the last 10 years (2014–2023). A time frame

TABLE 1 Summary of the number of selected papers.

	Scopus	WoS	Total
SS1. PA + SRL	106	131	237
SS2. PA + SRL + Higher education	45	55	100
SS3. PA + SRL + Higher education + Technology	13	14	27

of 10 years was considered appropriate because we believe that this last decade can be considered the inclusion and popularization of virtual classrooms in higher education. A Search String (SS) has been performed for the search in “Article title, Abstract, Keywords” combining the selected words, and adding a new filter in each iteration: Peer assessment/Peer feedback + Metacognition/Self-regulated learning/Self-regulation of learning + Higher education/Tertiary education/University + Technology/Moodle.

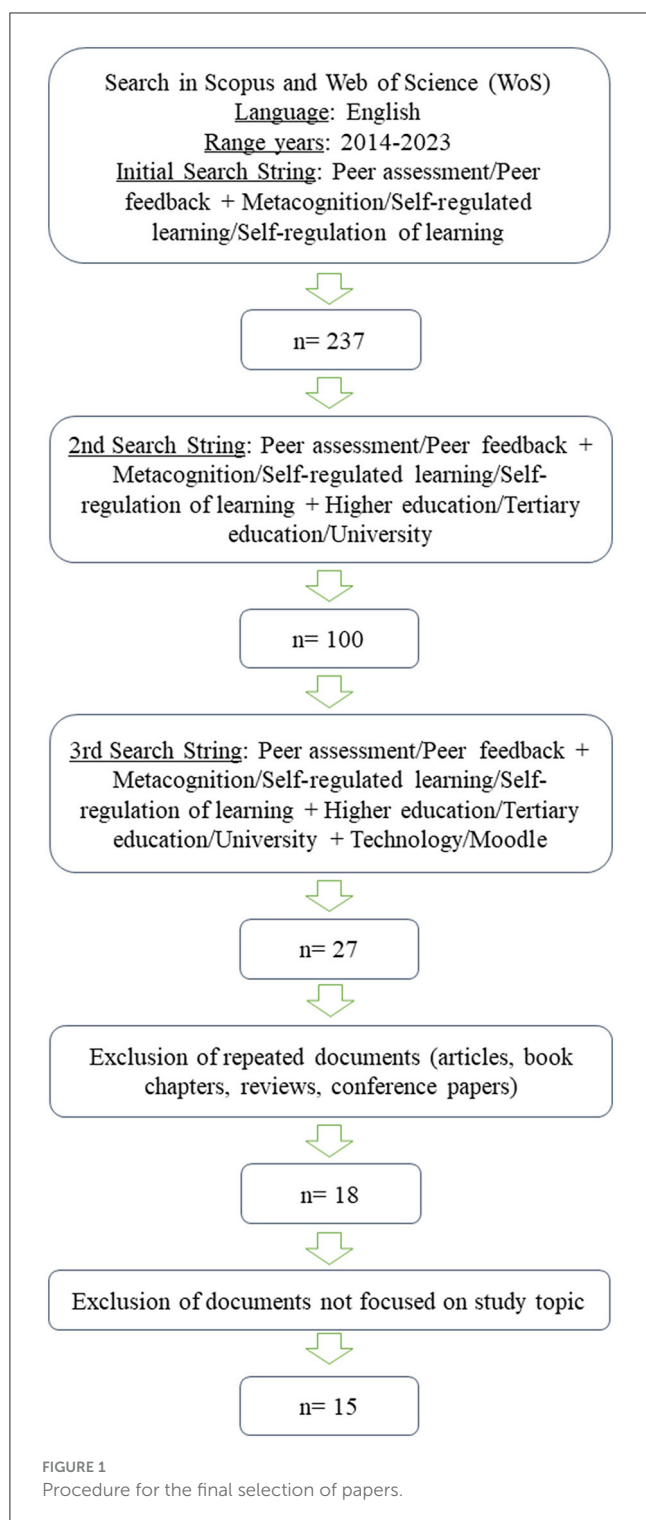
It is important to start the search by combining two keywords (Peer assessment + Self-regulated learning), as our study focuses on how the former can benefit the latter. In this way, SS1 has collected the following search criteria: (“peer assessment” OR “peer feedback”) AND (“self-regulated learning” OR “self-regulation of learning” OR metacognition).

Subsequently, the educational stage has been added because it is understood that the design of the activities may be different depending on the age of the students. Thus, SS2 includes the above search criteria plus the one relating to higher education: (“peer assessment” OR “peer feedback”) AND (“self-regulated learning” OR “self-regulation of learning” OR metacognition) AND (“higher education” OR “tertiary education” OR university).

Finally, the keyword on technology is included to obtain only those studies that incorporate it. In this way, the Search String was finally three. The final SS3 search has therefore included all important search criteria to answer the research questions: (“peer assessment” OR “peer feedback”) AND (“self-regulated learning” OR “self-regulation of learning” OR metacognition) AND (“higher education” OR “tertiary education” OR university) AND (technology OR Moodle).

The summary of the articles found in each one can be seen in Table 1. The result was 27 articles. Before continuing with the next phase, we proceeded to detect the articles that were repeated in both databases, detecting a total of 9, so that the number of articles for the first review was finally 18.

In phase 3, two additional criteria were defined for the inclusion or exclusion of articles after reading the abstracts. We proceeded to (1) exclude articles that were not relevant to the object of study, as they had other objectives and in which self-regulation of learning through PA was not the central element. After this screening, 15 articles were left. And (2) only those related to the use of technological tools that allow the design of activities similar to those allowed by an LMS, such as Moodle, were selected, i.e. the results can be applied to any virtual classroom. In this case, it has not been necessary to eliminate any article, as it has been possible to draw some procedure or conclusion for the review of all of them. The evaluation of the selected studies has not always



followed the same approach. However, all of them address the use of technology to facilitate peer assessment in higher education as their main theme, and all of them show the positive aspects to be taken into account for an optimal use of technology. Therefore, the final number of articles analyzed was 15 (Figure 1).

It is important to note here that this is a systematic review that attempts to address a very specific topic. Therefore, we have

preferred to have fewer articles, but to ensure that the articles reviewed allow us to fully answer the research questions. Thus, these 15 articles allow us to answer how a technological tool in higher education can simplify peer assessment to facilitate self-regulated learning. This is considered a sufficient number of articles as a starting point to move forward on this topic. In line with Popay et al. (2006), by including a narrative synthesis of the systematic review, a small number of articles is proposed. This allows to focus on the publications that best address the two research questions posed on the topic.

The selected articles are representative and of high quality, as the search has been carried out only in the most reliable databases: web of science and Scopus. In addition, all these publications have passed a rigorous blind peer review process, in which experts in the field have decided that these publications add value to the topic of peer review. Therefore, we did not want to discard any of them, regardless of whether they are journal articles, book chapters or conference papers. In the case of conference papers, not only an abstract of an experience is found, also the experience is expanded in the selected publication through results that demonstrate the usefulness of the experience.

In phase 4, data selection and extraction was done in an Excel document (*omitted for blind review, data in figshare*), trying to systematize the information around some important questions for the consideration and generalizability of the results of the reviewed articles: sample size, duration (<1 week, 2–5, 6–10, more than 10), technology (web, LMS or social media), assignment (system, professor, students), evaluation method (quantitative, qualitative, both), with or without scaffolding, organization (group, individual), number of evaluators per task, number of tasks per evaluator, course modality (in-person, blended, online). No other variables were considered relevant given the narrative nature of this systematic review.

Finally, in phase 5, the tripartite model for systematic review (Daniel and Harland, 2017) was applied. First, a description of the results of each of the 15 selected contributions was made, then a synthesis of the most important contributions was elaborated, and finally, a critique of applications to compile guidelines for the design of PA activities with technology, specifically oriented to a LMS, such as Moodle. The critique is presented as the discussion of results, as the guidelines obtained relate to the results of previous research.

3 Results

3.1 Description

First, a summary table (Table 2) has been prepared with the basic information of the 15 selected articles. Secondly, after a detailed reading each of the publications, the most important information provided by each article for our purpose, i.e., how PA can facilitate SRL in students, is described. Also, in some cases, the procedure of how the PA has been carried out has been included in the synthesis, as it has been considered important to consider some key aspects of the design of PA activities that have proved to be useful for SRL.

TABLE 2 Summary of contributions on our topic in each publication.

Year	Authors	Type of contribution	Title
2014	Janson, A.; Ernst, S.J.; Lehmann, K. and Leimeister, J.M.	Conference paper	Creating awareness and reflection in a large-scale IS lecture - The application of a peer assessment in a flipped classroom scenario
2015	García-Jiménez, E.	Article	Assessment of learning: From feedback to self-regulation. The role of technologies
2015	García-Jiménez, E., Gallego-Noche, B., and Gómez-Ruiz, M.Á.	Book chapter	Feedback and Self-Regulated Learning: How Feedback Can Contribute to Increase Students' Autonomy as Learners
2015	Hsu, P.L., and Huang, K.H.	Book chapter	Evaluating online peer assessment as an educational tool for promoting self-regulated learning
2016	Marín, V.I., and Pérez, A.	Book chapter	Collaborative e-Assessment as a Strategy for Scaffolding Self-Regulated Learning in Higher Education
2016	Ng, E.M.	Article	Fostering pre-service teachers' self-regulated learning through self-and peer assessment of wiki projects
2016	Raposo-Rivas, M. and Gallego-Arrufat, M.J.	Article	University students' perceptions of electronic rubric-based assessment
2017	Albano, G., Capuano, N., and Pierri, A.	Article	Adaptive peer grading and formative assessment
2017	Blau, I. and Shamir-Inbal, T.	Article	Re-designed flipped learning model in an academic course: The role of co-creation and co-regulation
2019	Fernández-Ferrer, M. and Cano, E.	Article	Feedback experiences to improve the continuous assessment: the use of Twitter as an emerging technology
2020	Roman, T.A., Callison, M., Myers, R.D., and Berry, A.H.	Article	Facilitating Authentic Learning Experiences in Distance Education: Embedding Research-Based Practices into an Online Peer Feedback Tool
2020	Swartz, B.	Conference paper	'Assessment as Learning' as a tool to prepare engineering students to manage ill-defined problems in industry
2020	Wang, Y.H.	Article	Design-based research on integrating learning technology tools into higher education classes to achieve active learning
2023	Zhu, H., Li, N., Rai, N.K., and Carroll, J.M.	Article	SmartGroup: A Tool for Small-Group Learning Activities
2023	Lluch, L. and Cano, E.	Article	How to Embed SRL in Online Learning Settings? Design Through Learning Analytics and Personalized Learning Design in Moodle

Janson et al. (2014) propose the design of their PA focused on supports interaction for awareness and reflection, and thus, improving learning outcomes. Regarding the procedure, after preparing the material with flipped classroom, students propose solutions in groups, and they have to comment on the proposals of the other groups. After receiving feedback from the other groups, each student must reflect individually on the strengths and weaknesses of their proposals, in order to revise and improve them based on the feedback.

García-Jiménez (2015) makes a proposal based on the literature on how the teacher should guide reflection on learning at the

beginning, giving more and more protagonism to the students. After this first scaffolding step, peers guide and monitor the process of student' reflection on their learning and its outcomes, to provide feedback on whether the reflection is sufficient and appropriate.

García-Jiménez et al. (2015) review and discuss how the PA helps students to understand what is required of them in the task, as it is necessary analyze and discuss the elements of the task in order to assess. If teachers allow students to participate in the design of assessment tasks, criteria and benchmarks, it improves their understanding so that they can assess with quality. In other

words, teachers should not impose assessment criteria, but listen to how students interpret what they mean until they understand them. This is very important for the development of SRL, i.e., that they understand that building feedback for their peers is more important than receiving it. Constructing feedback that allows the peer to progress in their learning, feedforward, will help the learner to identify strategies to improve their learning. In addition, receiving good feedback will encourage the learner to maintain or modify their effort on the task. At this point, technology can facilitate an appropriate interaction, a dialogue, between assessor and assessed, so that personalized feedback is achieved to promote SRL. Finally, they point out that technology can also provide feedback in different formats in addition to written feedback, which can facilitate its reception.

Hsu and Huang (2015) found that, in PA, grading was quite similar to teacher grading, more realistic than self-assessment. PA was positively valued in two ways: when students receive peer evaluation, even when the feedback is negative, it helps them to be reasonable and appreciate the possibilities for improvement; and in relation to SRL, when students evaluate, it helps them to compare with their work, to know where not to make mistakes and to improve their work. Moreover, to improve SRL, PA feedback is better than giving a mark, but it should be guided so that they learn to reflect well on what is expected from the task. Written feedback can be misinterpreted, so it is recommended to accompany it with face-to-face feedback.

Marín and Pérez (2016) used PA in preservice teacher training, using the Moodle tool to facilitate PA, with formative assessment strategies and feedback management. In the last phase of the Moodle workshop activity, they added an activity in which students had to self-assess and reflect on the feedback received in their e-portfolios. By reflecting on their work from the perspective of others, they were able to become aware of how to improve their work, a phase in which they work from an SRL perspective. Furthermore, in this experience, a weight was assigned to take account in the course grade, as the average of the evaluations of 3 peers is quite close to the one given by the teacher. One aspect that they consider necessary to implement in future proposals is a new “Conferencing” phase (Reinholz, 2016) so that they can discuss with their peer evaluators. These authors do not consider technology in this new proposed phase, so it would be necessary to see how to make the first part of the PA anonymous, and then know the identity of their assessors for the new phase.

Ng (2016) proposed the PA for the evaluation of wikis created by working groups, which were presented in a class to the rest of the groups. A representative from each assessing group was asked to give at least one positive observation and one suggestion for improvement via Moodle. Moreover, each student had to complete a rubric within 3 days of the presentation. Afterwards, each group reviewed all the feedback received to improve their work. In conclusion, although some did not find Moodle a good setting for providing feedback, they did note that in direct interactions they were unwilling to challenge themselves, so anonymous interaction through technology did help to provide more critical feedback.

Raposo-Rivas and Gallego-Arrufat (2016) highlighted, like other studies reviewed, a greater understanding of the evaluation

process when carrying out PA. In this case, a tool is used to assess competences and knowledge of other group members, but it is not done anonymously, so the comments reveal an assessment based on cronyism rather than criticism.

Albano et al. (2017) consider that PA has contributed to strengthening the development of students’ explanation and argumentation processes. By grading, they are also assessing their own learning. On the other hand, by using a method of triangulating the grades of 3 peers beyond the arithmetic mean (giving more weight to the most similar grades), the quality of the grading is usually adequate. In some specific cases, the teacher must intervene to provide high quality assessments, easily applicable in Moodle.

Blau and Shamir-Inbal (2017) proposed a PA in which the procedure included three phases: first reviewing an example in pairs critically, then assessing their task based on evaluation criteria, and finally evaluating the results of their peers, proposing questions and suggesting improvements. Metacognitive thinking thus occurred before PA, as a way of monitoring of learning. During PA, SRL was also produced by applying critical thinking during the analysis of other tasks, which they used to learn. At first they had difficulty keeping up and did not learn, but later they learned to self-organize in order to learn independently and flexibly.

Fernández-Ferrer and Cano (2019) carried out PA activities in all the topics of the subject and observed an improvement in quality after each iteration. They conclude that both their PA and the feedback received from peers have been useful for their own learning, as they have improved the relevance of what is requested in the assignment.

Roman et al. (2020) developed a tool for PA that allows comments to be added next to the assessed content, making it easier to know what each comment refers to. In this tool, different assessors evaluate a task, over several iterations. Being able to receive multiple perspectives on the work over several iterations, helped to further challenge the content and the task, resulting in more useful feedback to apply to future tasks (feedforward). An improvement over an LMS is that students must incorporate feedback from all peers, one by one (in LMS they paid more attention to some comments than others).

Swartz (2020) proposed solving 2 ill-defined problems, and the PA consists of metacognitively reflecting on the partner’s proposed outcome and helping the partner to continue solving. The lack of scaffolding meant that many students focused on figuring out how to use the tool, or how or when to provide feedback, and could not focus on reflecting and helping to solve the ill-defined problem. According to the results of the feedback collected from participants, in order to improve the “assessment as learning” approach so that SRL could be fostered, a second round of feedback and further extension of learning should be included.

Wang (2020) conducted two phases of the study: in the first phase, each student was required to provide feedback to the groups presenting the project (in the middle of the project and at the end of the project) by submitting a comment for discussion at the end of the presentation. In the second, feedback came from the learning journals anonymously. Students felt that the first phase was more useful for self-regulating their learning, as it was instantaneous. However, they also mentioned that the feedback in

the second phase could be more critical and comprehensive because it was anonymous. The third phase, with instant and anonymous feedback, was the most highly rated, as it was the most helpful for self-reflection.

Zhu et al. (2023) sought to exploit the metacognitive advantages of PA, which is assessed immediately after task submission, thus providing critical and comprehensive feedback. It was especially useful for lower-achieving students, in whom a greater improvement was observed. In designing the programme, the first update was to be able to keep the students in the same working groups, so that iterations could be applied gradually until the final product was achieved.

Lluch and Cano (2023) decided to include different activity options in Moodle for their PA activity. In addition to the workshop, the activity par excellence for PA in Moodle, they included forums to discuss the assessment criteria, and to improve understanding of why and for what purpose PA is introduced; open questionnaires to encourage self-regulation (objectives, planning, etc.); forms to integrate changes in the activities; and questionnaires to explain actions on the following phases. They end the activity with a reflection phase that enhances SRL after PA, including a final task, with the new version of the activity including improvements based on the feedback. After their experience, they conclude that SRL, associated with the Learning to Learn competence, should be developed throughout higher education, and that it is necessary to plan self-assessment and PA experiences to develop it. They propose to adapt these experiences for different levels of SRL during the progress of different courses, starting with scaffolded activities up to performing these tasks autonomously.

3.2 Synthesis

Peer feedback can be highly relevant in improving students' learning. This improvement is especially evident in lower-achieving students, where a greater improvement is observed after reflecting on the feedback received (Zhu et al., 2023).

Firstly, receiving good peer feedback helps students to be reasonable about failures, appreciating that there is room for improvement (Hsu and Huang, 2015). Receiving good feedback, which allows one to reflect on the comments to improve for the future, is known as feedforward. If the feedback is constructive, the learner should be able to reflect individually on their strengths and weaknesses, so that they can revise and improve the task based on the feedback (Janson et al., 2014).

In addition, the use of PA activities facilitates the teacher's work in situations where he/she has many students and cannot give personalized feedback to each student. The grades provided in PA are often quite similar to those of the teacher, rather than the students' own self-assessment grades (Hsu and Huang, 2015). If, in addition, an average grade of 3 peers' assessments is used, the grade is quite similar to that of the teacher (Marín and Pérez, 2016). Even triangulation methods can be used, which are very easy to apply with technology, and the quality of the grade is very high (Albano et al., 2017). As these authors point out, in some cases the teacher intervention may be necessary to adjust the grades, which is easy to implement with technology such as Moodle.

It can also be positive for students to know if they are doing it correctly if they can combine group and individual feedback, as group feedback helps them to better understand how to do it (Ng, 2016). This can be done in different ways, for example, in phases, with a group phase first and an individual phase afterwards to apply what they have learned (Janson et al., 2014), or according to the type of feedback, with group feedback being qualitative and individual feedback being quantitative with a rubric (Ng, 2016).

Secondly, and much more important for PA activities to benefit students' SRL, is the provision of feedback to their peers. Having to provide feedback helps students to understand the learning and task objectives, as they must analyse the task elements for assessment (García-Jiménez et al., 2015) and the assessment process itself (Raposo-Rivas and Gallego-Arrufat, 2016).

In this sense, understanding how to provide feedback is more important for SRL than receiving it in order to implement improvements, since generating a good feedforward helps the student him/herself to identify the strategies that will improve his/her learning (García-Jiménez et al., 2015). In addition to improving the processes of explanation and argumentation that facilitate deep learning (Albano et al., 2017). By evaluating peers, they evaluate their own learning, as they must compare both tasks to know where they should not make mistakes (Hsu and Huang, 2015).

In addition, if students are involved in the design of the assessment tasks, defining the criteria and reference levels, their understanding of the objectives of the tasks improves, and thus they can assess with greater precision and quality (García-Jiménez et al., 2015).

And, if possible, it is very beneficial for learners to maintain a dialogue between assessor and assessed, i.e., to facilitate several iterations that help to personalize the feedback, so that it properly understood and integrated, especially promoting SRL (García-Jiménez et al., 2015).

Thirdly, there is scaffolding, which has been found to be essential for students to learn how to provide good feedback based on the proposed assessment criteria, as they must learn to reflect on what is expected from the task (Hsu and Huang, 2015). If scaffolding is not provided, it is very likely that students will not know how to provide good feedback, as in the case of Swartz (2020) where students focused more on how to use the tool or perform the task, rather than reflecting on the content to help the peer improve their task.

The first and most common way to create this scaffolding is with the help of the teacher, who should guide the reflection at the beginning, and gradually give more of a leading role to the students (García-Jiménez, 2015). The second way to create scaffolding is with the support of peers. Peers can guide and monitor the reflection process to give feedback on whether the reflection is sufficient (García-Jiménez, 2015).

They can also conduct an analysis of examples in pairs/groups. For example, they start by analyzing an example in pairs and their own work developed individually, before conducting the PA (Blau and Shamir-Inbal, 2017). By following this procedure, they ensure that they employ metacognitive thinking by monitoring their own learning before the PA, but also during the PA because they apply critical thinking by analyzing other tasks, and being able to compare them with their own, which helps them to learn.

In this second case, it may be an extra effort for them to keep up, because they are not able to organize themselves and do not have a teacher as a reference point, but in the end they achieve independent learning (Blau and Shamir-Inbal, 2017).

It is also important to note that this procedure is learned and improved with practice, both by assessing peers and receiving their evaluations, which improves learning and understanding of the task and objectives, as the relevance of the requested content is improved (Fernández-Ferrer and Cano, 2019).

An important point to highlight is that the SRL enabled by PA is related to the Learning to Learn competence, which must be developed throughout the entire higher education stage, as it is an essential competence for lifelong learning (Lluch and Portillo, 2018). To this end, PA and self-assessment experiences should be planned progressively in the different higher education courses, starting with some kind of scaffolding until autonomous completion by students is achieved (Lluch and Cano, 2023).

Focusing on how technology can help in the design of PA activities to facilitate SRL, it is worth noting that some key elements of PA have clearly benefited from the use of technology.

Technology makes it easier for learners to have more than one iteration (García-Jiménez et al., 2015), as a single iteration may not be to self-regulate future learning (Swartz, 2020). Several iterations produce a great improvement over a traditional feedforward, as feedback is better understood, becoming more useful, allows for deeper questioning of content and improving learning (Roman et al., 2020). In fact, it is best to perform several iterations until the delivery of the final product, in the same working groups (evaluator-evaluated), to better apply the feedback received (Zhu et al., 2023).

However, it is necessary to rethink how to add a discussion with the evaluators in an appropriate way through the technology itself, as doing so without technology will allow the identity of the evaluators to be known (Marín and Pérez, 2016), which can be counterproductive. Anonymous PA allows for more critical feedback (Ng, 2016), as non-anonymous PA is based on cronyism (Raposo-Rivas and Gallego-Arrufat, 2016). Thus, the introduction of forums or other activity formats could be considered to maintain anonymity.

In addition to anonymity, instant feedback is necessary to improve self-regulation (Wang, 2020). Therefore, if we want it to be instantaneous yet anonymous, technology plays a crucial role. In addition to facilitating the improvement of one's own learning by receiving it instantaneously, providing it right at the end of the task helps assessors to better reflect on the task, thus providing more critical and comprehensive feedback (Zhu et al., 2023).

As we have said, technology offers the possibility of using different formats, such as video, audio, etc., beyond a written format that can be misinterpreted (Hsu and Huang, 2015), without the need to use a face-to-face format that makes anonymity disappear, thus favoring the reception of feedback (García-Jiménez et al., 2015). LMSs, such as Moodle, have different activities in addition to the workshop. The workshop activity is designed for PA, but it may be insufficient. It is worth highlighting the proposal by Lluch and Cano (2023) in which they add different types depending on the objective. Firstly, forums to involve students in the design of assessment criteria and to improve understanding of the task.

Secondly, open-ended questionnaires to improve the metacognitive phases for self-regulation of learning (goal identification, planning, monitoring, and self-assessment). Thirdly, individual forms and tasks to hand in assignments with the improvements introduced thanks to feedforward.

Being able to complement different types of activities in the same technological tool facilitates self-regulation, as students can comfortably self-assess and reflect on the feedback received, for example, in an e-portfolio (Marín and Pérez, 2016).

Technology has the potential to be updated with improvements when necessary. For example, in certain tools, such as the one designed by Roman et al. (2020), it is proposed that students incorporate all comments to improve their work. A dynamic for introducing this into LMSs would need to be explored, as students often only take into account the comments that are easy for them to include and ignore the others.

4 Discussion: critique

This discussion section provides the third phase of the tripartite model for systematic review (Daniel and Harland, 2017). It sets out guidelines for designing courses in virtual classrooms or similar technologies. Following these guidelines, teachers can be design peer review workshops that facilitate students' own self-regulated learning.

First, it is recommended that feedback is provided in different formats to improve its comprehensibility. In this way, learners do not rely solely on written feedback that can be misinterpreted (Hsu and Huang, 2015). For this purpose, written feedback can be used in addition to a rubric, which is easily configurable in the virtual classroom. A file in any format can also be added, e.g., a short one-minute video, with a reflection on what they have learned from the first submission to the last. Other types of tasks such as forums, open-ended questionnaires or individual forms and tasks can also be used (Lluch and Cano, 2023).

On the other hand, the grades proposed by the assessors can be used, although it is recommended that at least the average of 3 grades is obtained (Marín and Pérez, 2016). Thus, the quality of the assessment is very high, as suggested by Albano et al. (2017), and if there are cases where the assessments are very disparate, the teacher should review the assignment and provide their own feedback. In this case, the Moodle workshop averages the assessors' grades. In addition, the quality of the assessment is graded, depending on whether the mark awarded is like that of the other assessors. It is recommended that this assessor grading is considered to ensure that students assess their peers well. This activity also allowed the teacher to modify the marks if the final average mark is not considered adequate.

As we have seen, it is also important that the AP process is anonymous, in order to achieve more critical and comprehensive feedback (Ng, 2016). Otherwise, it will be based on cronyism and the tasks of friends will not be critically questioned (Raposo-Rivas and Gallego-Arrufat, 2016). In the specific case of Moodle, we have a specific configuration so that both the activity is assessed anonymously, and the identity of the assessors is unknown. It is also more useful for feedback to be instantaneous, both for the assessor,

who can provide more complete feedback, and for the assessed, who can apply the comments on the spot, improving the regulation of learning (Wang, 2020). The use of technology makes it possible to propose short timelines to ensure that feedback is instantaneous, as fixed deadlines can be set for each phase.

In addition, for peer assessment to truly facilitate self-regulated learning, students must be taught to provide feedback. This constructive feedback allows the student to reflect on the comments and apply them in a new and improved version of the task (Janson et al., 2014). For, as Malecka et al. (2022) argue, it is necessary to include the processing and application of the feedback received. Thus, they identify strategies to improve their own learning (García-Jiménez et al., 2015), and evaluate their learning (Hsu and Huang, 2015). Technology can be used to create questionnaires with good and bad examples of feedforward, and discuss the results with them in class to justify why it is or is not constructive.

The use of feedforward will be useful if the evaluation consists of several iterations, allowing a dialogue between evaluator and evaluated (García-Jiménez et al., 2015), helping to better understand the feedback and integrate it properly into the final product. The technology facilitates work with several iterations (García-Jiménez et al., 2015). Thus, the technology makes it possible to reopen phases that have already been completed in order to carry out a new submission, and, subsequently, a new evaluation. In the specific case of Moodle, the tool facilitates that the evaluators of a task are always the same in the different iterations, as recommended by Zhu et al. (2023). Furthermore, it is recommended to include a final task after the whole AP process, in which the learner can apply the knowledge developed through the reflection of the feedback (Janson et al., 2014). In this way, in addition to the PA activity, a task can be created in the virtual classroom for the student to hand in the final version of their work, which is assessed by the teacher. Another option is the re-evaluation of modified submissions by the assessors themselves, who can focus on the improvements included to revise the grading of the rubric.

Secondly, in addition to the characteristics that must be taken into account for good feedback, students must learn to evaluate their peers from a learning perspective. As proposed by Carless and Winstone (2023), literacy feedback from the teacher is necessary for proper scaffolding. Therefore, scaffolding is required, either by the teacher as a guide or by practicing with examples in pairs or small groups. This scaffolding enables a focus on building useful and relevant feedback on the objectives (Hsu and Huang, 2015). In the Moodle workshop, the teacher can include already corrected examples with feedback comments. These comments can be used to teach students what is expected at each point (García-Jiménez, 2015). In addition, these examples can also be reviewed in pairs or groups of three to ensure that they understand how they should approach and create the feedback (Blau and Shamir-Inbal, 2017). As Carless and Boud (2018) explain, the use of examples is ideal for developing feedback literacy.

Therefore, it is advisable to combine group feedback with individual feedback. They start with group feedback to discuss and reflect on what the feedback should look like (Ng, 2016). Applying this idea to the use of technology, the first PA activity can be done in pairs. In the workshop activity, by including part rubric and part open-ended feedback, it is possible to discuss in pairs at

which level of the rubric the assessed activities fall. Afterwards, they individually justify their decision in the comments. In addition, the pair can review the comments to discuss how to improve them.

It is also essential that the use of peer assessment and self-assessment is planned progressively, as they will learn to assess little by little. Finally, they will be able to develop the Learning to Learn competence, which is necessary for lifelong learning (Lluch and Cano, 2023). Thus, it is recommended to carry out several AP activities, approximately one per month or up to four in a four-month period. It is also recommended to support these activities with self-assessment, in the Moodle workshop the option can be enabled for them to assess their own work based on the assessment criteria, forms or tasks with short audio or video files can be used for them to reflect on their progress.

Finally, it should be noted that in this scaffolding process, it is advisable to involve students in the development of the assessment criteria and reference levels. In this way, they can check their interpretation of the objectives, so that they can assess the task more accurately (García-Jiménez et al., 2015). In the days prior to the PA activity, a forum can be opened to discuss the assessment criteria, for students to review and propose modifications. They can also be asked to give an example of what it would mean to be assessed at one of the benchmark levels of a criterion in a rubric. To ensure their participation in the forum, they can be asked to participate in pairs or groups of three in class or with a video call tool, and then discuss the forum comments together to construct a final rubric.

Thus, we can see, as Little et al. (2024) state, how all these scaffolding aids will help learners to manage their perceptions and attitudes toward the feedback process. In this way, they will then be able to improve their confidence and feedback agency, developing their feedback literacy.

5 Conclusions

Peer assessment facilitates metacognitive reflection, thanks to the use of formative feedback, which is used in most of the experiences reviewed (Alqassab et al., 2023). In order to achieve quality feedback, we start from the importance of students developing literacy feedback (Carless and Boud, 2018). This is due to the fact that in recent years an approach to feedback that focuses on learning, rather than just transmission has begun to be considered (Winstone et al., 2022). This helps them to plan and guide their own learning (Topping, 2009), as they need to understand the assessment criteria (Van Helden et al., 2023) to justify the feedback (Liu and Carless, 2006). Moreover, metacognition is especially applied when receiving it (Liu and Lin, 2007), as Ng (2016) appreciates that they reflect on it in order to apply it later in their work, according to Misiejuk and Wasson (2021).

Fernández-Ferrer and Cano (2019) confirm how experience improves the application of PA (Van Zundert et al., 2010), so they should train as proposed by Lluch and Cano (2023), or support with scaffolding, as suggested by García-Jiménez (2015) and Blau and Shamir-Inbal (2017). On the other hand, Marín and Pérez (2016), Ng (2016), and Raposo-Rivas and Gallego-Arrufat (2016) mention the importance of the anonymity they achieve with technology,

according to Panadero and Alqassab (2019), very easy to implement with technology.

We can conclude that, if the design guidelines drawn in this review are followed, it is possible to develop SRL with PA activities. As we have seen in all the studies included in this article, peer assessment activities provide more than just a benefit from the feedback received. Students, as reviewers, can gain a greater understanding of the task and improve their knowledge of the topic they are to assess. The reflection required during the assessment is conducive for them to regulate their own learning.

As limitations we can highlight the few articles that meet all the established search criteria. If the higher education and/or technology criteria were removed, the result would be much higher, and more design recommendations could have been achieved. It is therefore recommended that future literature reviews be conducted with a more open search.

Author contributions

BO-R: Data curation, Formal analysis, Methodology, Writing—original draft. JC-G: Conceptualization, Supervision, Validation, Writing—review & editing.

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Shyness and academic procrastination among Chinese adolescents: a moderated mediation model of self-regulation and self-focused attention

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Academic procrastination is a common concern among adolescents, but the correlation between shyness and academic procrastination and the internal mechanisms have not yet been thoroughly investigated. Based on a questionnaire survey with 1,279 Chinese middle school students, this study examined the effect of shyness on academic procrastination and its underlying mechanism of self-regulation and self-focused attention. Results revealed that: (1) shyness significantly predicted academic procrastination. (2) Self-regulation mediated the relationship between shyness and academic procrastination. (3) Self-focused attention played a moderating role in the first half of this mediation process. Specifically, higher level of self-focused attention strengthened the predictive effect of shyness on self-regulation. These results underscored the latent risks and protective factors associated with shyness, self-regulation, and self-focused attention in adolescent academic procrastination. In future research and interventions, attention may be directed towards improving individual internal factors to assist adolescents in effectively addressing issues related to academic procrastination.

KEYWORDS

shyness, self-regulation, self-focused attention, academic procrastination, Chinese adolescents

1 Introduction

Academic procrastination refers to unnecessary and irrational behaviors that lead to the delay of academic tasks (Steel and Klingsieck, 2016). It exerted an adverse impact on students' academic performance (Cormack et al., 2020) while also influencing their physical and mental health (Flett et al., 2016). Thus, exploring the determinants of academic procrastination becomes crucial in curtailing its prevalence among adolescents and encouraging their healthy development.

The critical determinants influencing academic procrastination were a medley of internal factors such as personality traits, self-regulation; and environmental factors like task complexity or teacher characteristics (Klingsieck, 2013; Steel and Klingsieck, 2016). Notably, the internal factors wield significant sway over individual behaviors. A deep-dive into these

factors can facilitate an enhanced understanding of students varying scholastic performances and diversified learning behaviors, thereby revealing the plethora of causes underpinning student behavior. Hence, an intensive exploration of these internal factors is pivotal to uncovering the mechanisms and repercussions of academic procrastination. This study, embedded within the constructs of Attention Control Theory and Self-focused Attention Theory, aims to unearth the influence and operation of these internal factors—namely shyness, self-regulation, and self-focused attention—on adolescent academic procrastination. The ultimate goal is to panoramically address this issue, thereby furnishing effective recommendations to foster robust academic growth within the adolescent cohort.

1.1 Shyness and academic procrastination

Shyness is characterized as the discomfort or inhibition individuals experience in social situations or under social evaluation (Coplan et al., 2004). Both theoretical constructs and empirical evidence suggests a potential association between shyness and academic procrastination.

While direct research establishing a correlation between shyness and academic procrastination was limited, existing studies underscored the significant role of personality traits in fostering academic procrastination (Klingsieck, 2013). Shyness, as a stable personality trait, induced negative emotions that hindered active participation in classroom discussions and discouraged seeking academic assistance (Chen et al., 2021). Furthermore, these emotions extended to impair crucial cognitive processes necessary for initiating individual tasks in academic settings, leading to divided attention and self-doubt (Geng et al., 2021; Leigh et al., 2021), ultimately diminishing task completion proficiency and fostering academic procrastination.

Secondly, Attentional Control Theory (Derakshan and Eysenck, 2009) posited that excessive worry might occupy cognitive resources, leading to insufficient allocation of cognitive resources to tasks and consequently impacting processing efficiency. Shy adolescents, who were more sensitive to potential social threats (LoBue and Pérez-Edgar, 2014), tended to have their attention distracted by social issues unrelated to academic tasks (Alm and Frodi, 2008; Leigh et al., 2021). An excessive worry about interpersonal interactions, social status, or performance in the class took up cognitive resources that should be devoted to the completion of academic tasks. This decreased the efficiency of accomplishing academic tasks, culminating in academic procrastination. Hence, it was evident that shyness is closely associated with academic procrastination in adolescents.

Thirdly, Social Cognitive Theory emphasized the influence of an individual's subjective expectancy of personal capabilities and the outcome of tasks on behavioral choices (Bandura, 1977). Shy adolescents, characterized by lower self-confidence and self-esteem (Crozier, 1995), may develop pessimistic beliefs, perceiving themselves as destined to fail in academic tasks due to heightened concerns about others' evaluations and persistent self-doubt (Miller, 1995; Coplan et al., 2004; Geng et al., 2021). This anticipation of failure may lead shy adolescents to psychologically avoid academic tasks, opting to postpone confronting challenges through academic procrastination. In the short term, procrastination may alleviate the pressure of potential failure, providing temporary psychological relief for shy adolescents. However, the trade-off for this comfort was a subsequent

compromise in academic performance. In essence, shyness not only impeded adolescents' academic engagement but also propelled them into a detrimental cycle of procrastination.

Empirical studies have indicated that shy individuals were more prone to experiencing academic challenges, exhibiting lower academic engagement, and achieving suboptimal performance in academic tasks (Hughes and Coplan, 2010; Nikel et al., 2022) – characteristics that align closely with academic procrastination. Based on the above analysis, this study posited that shyness can positively predict academic procrastination among adolescents (Hypothesis 1).

1.2 The mediating effect of self-regulation

Self-regulation is a valuable individual resource for adolescents, denoting the conscious adjustment of one's thoughts, emotions, and actions to achieve goals (Fries et al., 2008). Research indicated that self-regulation is a crucial factor in the learning process and played a pivotal role in achieving academic success (Robson et al., 2020). Individuals with high levels of self-regulation demonstrated unique advantages in learning activities. They can set clear learning goals and efficiently choose appropriate learning strategies. Through continuous assessment of academic progress, they can timely adjust their learning strategies, ensuring success in completing academic tasks (Ziegler and Opdenakker, 2018). Conversely, individuals with low levels of self-regulation exhibited significant disadvantages in the learning process. Their adaptability was notably poor when faced with new changes or challenges in academic tasks. They struggled to adjust states promptly in aspects such as time management, emotional regulation, and distraction elimination. Consequently, they were unable to efficiently accomplish academic goals within limited time, leading to academic procrastination (Park and Sperling, 2012; Valenzuela et al., 2020). Thus, self-regulation negatively predicted academic procrastination.

The relationship between shyness and self-regulation has also garnered scholarly attention. Shy adolescents tended to employ self-protective strategies, such as avoiding social interactions or relying on safety behaviors (Hassan et al., 2021). These strategies may consume significant cognitive and emotional resources, disrupting self-efficacy regarding academic tasks (Nikel et al., 2022). This interference exacerbated difficulties in task planning, time management, emotional regulation, and sustaining attention, thereby reducing individual self-regulation abilities (Leigh et al., 2021).

In conclusion, self-regulation likely served as a mediator in the relationship between shyness and academic procrastination. Adequate and effective self-regulation may contribute to mitigating the adverse impact of shyness on academic procrastination. Previous research has also identified self-regulation as playing a mediating role between personality traits and academic procrastination (Ljubin-Golub et al., 2019). Building on this, this study hypothesized that self-regulation serves as a mediator in the relationship between shyness and academic procrastination (Hypothesis 2).

1.3 The moderating effect of self-focused attention

Although shyness influenced adolescent academic procrastination through self-regulation, this impact varies among individuals. Several

researchers have emphasized the importance of studying the moderating factors between shyness and social adjustment (Chen et al., 2021; Geng et al., 2021). In this study, we explore potential differences in the relationship between self-focused attention and shyness affecting academic procrastination.

Self-focused attention referred to an individual's sustained attention and observation of their internal state or external performance, and was considered an important facilitating factor for self-monitoring and self-regulation (Bandura, 2001). Furthermore, according to Self-focused Attention Theory, when individuals focused their attention on themselves, they evaluated their behavior based on relevant standards, goals, and norms (Carver, 2012; Silvia and Eddington, 2012). Subsequently, they adjusted their behavior according to the evaluation results to achieve their goals (van Randenborgh et al., 2010; Silvia et al., 2014). Entering puberty, adolescents experienced an increase in self-awareness. This was accompanied by heightened self-focused attention, directing increased focus towards their thoughts, emotions, physical states, and how they were perceived by others (Steinberg, 2005). In conclusion, self-focused attention may play a facilitating role in adolescents' self-regulation.

Given that shyness can be perceived as a manifestation of social anxiety to a certain extent (McNeil, 2010), we can derive an understanding of self-focused attention based on our knowledge of anxiety. According to the Self-Focused Cognitive Processes in Models of Social Anxiety/Shyness (Norton and Abbott, 2016), the attentional processes of individuals with social anxiety/shyness interact with self-focused attention, consequently influencing their emotion responses and behavior. Research by Derakshan and Eysenck (2009) further suggests that these individuals tend to allocate cognitive resources predominantly to negative stimuli, potentially impairing their ability to self-regulate. This heightened sensitivity to external evaluations and social threat information, as supported by Geng et al. (2021), LoBue and Pérez-Edgar (2014), Miller (1995), leads individuals with social anxiety/shyness to excessively focus on critiquing their performance in social situations, diverting attention from immediate tasks and developmental needs. Consequently, even with heightened self-focused attention, the facilitating effect on self-regulation may be diminished in this population. Contrastingly, adolescents with low shyness yet heightened self-focused attention, took more recourse to using self-focused attention to meet their developmental requirements, potentially enhancing their self-regulation implementation. That is, the facilitating impact of heightened self-focused attention on self-regulation was more evident. Therefore, self-focused attention played a moderating role in the relationship between shyness and self-regulation, and this moderating effect aligned with the stress-vulnerability hypothesis (Li et al., 2012), whereby higher levels of self-focused attention were more beneficial for low-shy adolescents.

Although researchers have not yet examined the interactive effect of shyness and self-focused attention on predicting adolescent academic development, there is some indirect evidence supporting the stress-vulnerability hypothesis. For instance, researchers have found that self-focused attention elevated effort management in low anxious individuals, thereby enhancing test performance. However, this effect was less pronounced in high anxious individuals (Carver et al., 1983; Eddington and Foxworth, 2012).

Based on theoretical and empirical analyses, self-focused attention may play a moderating role in shyness and self-regulation. Specially,

it has a clear enhancement effect for low-shyness adolescents, but the effect is less evident for shy adolescents (Hypothesis 3).

The research framework of this study is as follows (see Figure 1).

2 Materials and methods

2.1 Participants

The study participants were chosen through cluster sampling, with five regular middle schools randomly selected in Shandong Province, China. Two classes from each of grades one and two, and one class from grade three in each school, were randomly chosen for the survey. Data was collected within classrooms, with 1,431 questionnaires distributed and 1,279 valid responses obtained, yielding an 89.38% effective response rate. The gender distribution included 632 males (49.41%) and 647 females (50.59%). Among the participants, 544 were only children (42.5%) and 735 were not (57.5%). In terms of residence, 781 participants lived in rural areas (61.1%) and 498 resided in urban areas (38.9%). Grade-wise distribution included 543 participants in grade one (42.5%), 559 in grade two (43.7%), and 177 in grade three (13.8%). The mean age of these adolescents was 13.49 ± 1.002 . The study was approved by the Ethics Committee of Taishan University and informed consent was obtained from students, parents, and teachers after explaining the study's nature, objectives, potential benefits, and possible risks.

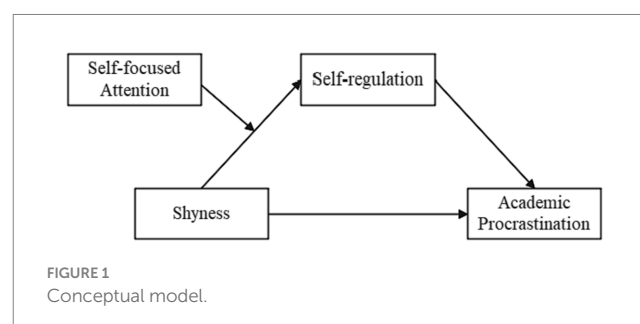
2.2 Measures

2.2.1 Shyness

We used the Revised Cheek and Buss Shyness Scale (RCBS; Cheek, 1983) to assess adolescent shyness, which has been widely used in Chinese students (Chen et al., 2021; Geng et al., 2021). Responses were recorded on a 5-point Likert scale across 13 items, resulting in a total score range of 13–65. Higher scores mean higher level of shyness. Sample items include “I am quite poor in social situations.” In this study, Cronbach's α for shyness was 0.90. The translation process, employing a translation-back translation approach, addressed inconsistencies, ensuring linguistic uniformity. Two developmental psychology professors evaluated the language expressions and confirmed their appropriateness.

2.2.2 Self-focused attention

The Self-focused Attention Scale (SFAS), developed by Kiroopoulos and Klimidis (2006), and revised by Xiao (2010), was used in this



study. The questionnaire uses a 5-point Likert scale across 17 items, with scores ranging from 17 to 85. Higher scores represent higher level of self-focused attention. Sample items include “I care a lot about the way I present myself physically.” This scale has shown good reliability and validity in previous research (Ding et al., 2021). In this study, Cronbach's α for self-focused attention was 0.75.

2.2.3 Self-regulation

Adolescents' self-regulation was assessed by Self-regulation Questionnaire (SRQ; Gao, 2011). The questionnaire encompasses three factors: motivation (e.g., I set goals before the beginning of each week.), strategy (e.g., For personal matters, I often do not set specific deadlines for completion.), and behavior (e.g., I often argue with classmates), and consists of 38 items. The questionnaire employs a 4-point Likert scale, with scores ranging from 38 to 190, where higher scores indicate greater self-regulation ability. The questionnaire has demonstrated good reliability and validity in previous research (Yu et al., 2019). In this study, Cronbach's α for self-regulation was 0.92.

2.2.4 Academic procrastination

We used the Academic Procrastination Inventory (API), developed by Aitken (1982) and adapted by Chen et al. (2008), to assess students' academic procrastination behavior. The questionnaire uses a 5-point Likert scale across 13 items, with higher scores indicating more severe procrastination. Sample items include “I always wait until the study tasks can no longer be postponed before starting them.” Cronbach's α for academic procrastination was 0.80. The API was a suitable tool for assessing academic procrastination and demonstrated good reliability and validity among Chinese students (Chen et al., 2008; Zheng and Xu, 2022).

2.3 Statistical analysis

All data analyses were carried out using SPSS 23.0 and the SPSS macro program PROCESS (Hayes, 2013). Initially, Harman's single-factor test was applied to assess common-method bias associated with self-report questionnaires. Following this, descriptive statistics and correlation analyses were conducted to explore the associations between variables. Subsequently, the SPSS macro program PROCESS (Model 4) was employed to evaluate the mediation effect of self-regulation. Lastly, conditional process analysis was performed using the SPSS macro program PROCESS (Model 7) to confirm whether self-focused attention moderated the mediation model.

3 Results

3.1 Common method biases test

We employed Harman's single-factor test to assess for the potential impact of common method bias. The results of this analysis revealed 21 factors with characteristic roots exceeding one, and the variance explained by the first factor amounted to 16.98%, falling below the conventional threshold of 40%. This demonstrated there was no pronounced methodological bias in this study.

3.2 Correlation analysis among study variables

Table 1 lists the means, standard deviations, and correlation matrix for the variables. All variables exhibited statistically significant correlations in conceptually expected ways. Shyness was positively associated with academic procrastination and negatively associated with self-regulation. Self-regulation was negatively associated with academic procrastination. Self-focused attention was positively associated with self-regulation.

3.3 Moderated mediation effect analysis

Using PROCESS and employing bias-corrected non-parametric percentile Bootstrap method for estimating confidence intervals of coefficients, we investigated the association between shyness and academic procrastination while controlling for the influence of gender.

Firstly, we used the PROCESS macro (Model 4) to examine the mediating role of self-regulation in the relationship between shyness and academic procrastination. The results indicated that shyness was negatively associated with on self-regulation ($\beta = -0.236$, $SE = 0.027$, $p < 0.01$) and self-regulation was negatively associated with academic procrastination ($\beta = -0.681$, $SE = 0.021$, $p < 0.01$). Moreover, shyness had a significant effect on academic procrastination through self-regulation ($\beta = 0.161$, $SE = 0.021$, $p < 0.01$). Shyness also had a direct significant effect on academic procrastination ($\beta = 0.225$, $SE = 0.027$, $p < 0.01$). Consequently, we concluded that self-regulation partially mediated the relationship between shyness and academic procrastination, with the mediation effect accounting for 71.429% of the total effect (see Table 2).

Subsequently, we employed Model 7 of the SPSS PROCESS macro program to scrutinize the moderated mediation model (see Table 3). Upon the inclusion of self-focused attention in the model, self-focused attention was found to positively predict self-regulation ($\beta = 0.112$, $t = 4.213$, $p < 0.01$). Additionally, it moderated the first half of the indirect effect ($\beta = -0.052$, $t = -2.037$, $p < 0.05$).

To clarify the characteristics of the interaction terms, a simple slope test was conducted to analyze the moderating effect of self-focused attention (see Figure 2). Generally, when self-focused attention was low ($M - 1SD$), a significant negative predictive effect of shyness on self-regulation was evident ($\beta = -0.179$, $t = -4.521$, $p < 0.01$). Conversely, when self-focused attention was high ($M + 1SD$), the negative predictive effect of shyness on self-regulation was more pronounced ($\beta = -0.283$, $t = -8.275$, $p < 0.01$). This indicated that the predictive effect of shyness on self-regulation varies at different levels of self-focused attention, with higher self-focused attention strengthening the predictive relationship between the two.

4 Discussion

This study constructed a moderated mediation model based on Attentional Control Theory and Self-focused Attention Theory, comprehensively investigated the association and potential impact of shyness on academic procrastination in adolescence. The findings revealed that self-regulation partially mediated the relationship between shyness and academic procrastination, and self-focused

TABLE 1 Descriptive statistics and Pearson correlations among study variables ($N = 1,279$).

	Variables	M	SD	1	2	3	4	5	6	7	8
1	Gender	1.510	0.500	1.000							
2	Shyness	34.459	8.324	−0.047	1.000						
3	SFA	57.388	9.709	0.045	0.021	1.000					
4	Motivational SR	35.455	6.651	0.121**	−0.218**	0.107**	1.000				
5	Behavioral SR	35.208	4.797	0.196**	−0.186**	0.016	0.620**	1.000			
6	Strategic SR	36.518	5.968	0.153**	−0.230**	0.177**	0.747**	0.600**	1.000		
7	Total SR	95.713	13.847	0.171**	−0.244**	0.119**	0.904**	0.808**	0.900**	1.000	
8	AP	31.004	8.925	−0.147**	0.232**	−0.102**	−0.634**	−0.611**	−0.620**	−0.702**	1.000

* $p < 0.05$ (two-tailed) and ** $p < 0.01$ (two-tailed). Gender was coded: 1 = boy and 2 = girl. SFA, self-focused attention; SR, self-regulation; AP, academic procrastination. Motivational SR, behavioral SR, and strategic SR are the three factors of SR.

TABLE 2 Mediation analysis ($N = 1,279$).

Dependent variables	Independent variables	β	SE	t	95% CI	R^2	F
AP	Gender	−0.272	0.054	−5.036**	[−0.378, −0.166]	0.072	49.538**
	Shyness	0.225	0.027	8.339**	[0.172, 0.278]		
SR	Gender	0.319	0.054	5.946**	[0.214, 0.424]	0.085	59.168**
	Shyness	−0.236	0.027	−8.820**	[−0.289, −0.184]		
AP	Gender	−0.055	0.040	−1.356	[−1.134, 0.024]	0.497	420.046**
	Shyness	0.064	0.020	3.125**	[0.024, 0.104]		
	SR	−0.681	0.021	−32.825**	[−0.722, −0.641]		

* $p < 0.05$ (two-tailed) and ** $p < 0.01$ (two-tailed). Bootstrap sample size = 5,000. Gender was coded: 1 = boy and 2 = girl. SFA, self-focused attention; SR, self-regulation; AP, academic procrastinations; LL, low limit; CI, confidence interval; UL, upper limit.

attention moderated the relationship between shyness and self-regulation.

The findings contributed to a comprehensive understanding of the internal mechanisms of academic procrastination. They not only addressed the knowledge gap regarding the relationship between shyness and academic procrastination but also provided a new perspective on understanding the academic challenges faced by shy adolescents. Moreover, these findings further supported and enriched the viewpoint that personality traits play a significant role in the learning process (De Raad and Schouwenburg, 1996). This study provided valuable insights into methodologies for educational practices and psychological health support.

4.1 Mediating effect of self-regulation

From the perspective of differential psychology, procrastination was considered a personality trait (Klingsieck, 2013). The results of this study supported this viewpoint: shyness positively predicted academic procrastination in adolescents, and this positive association can be explained by self-regulation. Shyness diminished individuals' self-regulation, consequently contributing to the occurrence of academic procrastination. This finding deepened our understanding of the internal mechanisms through which social pressure and emotional distress impact academic achievement. Two points can be considered to explain this result:

On the one hand, shyness negatively predicted adolescent self-regulation, with higher levels of shyness associated with poorer

self-regulation. From a cognitive perspective, shy adolescents exhibited lower self-efficacy (Nikel et al., 2022), making it challenging to clarify academic goals and formulate effective plans. On the emotional front, shy adolescents experienced more negative emotions, posing greater challenges in emotional management and making it difficult to regulate emotions for concentration. Regarding social interaction, shy adolescents faced difficulties in academic social interactions, reducing opportunities for external support and collaboration (Chen et al., 2021). Thus, the typical cognitive, emotional, and social interaction patterns in children can shape their abilities to manage emotions, behaviors, and thoughts in the process of goal achievement and environmental adaptation. Personality traits play a crucial role in self-regulation abilities.

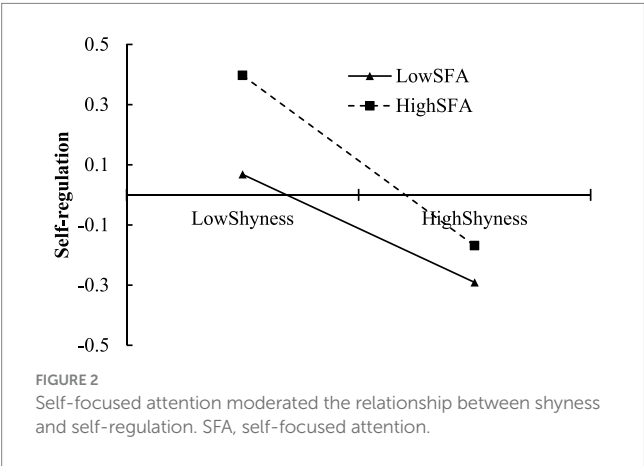
On the other hand, self-regulation negatively predicted academic procrastination, aligning with findings in the procrastination research field (Park and Sperling, 2012; Valenzuela et al., 2020). When adolescents can effectively monitor their own behavior and engage in self-assessment, they demonstrate advantages in task planning, time management, and emotional regulation, enabling them to complete academic tasks on time. Conversely, self-regulation failure, accompanied by a malfunction in emotional and psychological resource allocation, leads to academic procrastination. In summary, self-regulation played a crucial bridging role between shyness and academic procrastination.

Furthermore, in recent years, the phenomenon of procrastination has extended beyond the academic domain, sparking widespread interest in various fields, including financial risk and hindrances in career planning (Nguyen et al., 2013). Future research should explore

TABLE 3 Conditional process analysis ($N = 1,279$).

	β	SE	t	95% CI
Mediator variable model for predicting SR				
Gender	0.306	0.053	5.749**	[0.202, 0.410]
Shyness	−0.231	0.027	−8.597**	[−0.284, −0.178]
SFA	0.112	0.027	4.213**	[0.060, 0.165]
Shyness × SFA	−0.052	0.025	−2.037*	[−0.102, −0.002]
Dependent variable model for predicting AP				
Gender	−0.055	0.040	−1.356	[−0.134, 0.024]
Shyness	0.064	0.020	3.125**	[0.024, 0.104]
SR	−0.681	0.021	−32.825**	[−0.722, −0.641]
Conditional effect	Effect	Boot SE	Boot LLCI	Boot ULCI
M − 1SD	−0.179	0.040	−0.257	−0.101
M	−0.231	0.027	−0.284	−0.178
M + 1SD	−0.283	0.034	−0.350	−0.216

* $p < 0.05$ (two-tailed) and ** $p < 0.01$ (two-tailed). Bootstrap sample size = 5,000. Gender was coded: 1 = boy and 2 = girl. SFA, self-focused attention; SR, self-regulation; AP, academic procrastination; LL, low limit; CI, confidence interval; UL, upper limit.



the pivotal roles of other personality factors and self-regulation in procrastination behaviors across different domains, such as finance, medicine, and management. This mediating model offers valuable insights for educators and parents, suggesting that providing education, training, and practical activities focused on enhancing self-regulation skills for shy adolescents can improve their self-regulation, enhance task execution efficiency, effectively reduce the risk of academic procrastination, and better adapt to academic environments.

4.2 Moderating effect of self-focused attention

Theoretical and empirical studies indicated that self-focused attention has a significant impact on self-regulation (Carver, 2012; Silvia and Eddington, 2012; Silvia et al., 2014). This study validated this conclusion, demonstrating that self-focused attention facilitates self-regulation. However, previous research on self-focused attention

had predominantly focused on areas such as psychotherapy, medicine, and the self. The present study contributed to this exploration by introducing an investigation of self-focused attention and its crucial role in academic development.

Moreover, self-focused attention played a moderating role in the first half of the mediating process of “shyness → self-regulation → academic procrastination.” Specifically, adolescents with high levels of self-focused attention exhibited a heightened negative predictive impact of shyness on self-regulation compared to those with lower levels. This implies that heightened self-focused attention attenuated the self-regulation of highly shy adolescents, consequently exacerbating academic procrastination. Consequently, it is imperative to approach the dual role of self-focused attention in this mediation process cautiously: while it serves as a protective factor by bolstering self-regulation and mitigating academic procrastination, excessive self-focused attention in the presence of heightened shyness may exacerbate this risk, resulting in diminished self-regulation and heightened likelihood of academic procrastination. Hence, it is overly simplistic to assume a universally beneficial role for self-focused attention. Instead, its efficacy appears to be more pronounced among less shy adolescents, whereas its protective effects are constrained for those with heightened shyness. This observation aligns seamlessly with the stress-vulnerability hypothesis, suggesting that the resilience of protective factors (e.g., self-focused attention) may wane as risks (e.g., shyness) escalate to a certain threshold (Li et al., 2012). Consequently, optimism regarding the beneficial effects of self-focused attention as a protective factor should be tempered, while the detrimental effects of shyness as a risk factor warrant heightened scrutiny. In summary, this discovery underscored the critical importance of comprehending adolescent academic procrastination at the level of individual differences.

In educational practice, educators should foster adolescents’ self-focused attention to enhance their self-regulation and academic performance. This entails instructing them on effectively utilizing self-focused attention to monitor and adjust their cognition, emotions, and

behaviors, thereby better adapting to various situational and task demands. Furthermore, for shy adolescents, educators need to pay special attention to their emotional management and provide psychological support to alleviate anxiety and promote self-regulation, thereby reducing academic procrastination. Most importantly, the findings of this study highlight the interconnected nature of various internal factors influencing adolescents' academic procrastination, rather than acting independently. Therefore, future interventions should not solely focus on one aspect. Instead, integrated and systematic interventions are preferable, targeting three key areas: shyness, self-focused attention, and self-regulation. This comprehensive approach aims to achieve optimal intervention outcomes and promote the healthy development of adolescents.

4.3 Limitations and future directions

This study encountered several limitations. Firstly, due to its cross-sectional nature, causal relationships between variables could not be established. Future research should employ longitudinal designs to explore bidirectional and causal relationships among variables. Secondly, the reliance solely on self-reported data may introduce bias. Subsequent studies should incorporate data from diverse sources, including parents, teachers, and peers, to achieve a more comprehensive and objective measurement through cross-validation of information. Furthermore, future studies should endeavor to explore innovative measurement approaches and experimental designs to enhance the understanding of academic procrastination and its associated impact variables, particularly focusing on self-regulation. The integration of neuroimaging techniques such as functional magnetic resonance imaging (fMRI) or electroencephalography (EEG) holds promise for revealing neural correlates of self-regulation processes (Thibault et al., 2015). Additionally, cognitive training interventions or virtual reality simulations may provide valuable insights into the flexibility of self-regulation and inform targeted interventions (Buckley et al., 2014). By incorporating state-of-the-art methodologies, researchers can deepen their understanding of the mechanisms underlying academic procrastination, thus advancing more effective interventions and applications.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding author.

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Ethics statement

The studies involving humans were approved by Ethics Committee of Taishan University. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

HS: Conceptualization, Writing – original draft, Writing – review & editing, Data curation, Funding acquisition, Methodology. YY: Conceptualization, Writing – original draft, Writing – review & editing, Project administration, Resources, Supervision. CP: Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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Using the fused graphical lasso to explore the motivational self-system after a multimedia self-regulated learning training: a brief research report

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Introduction: The purpose of this study is to explore the effects of a randomized control trial designed to test the effect of a brief intervention used to improve self-regulated learning (SRL) in gateway biology courses using joint estimation of graphical models.

Methods: Students ($N = 265$; $n = 136$) from three sections of a hybrid-format introductory biology course were randomly assigned to participate in the multimedia science of learning to learn or a multimedia control condition. All participants completed a self-report battery of motivational measures. Course performance data was also collected.

Results: Network structures of motivation variables were estimated in two sub-groups (Treatment and Control). These networks showed a high level of correspondence in the relative magnitudes of the edge weights, however there were non-trivial differences in the edge weights between groups that may be attributed to the treatment and differences in predictability. While these findings suggest meaningful differences in motivational structures, the relatively small sample size may limit the stability of the estimated network models. The SRL strategy based interventions may have positioned the students motivationally to approach the challenging exam through activating the role of value and self-efficacy in their learning.

Discussion: Many of the ways analyses of typical intervention studies are conducted ignore the underlying complexity of what motivates individuals. This study provides preliminary evidence how Gaussian Graphical Modeling may be valuable in preserving the integrity of complex systems and examining relevant shifts in variations between motivational systems between groups and individuals.

KEYWORDS

Gaussian graphical modeling, fused graphical lasso, motivation, self-regulated learning, complexity

Introduction

Improving students' ability to self-regulate their own learning is important. Self-regulated learning (SRL) is a multifaceted process in which students actively engage in their learning, employing adaptive skills to achieve their goals through planning, performing, and reflecting on learning tasks (Pintrich, 2000; Schunk and Greene, 2017). Theories of SRL span various paradigms of cognition, affect, and behavior, with models differing in their conceptualization of metacognition, motivation, and emotion, as well as the structure and context of the learning process (Panadero, 2017). It is widely accepted, however, that the ability to monitor cognition, discriminate between well-learned and less well-learned knowledge, and implement strategies toward learning goals has significant implications for education across various aspects of learners' behaviors, emotions, and cognitions (Sitzmann and Ely, 2011). Recognized as dynamic and interlinked components, SRL involves monitoring, controlling, and regulating cognition, motivation, volition, effort, and the self-system, all of which contribute to effective learning (Ben-Eliyahu and Bernacki, 2015; Winne and Hadwin, 1998; Zimmerman and Schunk, 2001).

Instructors are increasingly integrating active learning designs into their courses (Eddy and Hogan, 2014; Theobald et al., 2020), requiring students to acquire, rehearse, and evaluate knowledge through diverse activities, including reading, assignments, videos, and collaboration (Lombardi et al., 2021). This may pose increased challenges for learners (Azevedo et al., 2019; Bernacki, 2023). Many early undergraduate science learners report feeling underprepared for self-regulated learning (SRL) in such environments (Perez et al., 2014), often due to lack of familiarity, confidence, time, or preparation (Shekhar et al., 2020). In response, researchers have called for scaffolding methods to develop cognitive strategies and SRL practices (i.e., workshops, trainings, and embedded classroom activities) (Dignath et al., 2008) and theories on how to train such learners are emerging (Hattie and Donoghue, 2016; McDaniel and Einstein, 2020). Autonomous engagement is particularly important in student success online learning environments (Broadbent and Poon, 2015). Digital skill training programs are increasingly being explored as effective tools for supporting and enhancing SRL abilities (Theobald, 2021).

One critical aspect of self-regulated learning is the dynamic relations that occur when multiple self-regulated learning processes co-occur in context (Ben-Eliyahu and Bernacki, 2015), including how students are motivationally poised to engage in strategic learning (Efklides, 2011). Students' perceptions of their academic endeavors, including their expectations, values, and goals need to be meaningfully shaped by their motivational valence (i.e., the degree to which these perceptions are experienced as positive or negative) and properly aligned in order for students to be successful. For example, recent work has used latent profile analysis to demonstrate how motivational variables with differing positive and negative associations combine when students are academically successful (Perez et al., 2023; Perez et al., 2019). Students with motivational profiles such as high confidence a low perceptions of costs associated with learning are more likely to earn better grades and score higher on exams (Perez et al., 2023). Complex systems perspectives on the study of motivation have described shifts in combinations as self-organizing psychological systems (Kaplan et al., 2012; Marchand and Hilpert, 2024).

Self-organization is the process by which a new order or pattern in a system arises from local interactions among parts of the system (Koopmans, 2020). In the context of motivation, self-organization can occur when the role, strength and direction of relationships among variables shifts as a result of a perturbation to the system (i.e., an intervention) leading to a more adaptive psychological state (Hilpert and Marchand, 2018). For example, after receiving training in self-regulated study skills, a student may feel more confident about their ability to perform well on a final exam (i.e., a shift toward stronger and more positively experienced self-efficacy) which may co-occur with a change in their goals for the exam from avoiding failure to performing well (i.e., a shift from avoidance goals to performance goals), and experience more positive emotions regarding taking the exam. The emergence of these changes in the student motivational system more poise them an increased change of academic success.

Although complex changes to the motivational system have been modeled using techniques such as latent profile analysis, these analytic techniques do not capture changes in the specific relationships between constructs. Network approaches, such as Gaussian Graphical Modeling (Epskamp, 2020), have become popular in other fields of psychology to study changes in constructs that underlie psychopathology (Epskamp et al., 2018a,b). These approaches have been useful not only because they maintain fidelity to the nature of complex systems themselves, (i.e., networks are the underlying structure of a complex system, see Mitchell, 2009), but also because they can be used to unpack the more specific changes between variables that occur within and between people over time (Costantini et al., 2019). Given the need for more research in this space, here we explore the effects of a randomized control trial designed to test the effect of a brief intervention used to improve self-regulated learning in gateway biology courses. Our previous work documents the details of the development and previous findings related to the intervention (Bernacki et al., 2020; Bernacki et al., 2021; Bernacki, 2023). For the current report, we show the effect of treatment on student motivation using network analysis. Our research questions were as follows:

RQ1: Is there evidence of improved self-organization in the motivational systems for students who received the treatment compared to those who engaged in control activities?

RQ2: For students who received the treatment, were their shifts in the betweenness, closeness, and strength of relationships among variables that aligned with motivational theory?

Methods

Participants and procedures

Students from three sections of a hybrid-format introductory biology course were randomly assigned to participate in the multimedia science of learning to learn or a multimedia control condition. Each module had three parts. Participants were 265 consenting undergraduates (27.17% male, 72.83% female). The ethnic/racial background of the students was as follows: 19.62% Asian/Asian American, 10.57% Black/African American, 35.85% Hispanic (Non-White), 12.83% Multiracial, 1.89% Pacific Islander, and 19.24%

White/Caucasian. Of these students, 70 successfully completed all three parts of the intervention and 66 successfully completed all three parts of the control. Of these data, 17 participants had data missing in the treatment group and 16 had data missing in the control group. Because of the sample size limitations, the missing data were imputed using the random forest method via the missForest package (Stekhoven, 2022), which predicts missing values iteratively by leveraging the relationships between the observed variables in the larger dataset. These imputed data were retained for the subsequent analyses and demographic information is provided in Table 1.

Measures

Multimedia science of learning to learn

The multimedia science of learning to learn training is a redesign of a brief digital skill training program designed to enhance cognitive, metacognitive, and behavioral and environmental regulation strategies (Bernacki et al., 2020) wherein textual content was replaced with digital videos, an adjustment aimed to enhance learning efficiency by allowing learners to save time through video viewing instead of reading (Koedinger et al., 2012). Consisting of three modules, the program included a total of 12 videos covering cognitive study strategies, self-regulated learning techniques, and goal achievement strategies in biology. Activities within the modules aimed to promote knowledge rehearsal and deeper understanding of the video content, offering a more engaging and effective learning experience compared to static materials. Further details on both this program and the control alternative are provided in Bernacki (2023).

Achievement goal questionnaire-revised

Achievement goals were measured across nine items designed to measure mastery approach orientation (e.g., My aim is to completely master the material presented in this course), performance approach orientation (e.g., I am striving to do well compared to other students) and performance avoidance orientation toward learning (e.g., My goal

is to avoid performing poorly compared to others) (Elliot and Murayama, 2008). Items were measured on a 7-point scale ranging from 1-strongly disagree to 7-strongly agree. These items demonstrate adequate subscale reliability, $\alpha = 0.84\text{--}0.94$ (Elliot and Murayama, 2008).

Self-efficacy

Self-efficacy was measured with five items (e.g., I can do almost all the work in this course if I do not give up) taken from the Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000). Items were measured on a 6-point scale ranging from 1-strongly disagree to 6-strongly agree. The items demonstrate reliability, $\alpha = 0.78$ (Midgley et al., 2000).

Perceived cost and value

Perceived cost and value were measured with 16 items adapted from Perez et al. (2014). Value was broken down into three factors with four indicators each, attainment value (e.g.), intrinsic value (e.g.), and utility value (e.g.) (Eccles and Wigfield, 1995). Cost was broken down into three factors with four indicators each, opportunity cost (e.g.), effort cost (e.g.) and psychological cost (e.g.) (Battle and Wigfield, 2003; Eccles, 1983). Items were measured on a 6-point scale ranging from 1-strongly disagree to 6-strongly agree. Subscales demonstrate adequate reliability, $\alpha = 0.75\text{--}0.93$.

Metacognitive self-regulation

Metacognitive self-regulation was measured with 12 items from a subscale of the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991) designed to measure the planning, monitoring, and regulating of self-regulatory activities (e.g.). Items were measured on a 6-point scale ranging from 1-not at all true of me to 6-very true of me and demonstrate adequate reliability, $\alpha = 0.70$ (Pintrich et al., 1991).

Data analyses

Recent advancements in network analysis have addressed the challenge of estimating and comparing networks across different groups while preserving their unique characteristics (Costantini et al., 2019; Danaher et al., 2014; Guo et al., 2011). Traditional methods, such as estimating separate networks or using information criteria, fail to effectively leverage similarities between groups without obscuring their differences. Here, joint estimation of graphical models was conducted using the Fused Graphical Lasso (FGL). Building upon the graphical lasso methodology, the FGL introduces additional tuning parameters to penalize differences between group networks, facilitating the identification of shared edges while preserving group distinctions. This approach builds on traditional methods using partial correlation networks for cross-sectional data (Costantini et al., 2015), which rely on regularization techniques like the least absolute shrinkage and selection operator (lasso; Tibshirani, 1996) to handle overfitting and instability in estimating partial correlation matrices (Friedman et al., 2008). The FGL promotes network parsimony, enhances model fit by exploiting group similarities, and more accurately identifies true group differences (Danaher et al., 2014). The choice of tuning parameters in regularization is determined through

TABLE 1 Sample demographic information by group.

	Control	Treatment
<i>n</i>	66	70
Age, mean years	20.3	20.6
% Sex		
Male	22.7	30.0
Female	77.3	70.0
% Ethnicity/race		
Black/African American	10.6	7.14
Asian	16.7	17.1
Hispanic or Latino	37.9	38.6
Native Hawaiian/Pacific Islander	6.1	–
White (Non-Hispanic Origin)	16.7	22.9
Two or more races	12.1	14.3

methods like the Extended BIC (EBIC; Chen and Chen, 2008) or cross-validation (Krämer et al., 2009).

To explore stable individual differences and similarities between subjects in the treatment and control groups, two between-subject partial correlation networks were estimated using the FGL joint estimation technique in the R package *EstimateGroupNetwork* (Costantini et al., 2019). Between subject networks provide information on the underlying structure of differences between subjects and can be helpful for illuminating complex interactions between psychological variables within a system (Epskamp et al., 2018a,b). Note that while the FGL improves model fit by exploiting similarities, if true networks are substantially different, it behaves akin to estimating networks independently, enabling the emergence of true differences. The *qgraph* package (Epskamp et al., 2012) was used for network visualization and centrality estimates. Tuning parameter selection was conducted via EBIC and consistent with package *qgraph*'s function *EBICglasso*. Network structures were analyzed using the means of survey responses taken at the end of the semester for each individual.

The predictability of individual variables constituting the motivational system was assessed as the extent to which the variance of each variable is accounted for by the other nodes in the network (R^2) using Mixed Graphical Models (MGM), implemented in R with the *mgm* package (Haslbeck and Waldorp, 2020). These predictability parameters were integrated into the FGL networks. Spearman correlation coefficients were computed between the lower triangular portions of the adjacency matrices of each network (edge weights) as a measure of overall similarity for each pair of networks. It quantifies the degree to which the rankings of the edge weights in one network correspond to the rankings in the other network. Additionally, mean connectivity values for each network were calculated and compared.

Centrality indices were computed for each joint estimated network to assess the prominence of nodes: (1) strength, quantifying a node's direct connections, (2) closeness, evaluating a node's proximity to others indirectly, (3) betweenness, assessing a node's role in mediating communication along average paths between other nodes (Costantini et al., 2015; Opsahl et al., 2010), and (4) expected

influence, representing the expected impact of each node on other nodes in the network. Nodes are connected to each other through edges, which represent associations between the entities they represent. The structure and properties of the network emerge from the arrangement and characteristics of these nodes and edges (Newman, 2010).

The accuracy of edge parameters and centrality estimates were assessed using the *bootnet* package (Epskamp et al., 2018a,b), employing a bootstrap sampling approach with 10,000-iterations. To gauge the stability of strength centrality metrics, we utilized the correlation stability (CS) coefficient. This involved iteratively correlating centrality metrics between the original dataset and subsamples containing progressively fewer participants. The CS coefficient indicates the maximum proportion of participants that can be removed while ensuring a 95% probability that the correlation between centrality metrics remains at least 0.7, ideally surpassing 0.5 (Epskamp et al., 2018a,b).

Results

Data and code are available on Open Science Framework (OSF) at https://osf.io/f6qwc/?view_only=c35c8f70c9264c56949b139c206497ed (blinded for review).

Preliminary analyses

A series of independent samples t-tests were run for the motivation variables collected at the start of the semester to establish baseline equivalence. Results are provided in Table 2. The t-tests suggest that there are no statistically significant differences between groups and effect sizes were negligible. Baseline network comparisons were too sparse for comparison.

Means, standard deviations and zero-order correlation matrices of the 11 motivation variables at the end of the semester and final exam are presented in Tables 3, 4 for the control and treatment groups, respectively.

TABLE 2 Means, standard deviations, and independent samples t-tests at baseline.

Variable	Control ($n = 66$)		Treatment ($n = 70$)		$t(134)$	p	Cohen's d
	M	SD	M	SD			
Mastery approach	6.22	1.34	6.38	0.74	−0.82	0.41	0.14
Performance approach	5.71	1.26	5.78	1.01	−0.35	0.73	0.06
Performance avoidance	5.67	1.59	5.68	1.46	−0.04	0.97	0.01
Self-efficacy	4.90	0.82	5.06	0.61	−1.23	0.22	0.21
Opportunity cost	2.04	1.07	1.86	0.96	1.02	0.31	−0.18
Effort cost	2.15	0.97	2.09	0.98	0.37	0.71	−0.06
Psychological cost	3.53	1.28	3.68	1.13	−0.68	0.50	0.12
Attainment value	5.25	0.65	5.32	0.57	−0.68	0.50	0.12
Intrinsic value	4.68	0.67	4.84	0.54	−1.57	0.12	0.27
Utility value	4.94	1.00	5.01	0.82	−0.48	0.63	0.08
Metacognitive self-regulation	4.76	0.67	4.77	0.72	−0.09	0.93	0.02

TABLE 3 Means, standard deviations, and zero-order correlations for the control group (*n* = 66).

	1	2	3	4	5	6	7	8	9	10	11	12
1. Final exam	–											
2. Mastery approach	0.09	–										
3. Performance approach	0.12	0.65**	–									
4. Performance avoidance	0.08	0.46**	0.69**	–								
5. Self-efficacy	0.09	0.48**	0.46**	0.24	–							
6. Opportunity cost	–0.28*	–0.10	0.15	0.11	–0.12	–						
7. Effort cost	–0.07	–0.37**	0.01	0.04	–0.15	0.60**	–					
8 Psychological cost	–0.10	0.05	0.08	0.22	–0.16	0.57**	0.43**	–				
9. Attainment value	0.04	0.61**	0.37**	0.26	0.57**	–0.20	–0.32*	0.15	–			
10. Intrinsic value	–0.04	0.53**	0.32*	0.28	0.57**	–0.09	–0.28*	–0.10	0.60**	–		
11. Utility value	–0.19	0.52**	0.51**	0.31*	0.60**	0.16	–0.17	–0.06	0.59**	0.63**	–	
12. Metacognitive self-regulation	0.12	0.45**	0.32*	0.29*	0.39**	0.04	0.15	0.13	0.42**	0.38**	0.25	–
<i>M</i>	60.52	5.79	5.17	5.21	4.49	2.62	2.73	3.78	4.71	3.96	4.29	4.40
<i>SD</i>	27.72	0.97	1.24	1.52	0.85	1.31	1.12	1.14	0.82	1.05	1.13	0.69

p* < 0.05, *p* < 0.01, ****p* < 0.001.

Measurement work was conducted on all of the latent constructs. First, corrected item-total correlations were calculated for all items within their respective construct. Across the constructs, item-total correlations were consistently above 0.03 aside from metacognitive self-regulation which ranged from 0.17 to 0.73. Two of these items that were reverse scored produced corrected item-total correlations <0.03 and were dropped at this point. They also did not correlate with the other items. In addition, a scree test and parallel analysis indicated the presence of two factors rather than one. Inspection of the individual items revealed that items 2, 4, 5, and 6 related more closely to specific study habits and were reading related. Items 3, 7, 9, 10, 11, and 12 seemed to encompass a more global metacognition related to the course. Given the interest in metacognitive self-regulation over study specific habits, items 2, 4, 5, and 6 were dropped. The remaining items were well correlated.

Next, the items were subject to four separate confirmatory factor analyses models using a fixed-mean referent loading approach to identification where items were specified to load on factors in line with scale publishers' hypotheses. For mastery learning, three factors were specified (performance avoidance, mastery orientation, and performance orientation), for expectancy value items, six factors were specified (opportunity cost, effort cost, psychological cost, attainment value, intrinsic value, and utility value), for metacognitive self-regulated learning one factor was specified, and for self-efficacy one factor was specified. The models all demonstrated acceptable fit to the data, Comparative Fit Index (CFI = 0.905–0.962), Tucker-Lewis Index (TLI = 0.890–0.943), and Standardized Root Mean Square Residual (SRMR = 0.040–0.069). Across models, the Root Mean Square Error of Approximation (RMSEA) values ranged from 0.075 to 0.254, however demonstrated wide 90% confidence intervals with lower bounds reaching 0.068. The confidence interval provides a range within which the true population RMSEA is likely to fall, with smaller and more narrow confidence intervals indicate greater precision in estimating the true RMSEA. With a smaller sample size, RMSEA is oversensitive

in rejecting true population models (Hu and Bentler, 1999). Here, the wide confidence intervals indicate this may be affecting its precision (Brown, 2015). Standardized factor loadings were all statistically significant and moderate to large in size, ranging from 0.506 to 0.966. Taken together, and provided the theoretical permissibility of the parameter estimates and sample size considerations, the models provided plausible representations of the underlying structure of the five constructs of interest. Cronbach's alpha ranged from 0.89 to 0.91, indicating good reliability. Means on all subscales were calculated and used for subsequent analyses.

RQ1: Is there evidence of improved self-organization in the motivational systems for students who received the treatment compared to those who engaged in control activities?

Network structure

Network structures of motivation variables were estimated in two sub-groups: (1) students who participated and completed the three part multimedia intervention (Treatment) and (2) students who participated and completed the three part multimedia control activities (Control). A non-paranormal transformation was applied to the data to relax normality assumptions (Liu et al., 2009). The analyses were conducted on multiple sets of imputed data. It should be noted that the small sample size, combined with imputation and data transformation, introduces variability into our results. The networks presented here represent one possible solution. These networks are presented visually in Figure 1.

The motivational system descriptively explained a larger proportion of the variance of variables in the Treatment (mean explained variance 79.82%) versus Control participants (mean explained variance 66.27%). The overall similarity was assessed by computing the correlations between the edge weights across networks for each pair of networks (*r* = 0.88). This means that as the edge weights increase in one network, they tended to increase in the other network as well, and vice versa. The mean connectivity values were

TABLE 4 Means, standard deviations, and zero-order correlations for the treatment group ($n = 70$).

	1	2	3	4	5	6	7	8	9	10	11	12
1. Final exam	–											
2. Mastery approach	0.18	–										
3. Performance approach	0.21	0.69**	–									
4. Performance avoidance	0.24	0.63**	0.85**	–								
5. Self-efficacy	0.29*	0.57**	0.70**	0.50**	–							
6. Opportunity cost	–0.08	–0.52**	–0.43**	–0.43**	–0.36**	–						
7. Effort cost	–0.24	–0.35**	–0.29*	–0.21	–0.18	0.59**	–					
8. Psychological cost	0.19	0.19	0.22	0.26	0.02	0.37**	0.23	–				
9. Attainment value	0.24	0.68**	0.69**	0.60**	0.60**	–0.47**	–0.36**	0.17	–			
10. Intrinsic value	0.10	0.36**	0.23	0.16	0.42**	–0.38**	–0.10	–0.02	0.41**	–		
11. Utility value	0.15	0.32*	0.06	–0.07	0.41**	–0.14	–0.20	–0.00	0.45**	0.64**	–	
12. Metacognitive self-regulation	0.02	0.54**	0.45**	0.28*	0.40**	–0.31*	–0.28*	0.33*	0.33*	0.50**	0.31*	–
<i>M</i>	62.49	5.87	5.52	5.70	4.55	2.56	2.73	4.00	4.83	4.00	4.14	4.49
<i>SD</i>	26.22	0.92	1.11	1.10	0.91	1.23	0.99	1.11	0.81	1.12	1.31	0.87

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

both 0.039. Based on these metrics, the networks in the control and treatment groups exhibit similarity.

While the networks may possess a high level of correspondence in the relative magnitudes of the edge weights between the two networks, there could still be differences in specific edges or connections between nodes. These differences might not be captured adequately by measures such as the mean connectivity or a correlation coefficient alone. To explore differences between the networks, we examine edge-wise comparisons and centrality measures.

In the Control sample, 18 of 66 possible edges (27.27%) were estimated to be above zero. This is notably different than the Treatment sample in which 24 of 66 possible edges (36.36%) were estimated to be above zero. It suggests a relatively larger number of edges play significant roles in connecting different nodes and controlling the flow of information or interactions within the network for the Treatment condition. These edges likely act as bridges or bottlenecks, influencing the overall network structure and dynamics. In the Control sample, absolute edge values ranged from -0.104 (effort cost with final exam) to 0.457 (performance orientation and performance avoidance). In the Treatment sample, absolute edge values ranged from -0.125 (perceptions of intrinsic value with opportunity cost) to 0.438 (performance approach orientation and performance avoidance orientation). All edges present in the Control network were also present in the Treatment network. There are also notable absences between nodes in the both groups. This suggests that some measured variables may have acted statistically independent when considering all other variables in the motivational system (their partial correlation is zero), or that there was not enough statistical power to detect a connection between them. In terms of unique edges in the Treatment condition, self-efficacy was connected to final exam (0.107), opportunity cost was marginally connected to mastery orientation (-0.009), attainment value was connected to performance approach orientation (0.150), opportunity cost was connected to attainment value (-0.112) and intrinsic value (-0.125), and metacognitive self-regulation were marginally connected to utility value (0.015).

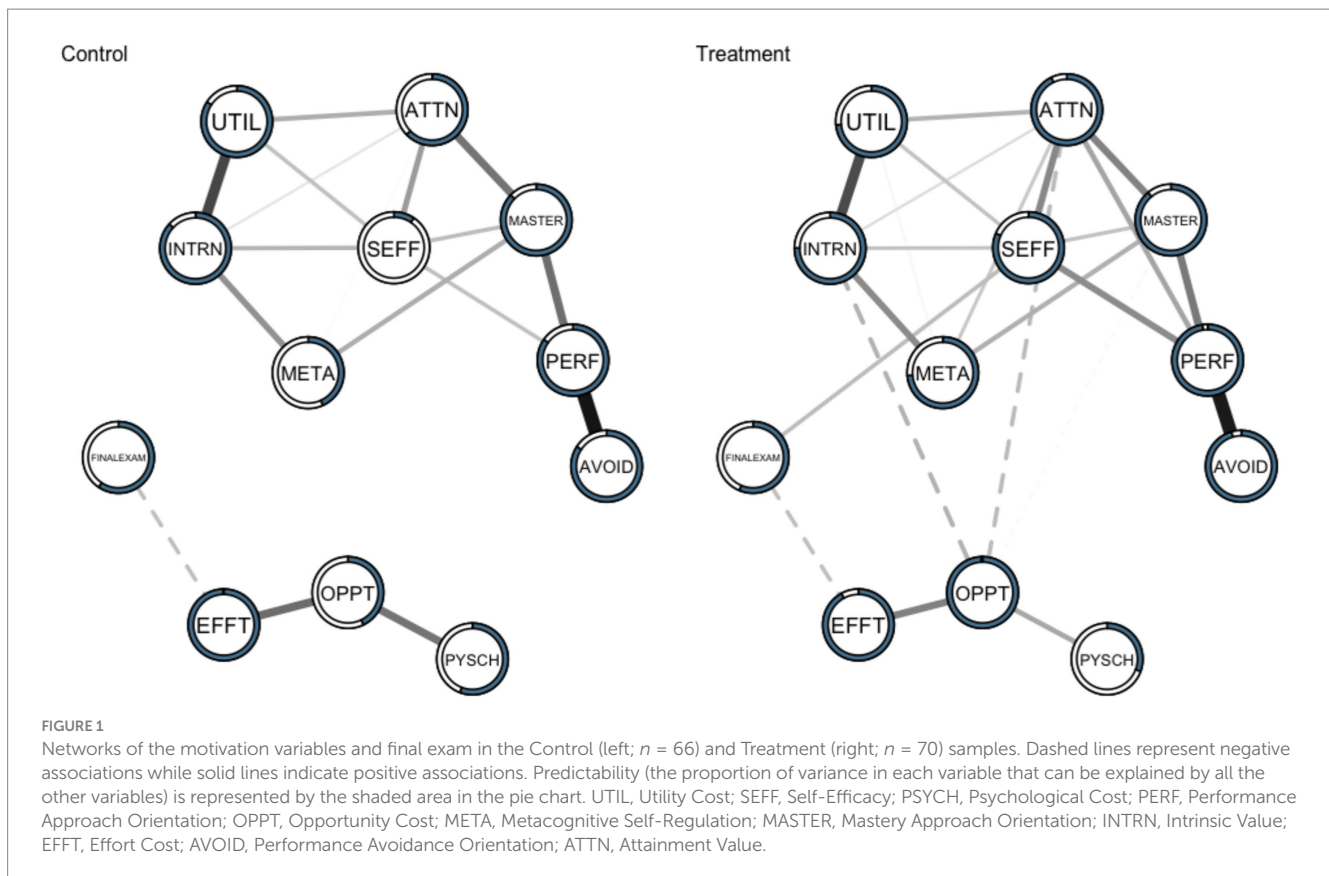
RQ2: For students who received the treatment, where their shifts in the betweenness, closeness, and strength of relationships among variables that aligned with motivational theory?

Centrality indices

Without understanding the reliability of the network structure and the consistency of centrality estimates, it is difficult to determine if the variations in centrality estimates are meaningful or not. We calculated the maximum drop proportions needed to retain a correlation of 0.7 in at least 95% of the samples for various network metrics using bootstrap network estimation methods so that the spread of parameter and centrality estimates could be assessed. Simulation studies suggest that a correlation stability (CS) coefficient should ideally be above 0.5 and not below 0.25 to interpret centrality differences meaningfully (Epskamp et al., 2018a,b). CS coefficients suggest that the jointly estimated between-network edge centrality estimates (0.500) and strength centrality estimates (0.500) demonstrate adequate stability. CS coefficients for betweenness (0.051) and closeness (0.147), however, were below the recommended threshold for interpretability. The small sample size is likely to blame as networks with increasing sample sizes are estimated more accurately. In addition, sparsity in the network structure (when many edge-weights are expected to equal zero) can introduce bias in the bootstrapping (Epskamp et al., 2018a,b). We present all of these metrics here with this caution and emphasize that betweenness and closeness may not be interpretable with the present sample. Figure 2 shows centrality indices for all variables for both samples.

Discussion

The purpose of this study was to explore the application of a novel network analysis technique (Fused Graphical Lasso; Costantini et al., 2019; Danaher et al., 2014) to examine the effects of a brief multimedia self-regulated learning intervention in gateway biology



courses on the motivational self-system. We emphasize that the results presented are exploratory in nature and should not be interpreted with generalizability in mind. The small sample size presents a severe limitation to the reliability of the results. As noted by [Danaher et al. \(2014\)](#), complex network analysis techniques like Fused Graphical Lasso do not function well with small samples, leading to high false discovery rates. We offer an interpretation of the networks here to demonstrate the potential of using network analysis to uncover subtle differences in motivational dynamics between intervention and control groups, providing a more nuanced perspective on treatment effects that may not be evident through traditional statistical approaches.

Our findings suggest that, while the treatment and control networks remained correlated, there were non-trivial differences in the edge weights between groups that may be attributed to the treatment. In the control group, effort cost in the motivation system is related to final exam performance, and the three cost variables are disconnected from the rest of the motivational system. These findings suggest that for students who did not receive treatment, sunken effort was negatively associated with exam performance—i.e., effort that is expended without reward is costly ([Inzlicht et al., 2018](#)). However, we saw the emergence of a statistical relationship between self-efficacy and final exam performance in the treatment group that was not present in the control group, accompanied by an increase in the amount of variance explained in self-efficacy. The increasing role of self-efficacy in the treatment group co-occurred with the emergence of statistical relationships between attainment value and performance orientation (+), attainment value and metacognition (+), attainment value and

opportunity cost (−), as well as intrinsic motivation and opportunity cost (−). The emergence of these edges led to higher betweenness values for attainment value, opportunity cost, and self-efficacy in the treatment group. These changes may be indicative of a self-organizing motivational system, where the treatment simultaneously enhanced confidence, raised perceptions of attainment value, and lowered the perception that other opportunities were more important than preparing for the final exam. The SRL strategy based interventions may have positioned the students motivationally to approach the challenging exam through activating the role of value and self-efficacy in their learning.

While these results are exploratory, there are important potential implications for future research. Evidence of improved academic achievement after SRL interventions in online and digitally rich hybrid classes is mixed and the impact of these interventions on achievement produces a wide range of effect sizes, most typically hovering around moderate to small ([Heikkinen et al., 2023](#); [Theobald, 2021](#); [Xu et al., 2023](#)). In the current sample we did not find a significant difference between treatment and control on mean level course performance, likely due to insufficient power. In addition, there were no significant differences in motivational variables between the groups in t-tests, though sample size is likely a consideration. Even so, many of the ways analyses of typical intervention studies are conducted ignore the underlying complexity of what motivates individuals ([Marchand and Hilpert, 2024](#)). Here we see promising evidence to suggest that students who received the treatment were likely better poised motivationally to succeed on the final exam in the class. While this did not translate into significant exam differences overall, the FGL provided a way to look more closely at treatment

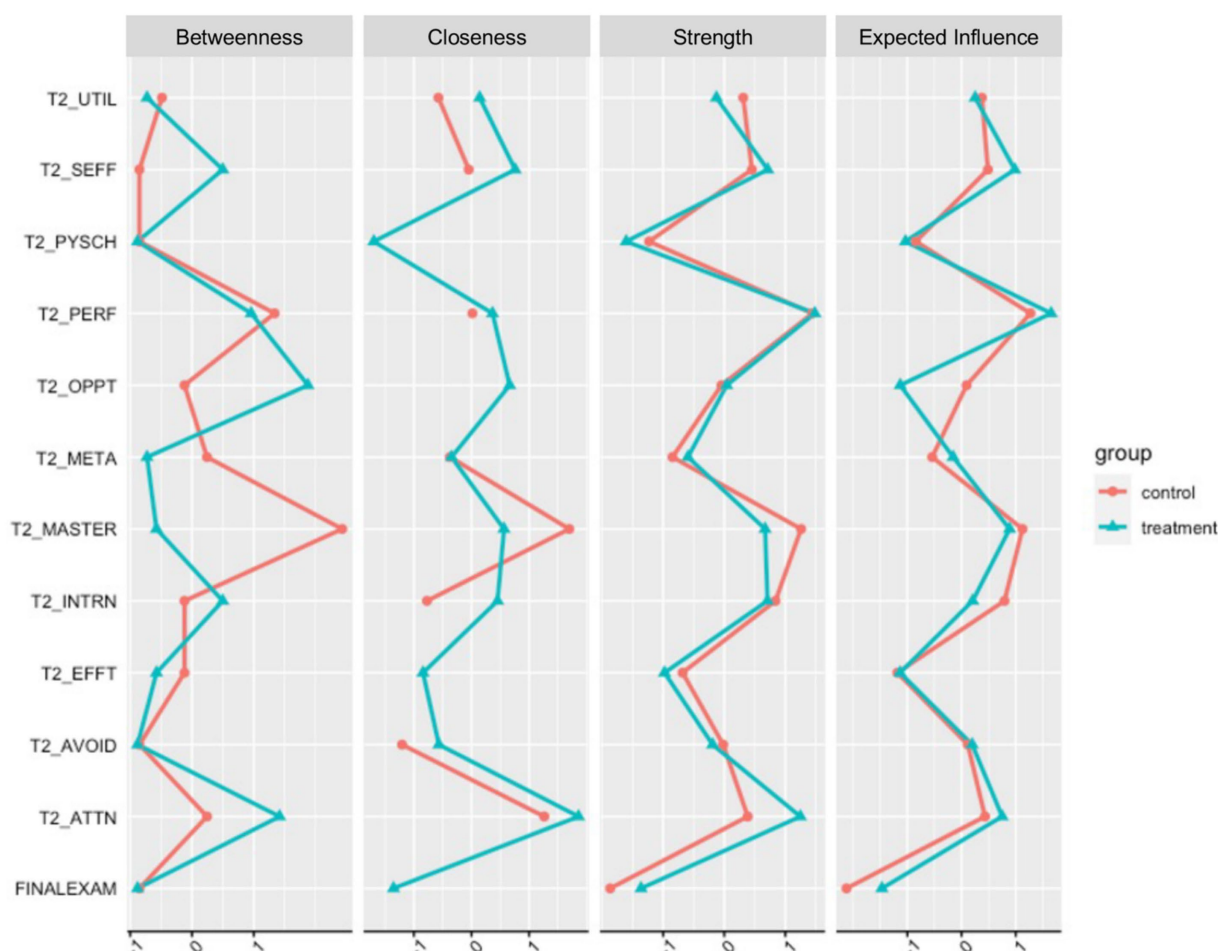


FIGURE 2

Nodes centralities for each of the variables in the motivational system for the Control (red; $n = 66$) and Treatment (blue; $n = 70$) samples. For ease of comparison, centrality values were standardized (z-scored) in each sample. UTIL, Utility Cost; SEFF, Self-Efficacy; PSYCH, Psychological Cost; PERF, Performance Approach Orientation; OPPT, Opportunity Cost; META, Metacognitive Self-Regulation; MASTER, Mastery Approach Orientation; INTRN, Intrinsic Value; EFFT, Effort Cost; AVOID, Performance Avoidance Orientation; ATTN, Attainment Value.

effects that may otherwise be missed in the pursuit of a significance threshold.

These findings suggest that SRL interventions may be most effective when they simultaneously target multiple facets of motivation, such as strengthening self-efficacy while reducing perceived opportunity costs. Instructors and instructional designers may consider integrating SRL strategies that explicitly address these motivational components to better support students in challenging academic settings. Interventions may be made more effective by incorporating reflective exercises that help students recognize their progress and align their learning goals with personal values, thereby reinforcing motivation throughout the course. This study also provides preliminary evidence how Gaussian Graphical Modeling (Epskamp, 2020), may be valuable in preserving the integrity of complex systems and examining relevant shifts in variations between motivational systems between groups and individuals. Future research should aim for larger sample sizes to enhance the robustness of network analysis findings and to further validate the application of these methods in understanding self-regulated learning interventions.

Data availability statement

The datasets presented in this study can be found in online repositories. Data and code are available on Open Science Framework (OSF) at https://osf.io/f6qwc/?view_only=ca29cf78206d4034858056428c20e62f.

Ethics statement

The studies involving humans were approved by University of Nevada Las Vegas Social/Behavioral IRB. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

SW: Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing, Conceptualization. JH:

Funding acquisition, Methodology, Project administration, Writing – original draft, Writing – review & editing, Conceptualization. MB: Funding acquisition, Project administration, Writing – review & editing, Investigation, Supervision. JG: Funding acquisition, Investigation, Project administration, Supervision, Writing – review & editing. CS: Project administration, Funding acquisition, Investigation, Writing – review & editing.

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Validation of the self-regulation of learning instrument for undergraduates

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Introduction: Self-regulation of learning is an essential variable in university students' educational process and integral development, especially in the first semesters. Given its relevance, significant, valid, and reliable instruments are required for its measurement. Therefore, this study aimed to determine the psychometric properties of the SRLI-U scale that assesses Self-Regulation of Learning in Undergraduates.

Methods: An instrumental design was used, and the questionnaire was administered to 348 Chilean first-year university students (60.1% female) aged between 18 and 21 years ($M = 18.85$; $SD = 0.773$).

Results: Adequate adjustment indexes of the second order model were evidenced considering three dimensions theoretically coherent with Zimmerman's model (1) Learning Disposition, $\Omega = 0.861$, (2) Learning Performance, $\Omega = 0.842$, and (3) Learning Self-evaluation, $\Omega = 0.887$; and a general factor $\Omega = 0.936$.

Conclusion: It is a valid and reliable instrument for evaluating levels of self-regulation in Chilean university students.

Discussion: The SRLI-U constitutes a valuable tool for educational practice because it allows for evaluating, monitoring, and intervening the self-regulation of learning levels. Theoretical and practical implications are discussed, as well as the study's limitations.

KEYWORDS

self-regulation of learning, higher education, university students, questionnaire, psychometrics, SRL, validation

1 Introduction

Self-regulation of learning (SRL) is a fundamental aspect of the educational process, especially in the university context and during the first semesters (Pérez et al., 2021). Indeed, at this educational level, students face a more demanding and broader curriculum, challenging teaching styles and evaluations, compared to their experience at the previous academic level (middle school). Hence, at this stage, learning difficulties increase. However, when students are self-regulated, they can adapt more quickly to these changing demands (Sáez-Delgado et al., 2023). Thus, students' displayed capacity to manage their learning processes is crucial

for academic success, long-term skill development, and career retention (López-Angulo et al., 2023).

The importance of SRL is based on the following aspects: (a) Increased academic performance, as the evidence available at different academic levels solidly demonstrates that those students who possess self-regulation skills achieve optimal or outstanding performances; (b) Adaptability and flexibility, given that SRL implies adjusting strategies according to specific needs and challenges; (c) Development of metacognitive skills, since SRL involves reflection on the learning process itself, where students have to evaluate their understanding, identify areas for improvement and adjust their approach to achieve effective learning; (d) Reduction of anxiety, since the ability to self-regulate allows students to manage anxiety related to exams, deadlines and academic tasks because they have goals and a clear study strategy, which makes them feel more confident and prepared; (e) Promotion of autonomy, this is because SRL empowers students by making them active agents of their own learning process instead of relying exclusively on the teacher's instruction, where they are able to make informed and autonomous decisions; and (f) Ability transfer, it can be stated that self-regulation skills not only benefit the academic setting, but also apply to everyday life and/or future professional careers, i.e., students who learn to self-regulate are better prepared to face challenges in any context (Dent and Koenka, 2016; López-Angulo et al., 2022; Sáez-Delgado et al., 2018). In summary, SRL is an essential component for the comprehensive development of university students.

Self-regulated students are characterized by their ability to initiate cognitive, metacognitive, affective, and motivational processes. They can set their objectives, establish clear goals, plan their work, and monitor their progress by reflecting on their learning. Self-regulating their process allows them to optimize their time and effort, which translates into greater probabilities of success (Wong et al., 2019). In contrast, students with limited application of SRL strategies in their formative instances do not obtain good results (Psathas et al., 2023; Sáez-Delgado et al., 2021, 2023) and may present a risk of dropout (López-Angulo et al., 2023). Therefore, fostering these skills contributes significantly to their academic success and personal and professional growth.

1.1 Self-regulation of learning theoretical models

There are different SRL models available in the literature to define this construct and its components (for an in-depth review of each model, it is suggested to consult the works of Panadero, 2017; Puustinen and Pulkkinen, 2001). However, all of them agree that the student is the primary agent of his/her learning, has the responsibility, and can learn in interaction with the context. The present study is based on Zimmerman's theoretical model (Zimmerman, 2000), chosen mainly for its outstanding recognition at the international level (Wong et al., 2019) and for its ease of operationalization. This approach considers SRL as a competence developed through different tasks and environments.

The model proposed by Zimmerman (2000) considers a socio-cognitive perspective and emphasizes on strategies with complex and dynamic interactions influencing the students' engagement and effort toward optimal learning and performance, which are enhanced in highly autonomous learning environments. This author described SRL

processes as triadic, referring to the dynamic influence of self-regulatory processes on environmental events, personal, behavioral factors. Thus, he distinguished three phases of self-regulation that function in a cyclical, interrelated, and recursive manner during the learning process: disposition, performance, and self-evaluation (Zimmerman, 2013).

In the first phase, disposition, self-regulated learners are expected to actively engage in task analysis processes (i.e., goal setting and planning, designing a strategy for their learning). Then, the performance phase is activated when learners employ strategies to process learning material, seek help when needed, manage their time, structure their environment, and control their learning processes, being able to implement self-monitoring (i.e., self-instructions, focusing attention) and self-observation (i.e., self-registration and self-experimentation) strategies. Finally, the third phase self-evaluation occurs when students must assess their performance and adjust their strategies to achieve their learning objectives, i.e., self-judgment (self-evaluation of their learning process and causal attributions, and adaptation or defense) occurs in the final phase. These three phases repeat cyclically and iteratively throughout the learning process (Zimmerman, 2000). This description highlights that SRL is a multidimensional, complex, and recursive phenomenon that involves a set of cognitive, social, metacognitive, and behavioral processes whose interlocking is articulated in a cyclical model (Sáez-Delgado et al., 2022, 2023).

The ability of students to regulate their learning process is related to their commitment and achievement of personal learning objectives (Moreno-Marcos et al., 2020). However, one of the highly documented problems in education is that students often exhibit suboptimal levels of SRL at different levels of their academic trajectory (Sáez-Delgado et al., 2023), which in higher education makes them more likely to drop out of their programs of study (López-Angulo et al., 2023). Therefore, to describe, analyze and intervene in the promotion of this process, it is necessary to have a relevant and valid instrument.

Regarding the above, self-report measures constitute one of the primary methods for assessing SRL due to their relative ease of administration and scoring. However, psychometric properties are a fundamental need when assessing the quality of such measurement protocols (Roth et al., 2016).

1.2 Instruments for measuring self-regulation of learning in university students

A systematic literature review characterized various measurement instruments on SRL designed for students at different educational levels (León-Ron et al., 2020). The findings showed 31 instruments available, of which 57.5% correspond to instruments developed, adapted and validated in Higher Education. About the countries where these psychometric studies have been conducted, 24 countries were identified; however, it is in Europe where more psychometric studies on SRL were developed (40%); on the contrary, Central and South America and Oceania represented the lowest percentage (10 and 3%, respectively). This gap has been documented in other research, which indicates that Latin America is in the preliminary stage of developing of instruments to measure SRL and that further studies are required (López-Angulo et al., 2020).

An analysis of the instruments developed to measure SRL in university students allowed the authors of the present study to make a classification. Firstly, some instruments measure specific skills and strategies for learning, for example, a second language. Secondly, instruments focused on specific contexts, such as professions or online teaching modalities. Other instruments have been developed based on theoretical models other than Zimmerman's. Finally, there are instruments developed based on Zimmerman's theoretical model. In the following sections, we will analyze each category in detail.

Among the instruments that aim to know how students use specific SRL skills and strategies to learn a second language, an item example is: *For me, successful learning of English is more important than my grades or opinion of my teachers, family, or Friends* (e.g., Salehi and Jafari, 2015; Teng and Zhang, 2016). Other instruments along the same lines are those focused on assessing the use of SRL in specific skills, such as writing. An item example is: *When writing, I use some literary devices to make the composition more interesting* (e.g., Teng and Zhang, 2016). For reading comprehension, an item example is: *From that first glance, I question myself to the point of clarifying what I know about the subject* (e.g., Solano-Pizarro et al., 2004). In these cases, the content of the items covers aspects of language learning and writing. Thus, the items not only assess the process of self-regulation but also reflect the context in which they are being assessed.

Other instruments focus on specific contexts, either linked to a specific profession, career, or course modality (e.g., Iyama and Maeda, 2018). An item example is: *Using my own words, I want to explain important points I have learned in my clinical nursing practice*. A significant limitation is that the scale is titled "Development of the Self-Regulated Learning Scale in Clinical Nursing Practice for nursing students," and it is composed of only two subscales, one for motivation and one for learning strategies. Another instrument of this group is that of Barnard et al. (2010), which evaluates learning in online courses. An item example is: *I set standards for my assignments in online courses* (Barnard et al., 2010).

There are also instruments developed with theoretical models other than Zimmerman (2000), such as the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1993), which is based on Pintrich (2000) model and comprises two dimensions: Motivation and Learning Strategies.

Of the questionnaires that were developed based on Zimmerman's theoretical model, the Academic Self-Regulated Learning Scale (A-SRL-S) (Magno, 2010) is composed of seven factors: memory strategy, goal setting, self-evaluation, help seeking, structuring the environment, responsibility for learning, and planning and organization. Similarly, the Learning and Study Strategies Inventory (LASSI) (Weinstein and Palmer, 2002) covers three dimensions: ability, disposition, and self-regulation. Although both instruments explicitly measure SRL, they do not exhaustively evaluate the aspects contained in Zimmerman's model. Also, there is the Inventory of Self-Regulation of Learning Processes (IPAA) (Rosário et al., 2007), has a significant limitation: the items that make up the scale are not univocal, some items evaluate two actions in one sentence, which can cause confusion. Therefore, the items must be specific and capable of capturing the abstract construct they intend to measure to guarantee the validity of the scales (Löhr, 2022; Diamantopoulos et al., 2012; Lilienfeld and Strother, 2020; Tavakol and Wetzell, 2020). Conversely, it may have significant consequences in the measurement error of latent variables (Rhemtulla et al., 2020).

A scale that overcomes these limitations and is based on Zimmerman's theoretical model is the Instrument to Measure Self-Regulation of Learning Phases (Sáez-Delgado et al., 2022), which was designed to measure the three phases of the SRL process (disposition, performance and evaluation) in Chilean secondary students. This scale has several advantages: (1) It considers the different dimensions (behavioral, motivational and cognitive) that are part of the study and learning processes of students (Roth et al., 2016); (2) It is based on Zimmerman (2000) theoretical model of SRL phases; (3) It showed good adjustment indexes in the original study; and (4) It allows identifying those variables with inadequate levels. Therefore, it is presented as an alternative and valuable scale to measure SRL in university students.

1.3 The present study: gap and research questions

Despite the relevance of the SRL, to our knowledge, there are no validations of the Instrument to Measure Self-Regulation of Learning Phases (Sáez-Delgado et al., 2022) in university students. Therefore, the general objective of this research was to validate and estimate the psychometric properties of an instrument to measure the phases of self-regulation of learning in Chilean university students. Specifically, we sought answers to the following questions:

- QR1: What is the factorial structure of the Instrument for Measuring the Self-Regulation of Learning Phases in Chilean university students?
- QR2: What are the discriminant validity indices of the Instrument for Measuring the Self-Regulation of Learning Phases in Chilean university students?
- QR3: What are the reliability indices of the Instrument for Measuring the Self-Regulation of Learning Phases of in Chilean university students?

2 Methods

2.1 Design

An instrumental design was used to carry out the study, which according to the classification of Ato et al. (2013), it considers the psychometric characteristics analysis of the Instrument to Measure Self-Regulation of Learning Phases (Sáez-Delgado et al., 2022) in a sample of Chileans university students.

2.2 Participants

Participants comprised 348 first-year university students from STEMS careers university in southern Chile participated. Of the total 136 were men (39.1%), 209 women (60.1%), and 3 preferred not to say (0.9%). Their ages ranged from 18 to 21 years ($M = 18.85$; $SD = 0.773$). Non-probability convenience sampling was used, considering the cohort of first-year students.

2.3 Instruments

Scale to measure self-regulation of learning phases (Sáez-Delgado et al., 2022): is composed of three subscales that account for the process of self-regulation of learning in consonance with the cyclical model proposed by Zimmerman (2000). It is a self-report instrument with a 7-point Likert scale, ranging from 1 meaning never to 7 meaning always. The validation with high school students showed adequate psychometric properties, with a structure composed of three factors. The first scale, before studying (Learning Disposition Phase), is composed of 5 items that measure the frequency with which students use self-regulation strategies to prepare for their study, e.g., “Before starting to study, I set short-term academic goals (daily, weekly),” and reliability was adequate ($\alpha > 0.79$; $\Omega > 0.82$). The second scale, while studying (Learning Performance Phase) is composed of 6 items and measures the frequency with which students use strategies to control their study based on a previously established planning that includes the goals to be achieved, e.g., “While studying, I check if I am learning,” and the reliability was adequate ($\alpha > 0.87$; $\Omega > 0.91$). The third scale, after studying (Learning Self-evaluation Phase), is composed of 5 items and measures the frequency with which students reflect on the results obtained in some school task or test, e.g., “When I finish studying, I self-evaluate whether I made progress in relation to my previous knowledge,” and reliability was adequate ($\alpha > 0.85$; $\Omega > 0.87$). The items’ average represents the score for each scale. Frequency values for using self-regulation strategies indicate: (a) Learners at optimal SRL levels (6–7 points), (b) Learners at suboptimal SRL levels (3–5), (c) Learners at insufficient SRL levels (1–2).

Meaning in life questionnaire (Steger et al., 2006): consists of 10 items designed to assess the meaning of life. This instrument was translated into Spanish through translation and back-translation, thus ensuring its linguistic equivalence. The questionnaire is composed of two subscales: “Presence of Meaning,” which includes items 1, 4, 5, 6, and 9; and “Search for Meaning,” which comprises items 2, 3, 7, 8, and 10. The answers in the questionnaire are given through a Likert-type scale, ranging from 1 (totally false) to 7 (totally true).

Additionally, sociodemographic data was collected, including sex, age, career, and other data relevant to the study.

2.4 Procedure

Data collection was carried out as part of a larger research project. The project coordinators established contact with the academic authorities to whom the purpose of the study was explained. After obtaining their authorization, dates for administering the questionnaires were agreed upon. The surveyors entered the classrooms, offered students the opportunity to participate after explaining the objectives of the research. Those students who agreed to participate signed an informed consent form before completing the questionnaire. The Ethics Committee CEBB1394-2023 approved this research.

2.5 Data analysis

First, descriptive analyses of the items that make up the instrument were performed to evaluate their distribution using

descriptive statistics, together with skewness and kurtosis coefficients. To examine the factorial structure, a Confirmatory Factor Analysis (CFA) was implemented to evaluate its underlying structure and compare its settings (Bollen, 1989). The Robust Maximum Likelihood Estimation (MLR) method was used, which does not require normality of the data due to its robustness in identifying significant effects (Lloret-Segura et al., 2014). The analysis was carried out with MPlus 8.4 software, evaluating the model fit using several indices: a non-significant Chi-square value ($p \geq 0.05$) (Tabachnik and Fidell, 2007), a Root mean square error of approximation (RMSEA) and Standardized root mean square residual (SRMR) below 0.07, and a 90% confidence interval (CI) between 0.000–0.050 (Hu and Bentler, 1999; Steiger, 2007), and Comparative fit index (CFI) and Tucker-Lewis Index (TLI) values above 0.94, in addition to requiring that the factor loadings of the items be significant and above the threshold of 0.40 (Hair et al., 2014). Correlations between dimensions and items were also performed to deepen the analysis. In addition, as part of the construct validation, discriminant validity analyses were performed, implying that two theoretically unrelated variables reflected on low or non-existent correlations. In this research, which explores validity based on discriminant measures, correlations of magnitude < 0.50 indicate that the instruments assess different constructs. Validity was estimated with the Meaning in Life Questionnaire (Steger et al., 2006). Reliability was calculated using McDonald (1978) Omega coefficient (Ω), a measure considered more accurate than the alpha coefficient since it considers factor loadings rather than simply the number of items or response options (Hayes and Coutts, 2020), expecting to obtain values above 0.70. The JASP software version 0.8.3.1 was used for this calculation.

3 Results

Table 1 shows the descriptive statistics for the 16 items of the instrument. The scores for all items were slightly higher than the scale’s midpoint. The analysis of skewness and kurtosis presented values according to expectations, so a normal distribution is assumed (Hatem et al., 2022).

3.1 QR1: analysis of the factorial structure

Exploratory CFAs were performed to evaluate the factorial structure of the instrument form measuring the self-regulation of learning phases since these analyses allow the modeling of different factorial solutions (Bollen, 1989; Schmitt, 2011). Table 2 presents the fit results obtained for the different models tested.

First, a CFA was performed considering the three subscales suggested by the creators of the instrument (Sáez-Delgado et al., 2022); as can be seen, only subscale 2 had adequate fit indices, so it was decided to test a solution of three first-order related factors. However, it did not fit as expected.

Given this scenario, it was decided to respecify the model, considering the trajectories indicated by the Mplus through the analysis of the modification indexes. The relationships were only added considering their theoretical sense; since this instrument

TABLE 1 Descriptive statistics of the SRLI-U items.

Items	Mean	Standard deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Error	Statistic	Error
1	4.97	1.536	−0.715	0.131	0.061	0.261
2	5.16	1.396	−0.770	0.131	0.408	0.261
3	4.45	1.789	−0.310	0.131	−0.879	0.261
4	5.50	1.469	−1.253	0.131	1.332	0.261
5	5.15	1.561	−0.875	0.131	0.282	0.261
6	5.05	1.538	−0.780	0.131	0.062	0.261
7	5.32	1.275	−0.759	0.131	0.407	0.261
8	5.07	1.466	−0.808	0.131	0.286	0.261
9	5.39	1.346	−1.074	0.131	1.076	0.261
10	5.43	1.516	−1.175	0.131	0.914	0.261
11	5.28	1.293	−0.804	0.131	0.697	0.261
12	5.10	1.478	−0.793	0.131	0.363	0.261
13	5.12	1.499	−0.749	0.131	0.094	0.261
14	4.84	1.734	−0.628	0.131	−0.438	0.261
15	5.11	1.525	−0.769	0.131	0.085	0.261
16	4.86	1.708	−0.664	0.131	−0.369	0.261

TABLE 2 Estimates of the analyzed models.

Model	χ^2	Df	RMSEA	(90% CI)	SRMR	CFI	TLI
Learning Disposition Phase	28.042*	5	0.115	0.076–0.158	0.036	0.943	0.886
Learning Performance Phase	13.115*	9	0.036	0.000–0.076	0.022	0.992	0.986
Learning Self-evaluation Phase	30.638*	5	0.121	0.082–0.164	0.040	0.930	0.861
Three related first-order factors	404.433*	101	0.093	0.084–0.103	0.059	0.860	0.833
One second-order factor and three first-order factors	404.433*	101	0.093	0.084–0.103	0.059	0.860	0.833
One second-order factor and three first-order factors with modification indexes	234.222*	97	0.064	0.053–0.074	0.045	0.937	0.923

* $p < 0.05$.

accounts for a theoretical model of three related and sequential phases, items sharing similar contents, although belonging to different factors, tended to show linked residuals. In this case, the residuals of items 10 and 4 ($MI = 69.347$), 13 and 12 ($MI = 45.193$), 16 and 3 ($MI = 27.149$), and 14 and 10 ($MI = 22.738$) were correlated. These pairs of items allude in their wording to the conditions of the place chosen to study, self-evaluation of the fulfillment of study goals, elaboration of a schedule to organize study time, and conditions of the place chosen to study, respectively. Thus, a better fit was obtained in the model. As shown in Table 2, the last solution

is the one that presented the best fit and is consistent with the theoretical approach of (Zimmerman, 2000), a structure of one second-order factor and three first-order factors is confirmed.

Table 3 reports the factor loadings obtained for the three factors proposed for the analysis, all of which presented significant loadings in the second order factor. All items had loadings above 0.40; this reflects adequate levels of association in all items of the instrument with respect to the dimensions, thus confirming three dimensions: (1) Learning Disposition, (2) Learning Performance and (3) Learning Self-evaluation (see Table 3).

TABLE 3 Factor loadings for the SRLI-U.

Items	F1	F2	F3
1	0.752**		
2	0.823**		
3	0.703**		
4	0.672**		
5	0.699**		
6		0.677**	
7		0.748**	
8		0.810**	
9		0.817**	
10		0.692**	
11		0.860**	
12			0.752**
13			0.788**
14			0.737**
15			0.854**
16			0.699**

** $p < 0.01$.

TABLE 4 Item-dimension correlations.

Items	F1	F2	F3
1	0.811 **		
2	0.824**		
3	0.838**		
4	0.728**		
5	0.780**		
6		0.756**	
7		0.809**	
8		0.864**	
9		0.823**	
10		0.756**	
11		0.860**	
12			0.798**
13			0.831**
14			0.815**
15			0.844**
16			0.790**

** $p < 0.01$.

As for the correlations of the instrument items, Table 4 shows that all items correlated significantly with the dimension to which they correspond, reflecting adequate levels of association in all instrument items concerning their dimensions.

Considering this confirmed structure, it is different from what the authors proposed in the original version of the instrument (Sáez-Delgado et al., 2022), presenting a structure composed of three interrelated dimensions, which in turn forms a global construct that

accounts for the process of self-regulation of learning, its cyclicity, and functioning by phases (Figure 1).

This confirms a second-order factorial model composed of 16 items, where factor 1 (learning disposition) measures aspects related to the self-regulation strategies used by students to prepare their study, for example, setting academic goals, preparing materials, making a schedule, defining a suitable place and prioritizing a to-do list; factor 2 (learning performance) refers to the self-regulatory learning strategies that students use to monitor their study based on the previously established planning that includes self-monitoring while studying, i.e., checking if the time is sufficient, if the learning strategies they are using are effective, if the materials are sufficient, if the place is adequate, if they are meeting or not meeting the study goals, and checking if they are learning; factor 3 (learning self-evaluation) captures the self-regulation strategies of learning that students use to verify and self-evaluate the effectiveness of the study planning executed, i.e., self-evaluate if they made progress with respect to previous knowledge, if they met the goals they set, if the place was adequate, if the learning strategies were effective, and if they met the schedule. These factors make up a general factor, which based on the theoretical meaning of the items, will be called Phases of Self-Regulation of Learning, see Annex 1.

3.2 QR2: analysis of discriminant validity indices

With the Meaning in Life scale (Steger et al., 2006), validity based on divergent measures was explored. The results in the table indicated the existence of significant correlations between the factors of the instruments, with a range from $r = 0.303$ to $r = 0.359$; despite this, it has a low magnitude (Table 5). These findings suggest that both instruments are assessing different constructs.

3.3 QR3: analysis of reliability indices

As shown in Table 6, each dimension of the scale has adequate indices, being higher than 0.70 and lower than 0.93. These coefficients suggest that the dimensions and the instrument are reliable for measuring the phases of self-regulation of learning in Chilean university students.

4 Discussion

This research aimed to validate and estimate the psychometric properties of the Self-Regulation of Learning Instrument for Undergraduates (SRLI-U), which arose from the need for a valid and reliable instrument with these characteristics in Chilean university students. The main results are discussed below, along with the conclusions, limitations and future lines of research.

The results confirm the instrument's validity and reliability and the SRL's phased functioning. However, unlike its original version with Chilean high school students, the questionnaire presents a structure of three interrelated dimensions (learning disposition, learning performance and learning self-evaluation) that integrate a global construct on SRL. It is inferred that this difference between both scales

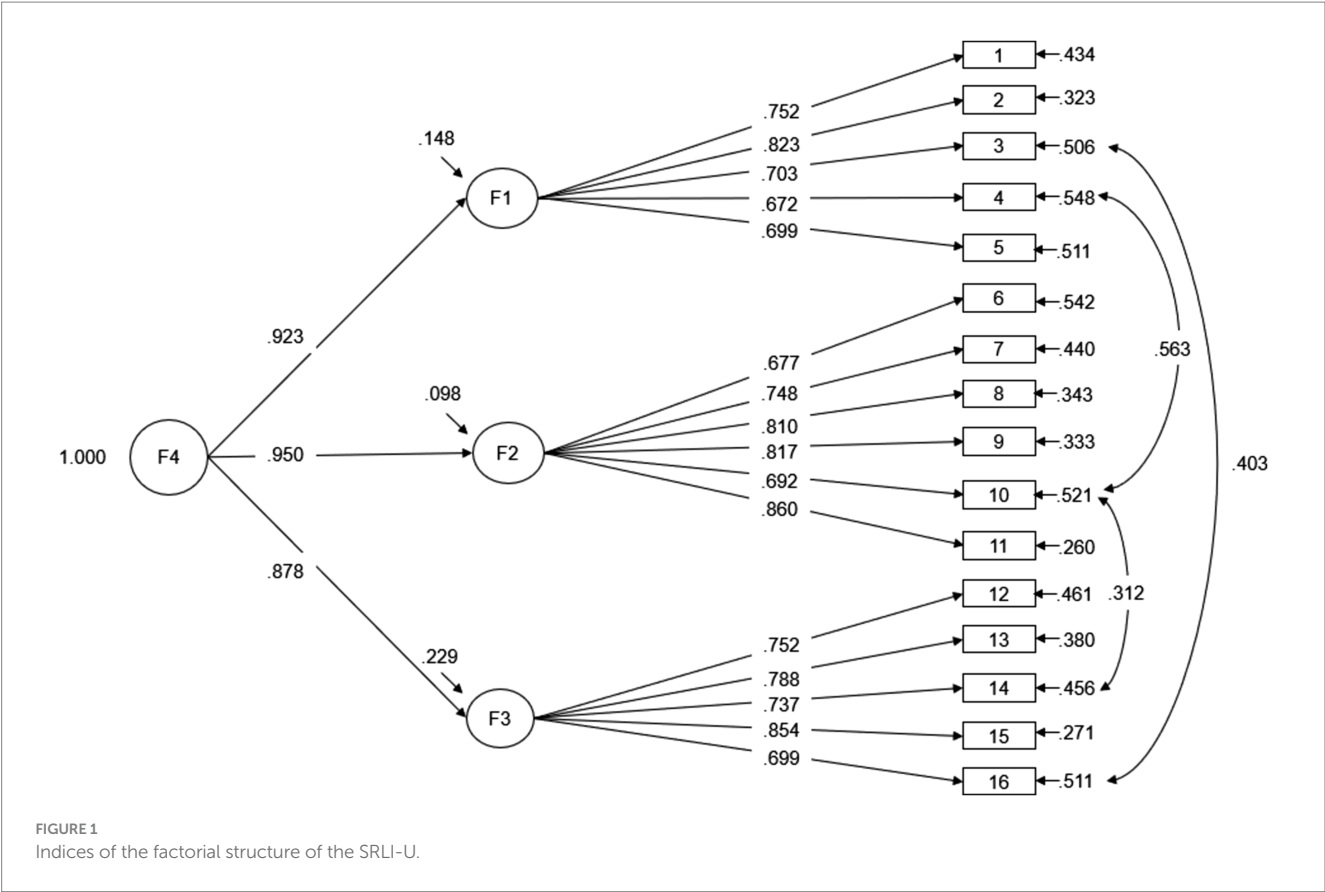


TABLE 5 Correlations between variables.

Variables	1	2	3	4	5
(1) Learning disposition	1.000				
(2) Learning performance	0.747**	1.000			
(3) Learning self-evaluation	0.679**	0.749**	1.000		
(4) Presence of meaning	0.359**	0.358**	0.338**	1.000	
(5) Search for meaning	0.303**	0.303**	0.318**	0.303**	1.000

** $p < 0.01$.

is due to a greater metacognitive capacity of university students compared to high school students since these skills are developed over time in interaction with the context (Panadero, 2017; Puustinen and Pulkkinen, 2001), which is why in this study a global construct of SRL is presented.

The results showed that the subdimensions were consistent with the underlying theoretical model developed by Zimmerman (2000). From the socio-cognitive perspective (Zimmerman, 2000), the instrument “Phases of Self-Regulation of Learning” corroborates that the development of SRL constitutes a dynamic process where, once students establish goals for their learning, they seek to monitor and regulate such processes for their achievement, which involves both personal and environmental factors. In this respect, evidence shows that SRL evolves over time (Higgins et al., 2021). Therefore, the student becomes an active agent in his/her learning process. This last aspect is relevant considering that, in their first university years,

students face academic, social, and emotional challenges and demands (López-Angulo et al., 2021). To address these challenges, they must learn to implement metacognitive and self-regulatory learning strategies (Tinto, 2010; López-Angulo et al., 2024).

Regarding divergent validity, the results showed significant but low correlations between the SRL scales and the Meaning in Life Questionnaire. These findings suggest that both instruments assess different constructs (Fornell and Larcker, 1981). This distinction is crucial because it emphasizes the independence of the measured constructs and demonstrates that a high level of SRL does not necessarily imply a search for meaning in life. The literature supports this separation, indicating that self-regulation focuses more on learning processes, whereas meaning in life addresses existential and personal aspects. These findings have important practical implications, indicating the need to select the appropriate instrument according to the measurement objective.

TABLE 6 Internal consistency coefficients.

Factors	Items	Cronbach's alpha	McDonald's omega
F1	1, 2, 3, 4, 5	0.860	0.861
F2	6, 7, 8, 9, 10, 11	0.817	0.842
F3	12, 13, 14, 15, 16	0.886	0.887
General factor		0.933	0.936

Regarding reliability, the indices obtained in this study indicate that the instrument presents acceptable psychometric properties, with values above 0.70, a commonly accepted standard in psychological and educational research (Streiner et al., 2024). This reliability is crucial to ensure that the instrument can consistently identify SRL processes in Chilean university students. Additionally, it is important to consider the impact of the cultural and educational context on the reliability of the instrument. Differences in the interpretation of the items among different groups may influence the results, suggesting the need for future research to evaluate the instrument's stability in different contexts. The above allows proposing an instrument with acceptable psychometric properties to identify these processes in Chilean university students.

4.1 Applicability and utility

This study has important theoretical and practical implications. From the theoretical edge, it contributes to the advancement in psychometric research on measuring SRL, overcoming limitations of previous studies that have shown low rigor in the content validation of their instruments (López-Angulo et al., 2020). Additionally, it contributes to a theoretical gap regarding the development of validated questionnaires in Latin America (Hernández et al., 2017; León-Ron et al., 2020; López-Angulo et al., 2020).

From the practical perspective, a valid and reliable instrument to measure SRL in university students is of utmost relevance, demonstrating practical applications beyond the research. Specifically: (a) It allows an accurate assessment of the student's self-regulatory skills, facilitating an in-depth understanding of how they manage their learning process; (b) It facilitates the design of educational interventions, especially when a group of students with difficulties in their phases of the self-regulatory process is identified while applying the instrument, allowing to visualize in which of them to emphasize for their promotion and development. Based on this, specific strategies can be developed to improve these skills (Sáez-Delgado et al., 2018); (c) Progress Monitoring, having a valid and reliable instrument allows monitoring the progress of the student body over time, thus observing whether their self-regulatory skills improve, remain stable or require attention (Mella-Norambuena et al., 2021); (d) Identification of Individual Needs, this is especially relevant, as each student is unique in how they self-regulate, which guides the adaptation of teaching strategies accordingly for the faculty (Contreras-Saavedra et al., 2024); (e) Improvement of teaching practice, making available an SRL phasing instrument available allows teachers to assess and understand their students' self-regulatory skills, helping them to adapt their pedagogical approach and offer specific support when needed (De La Fuente et al., 2020; López-Angulo et al., 2022).

In summary, this study provides an adequately validated instrument to measure SRL becoming a valuable tool for research and educational practice. It thus contributes to the comprehensive development of students and their academic success.

4.2 Limitations and future research

The obtained results provide valuable information on the validity and reliability of the SRLI-U. However, it is important to consider some limitations and areas for future research. A relevant element that must necessarily be mentioned is the type of instrument that was validated in this study, which is a self-report. Considering that it was applied to university students, it is likely to present, to some extent, the so-called social desirability bias in the process of collecting the responses obtained (Durmaz et al., 2020; Fisher and Katz, 2000). Specifically, this implies questioning the scores obtained by the scale that could obtain a high average in the different phases of the SRL process. Now, while there are other alternatives for measuring SRL in college students, for example, observational instruments, measurements through the learning analytics approach, and more recently with measurement challenges based on artificial intelligence (Molenaar et al., 2023), possible difficulties or limitations are identified with these instruments. Therefore, the recommendation is that future research that seeks to measure SRL in university students should consider integrating more than one measure method to achieve a more accurate understanding of this phenomenon.

5 Conclusion

In conclusion, this study represents a significant advance in research on self-regulation of learning (SRL) by providing a validated and reliable instrument that measures the SRL phases in Chilean university students. The results confirm that the scale presents a robust factorial structure with three interrelated dimensions: Learning disposition, learning performance, and learning self-evaluation.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Ethics, Bioethics, and Biosafety Committee, Vice-Rectorate for Research and Development (VRID), Universidad de Concepción. Ethics Committee approval number: CEBB1394-2023. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

YL-A: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration,

Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. FS-D: Conceptualization, Methodology, Supervision, Writing – review & editing. MG: Supervision, Writing – review & editing. JM-N: Data curation, Formal analysis, Software, Supervision, Validation, Writing – review & editing. YG-R: Supervision, Visualization, Writing – review & editing. KM-I: Conceptualization, Visualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2024.1464424/full#supplementary-material>

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Developing a scale to explore self-regulatory approaches to assessment and feedback with academics in higher education

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Introduction: Students need to acquire high level self-regulatory skills if they are to be successful within higher education, and academics need support in facilitating this. In this article we explore how the current research gap between knowledge of self-regulatory assessment and feedback (SRAF) practices, and academics' professional training in it can be bridged.

Methods: SRAF tools were used with academics to explore their understandings of and training needs in SRAF; central to this work was the development of a SRAF scale. We consider the value of such tools in supporting academics' professional development needs in SRAF. The reliability and validity of the SRAF scale was tested using exploratory factor analyses (EFA).

Results: Iterative EFA resulted in a 17 item support required SRAF scale (SR). Two underpinning factors: *Creating the Conditions for SRAF*, and *Supporting Students' SRAF Skills Development* were identified. The reliability of the instrument supported its primary use as a tool to facilitate academics' professional development in fostering students' self-regulatory skills.

Discussion: Our findings highlight the importance of supporting academics in developing strategies to maximize students' metacognitive skills and motivation in assessment and feedback, contingent on effective assessment design. Such professional development needs to be mindful of individual and contextual factors impacting academics' access to, and confidence and competence in, using SRAF in practice. This research is important in highlighting potential disconnects between where academics' focus their attention in assessment, and what is known to have most impact on student learning success. The SRAF tools have considerable potential in supporting translation of theory into practice as part of sustained professional development for academics in higher education.

KEYWORDS

self-regulatory assessment and feedback practices, higher education, academics, professional development, scale reliability

1 Introduction

The importance of supporting students' self-regulatory learning (SRL) skills development in impacting their achievements in higher education is well known (Hayat et al., 2020; Büchele, 2023; Hattie, 2023; Evans and Waring, 2023a). Supporting academics in providing such skills support to students is challenging given that training in self-regulatory practices is significantly underrepresented in professional development provision for academics in higher education (Ruiz and Panadero, 2023). Translation of knowledge on effective self-regulatory assessment and feedback (SRAF) into practice is limited by the lack of guidelines available to academics on how to do this well (Honig and Coburn, 2007; Jansen et al., 2019). Academics need to know how to support students' SRL skills development, and as part of this, they need better understanding of the relationships between learner characteristics and personal goals, and cognitive, metacognitive and emotional regulatory processes, and how these impact learning.

As identified above, supporting students' SRL skills development is essential given the relationship between self-regulatory capacity and student achievement (Schneider and Preckel, 2017; Lin et al., 2022). Students enter higher education with varying levels of self-regulation. Of significant importance is that students' abilities to self-regulate can be developed (Vosniadou, 2020), while accepting that some students are more capable of self-regulatory flexibility than others (Kozhevnikov et al., 2014). To support students' academic development, and to utilize resources most effectively it makes sense for academics to focus on those SRL skillsets that are most implicated in student success (Dinsmore, 2017). As noted by Russell et al. (2022), academics' self-regulation plays an important part in how academics' support student SRL skills development. For academics to be able to do this effectively, they need to be aware of their own SRL skillsets, identify and focus on those high level SRL skills students most need within a specific context, and model these skillsets confidently with their students.

However, the complexity of the self-regulation construct makes translation of it into assessment and feedback practice in higher education difficult given that is an umbrella concept (Panadero, 2017) comprising many different variables and approaches with different theoretical underpinnings. Evans et al. (2021, p. 10) in exploring the multi-faceted nature of self-regulated learning (SRL) define it as:

a learner's ability to regulate his/her learning in different contexts... SRL can be viewed as a construct, a process and an ability that can be developed... SRL may comprise state (approaches developed in response to a specific context) and trait elements (established patterns of working that are consistent across contexts).

Zimmerman (1998, p. 329) argued that "students can be described as self-regulated to the degree that they are metacognitively, motivationally, and behaviorally active participants in their own learning process", and that "students' learning must involve the use of specified strategies to achieve academic goals on the basis of self-efficacy perceptions". Self-efficacy in this context refers to students' perception of their own abilities to manage the learning process effectively, and achieve their desired goals. In exploring the structure of self-regulation, Zimmerman and his contemporaries discuss the

recursive stages involved in managing a task such as *forethought* (planning and goal-setting), the *performance phase* (selection of appropriate strategies to complete a task and ongoing monitoring and review to maintain motivation and adjust strategies as necessary), and a *self-reflection phase* (involving self-evaluation of effectiveness and reframing as necessary in pursuit of goals). In all these phases metacognitive (understanding of which strategies to use), cognitive (how individuals make sense of and process information) and affective strategies (management of emotional aspects of learning) are required (Evans et al., 2021).

In this work, we were particularly interested in the metacognitive skills students deploy in assessment and feedback while acknowledging the interdependence of these with cognitive and affective strategies. The mediating nature of task requirements (e.g., nature of assessment), the context (e.g., extent to which the design of assessment requires and values students' acquisition of high level self-regulation skills), and individual characteristics (e.g., self-efficacy and motivation) make it difficult to ascertain how best to support students in choosing the most appropriate SRL strategies and using them well (Dresel et al., 2015). Jansen et al. (2019) concluded from a review of 142 studies that academics need to support students' engagement in SRL activities as well as their achievement; they argue that the lack of significant moderators of the effects of SRL interventions makes it difficult to provide concrete design guidelines for such SRL interventions. In providing more specific guidance, Hattie et al. (1996) recommended that training should be in context, and use tasks within the same domain as the target content, and promote a high degree of learner activity and metacognitive awareness. Evans and Waring (2023a) have gone further in articulating the key elements of a SRAF approach to support translation of research into practice through encouraging academics to articulate what those high level self-regulatory skills are that they want students to develop, and by providing a route map of how to build participatory assessment designs that provide the conditions in which development of these skills can flourish.

In this article we describe a pilot exploratory project developed to support better understanding of SRAF in practice, conscious of the relative lack of research on supporting academics' professional development in SRAF in higher education research. This research is important given that academics' knowledge of self-regulatory approaches impacts the quality of assessment design (Dörrenbächer and Perels, 2016; Peeters et al., 2016), and the fact that professional development for academics in this area is in its infancy (Evans and Waring, 2023a; Dinsmore et al., 2024).

This research is situated within the context of developing tools to support academics' translation of SRAF into practice as part of an international Erasmus+ research funded project. This project used an established, research-informed assessment framework (EAT). The Equity, Agency and Transparency (EAT) framework was chosen to explore how best to support academics' access to, and effective use of relevant SRAF approaches given its underpinning theoretical framing around agentic, inclusive, and self-regulatory approaches to assessment and feedback. This theoretical and conceptual framework (Evans, 2016, 2022) synthesizes what is known about effective assessment and feedback (Evans, 2013) and integrates this with an understanding of self-regulatory learning approaches and individual differences in learning. EAT was developed from extensive systematic review of the literature and evolution of the framework with staff and students across disciplines and higher education institutions. Its visual

form is that of a wheel which guides academics to consider 12 core entry level questions about how they support students' SRAF, and asks students how they engage with SRAF. There is a vast body of resources to support learners (academics and students) to consider how best to develop and evaluate the effectiveness of their approaches to SRAF using a research-informed approach. A key strength of the approach is it can be adapted to any context and any level of analysis (individual, course, discipline, faculty, institution) (Evans et al., 2022a).

Conceptually, EAT (Evans, 2022) highlights the central role of academics in designing assessment environments that support students' SRL skills development in partnership with them. Partnership involves active engagement with students in decision-making processes about assessment and feedback to support co-ownership of assessment, dependent on supporting students' skills development and confidence in being able to step up to take a more central role in the assessment and feedback process, and includes defining the limits of their engagement. Through partnership in assessment, it is argued that student agency is increased, creating opportunities for students to impact the quality of assessment, which in turn enhances the conditions to support SRL skills development (Evans and Waring, 2021).

Emphasis on how conditions are created to promote student ownership and agency in assessment is a central element of our SRAF pedagogical framing and aligns with Bandura's (1986, 2001) idea of agency in how individuals deliberately guide their behavior (the actions they choose and how they execute them in pursuit of goals), and Reeve's (2013) notion of agentic engagement in how individuals are empowered by their environment so they are able to leverage change within it. It also requires academics to be discerning in selecting what high level self-regulatory skills they wish to focus on related to their specific context.

In this article we: (i) consider what a SRAF approach is, and the key dimensions of it implicated in student learning in higher education, (ii) explore what SRAF support academics want to enhance their assessment practice, and in relation to their perceived use of SRAF, and (iii) consider the implications for the development of SRAF professional development in higher education from using SRAF tools with colleagues. To address these questions, we firstly, explore the context of SRAF in higher education. Secondly, we describe pedagogical tools developed to support understanding of SRAF including the development of a scale to explore academics' perceived frequency of use of SRAF practices, and associated professional development needs, drawing on the model developed by Dinsmore et al. (2024). Thirdly, we model the outcomes from our work with academics on using SRAF tools, and explore the implications of these findings for enhancing SRAF professional development in higher education.

2 Developing a SRAF pedagogy

Evans and Waring (2023a,b) coined the term SRAF pedagogies to refer to assessment and feedback practices that focused on the systematic development of students' SRL skillsets, and critical evaluation of them in practice. In their approach SRL is embedded within all aspects of assessment design and emphasis is placed on supporting students' knowledge, skills and confidence in their ability to choose the most appropriate learning strategies and to use them effectively within a specific context (i.e., attuned to disciplinary and

professional needs). According to Evans and Waring (2023a, pp. 11–12).

SRAF considers learner characteristics and personal goals, and how cognitive, metacognitive, and emotional regulatory processes come together to support learning. Of critical importance is the degree of alignment between academics' and students' perceptions of quality in impacting improvements in learning ... A key emphasis in the design of self-regulatory assessment has to be on how we maximize the opportunities for students to gain an understanding of quality for themselves.

There are many potential permutations of SRAF pedagogies which may have different emphases depending on different theoretical perspectives on SRL, and in relation to how academics perceive the role of students in the process. Evans and Waring (2023a) highlight the importance of effective assessment design in creating the necessary conditions for SRAF to support students' agentic engagement with assessment and feedback. Agentic engagement involves students' abilities to evolve their learning context to address their assessment needs. In providing explicit guidelines on SRAF, they argue that academics need to start by articulating what the core SRL skills they want students to acquire within their discipline are.

In drawing together research on SRAF, Evans and Waring (2023a) argue that emphasis should be on ensuring the assessment context supports SRL development, and provides focused skills training by attending to the following:

- Embedding SRL skills development within discipline-specific contexts (Hattie et al., 1996).
- Ensuring SRL skills development is integrated into all aspects of assessment and feedback design (Evans, 2016, 2022).
- Addressing academics' and students' conceptions of their roles in assessment and feedback to support student agency and autonomy (Vermunt and Donche, 2017).
- Focusing activities to support alignment of academics' and students' conceptions of quality.
- Working with students to support their engagement as co-constructors of assessment and feedback practices to support internalization of standards (Hattie et al., 1996; Simper, 2020; Nicol, 2022).
- Making explicit what the core high level SRL skills are that students need to be successful within a course (Evans, 2016, 2022; van Merriënboer and de Bruin, 2019).
- Focusing on the development of high-level SRL skills that have the most impact on learning outcomes (e.g., motivational and metacognitive) (Dinsmore, 2017; Panadero, 2017; van Merriënboer and de Bruin, 2019; Dekker et al., 2023).
- Providing repeated opportunities for students to observe, emulate, apply and evolve self-regulation strategies that are most relevant to the contexts they are working in (Zimmerman and Kitsantas, 2005; Dunlosky et al., 2013).
- Using data and technologies with academics and students to support their understanding of their learning, and the implications of different teaching and learning approaches on outcomes (Tempelaar et al., 2021; Hattie, 2023).
- Acknowledging and addressing the increasing role of digital including artificial intelligence (AI) literacy in self-regulatory

skills development (Istifci and Goksel, 2022; Krempkow and Petri, 2022).

- Placing emphasis on high quality professional development in SRAF supported by high quality research design including evaluation processes (Panadero, 2023).

3 Theoretical framing

3.1 SRAF skills development

In developing SRAF professional development frameworks and tools, as previously identified, we drew on the EAT assessment and feedback framework (Evans, 2016, 2022) given its strong integrated theoretical frame. EAT brings together constructivist, socio-cultural and socio-critical theories in supporting effective self-regulatory assessment and feedback (Evans, 2013) with understanding of student approaches to learning (SAL) (Vermunt and Verloop, 1999), and agentic engagement (Reeve, 2013).

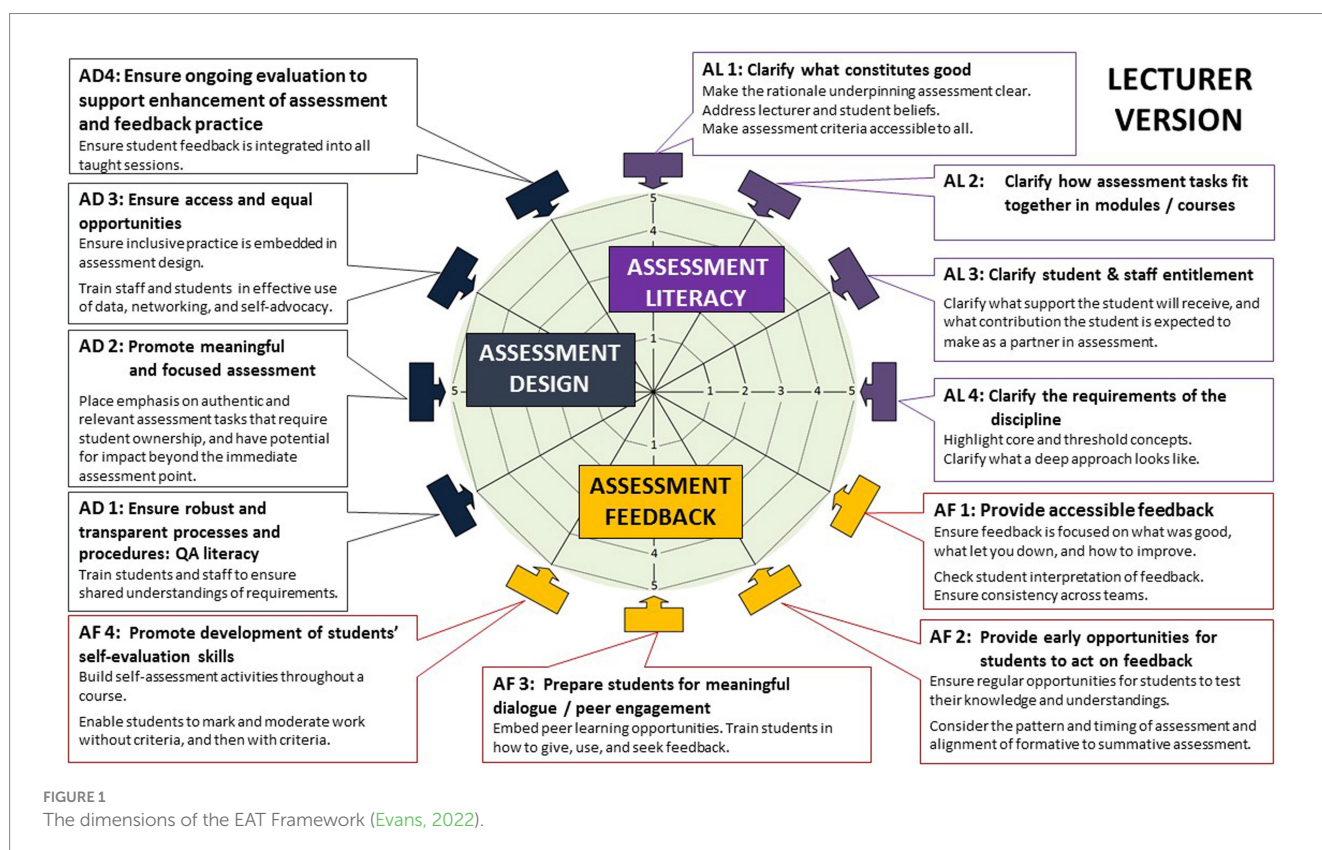
EAT aligns with socio-cognitive (Bandura, 1986, 1991, 2001; Pintrich, 1989, 2004; Zimmerman, 2001; Zimmerman and Campillo, 2003) and information processing self-regulation models (Winne and Hadwin, 1998; Winne, 2001). Socio-cognitive models emphasize the role of interaction with others in impacting learning behaviors, and information processing models focus on how individuals make sense of information, and the cognitive, metacognitive, and affective processes inherent in this.

In Figure 1, EAT portrays effective assessment and feedback practices (Evans, 2013) as 12 interconnected sub-dimensions of

assessment literacy (AL), assessment feedback (AF), and assessment design (AD). The EAT sub-dimensions are all highly integrated, in that actions taken in one aspect of assessment and feedback practice have an impact on others. Academics are asked to consider how they engage students in supporting their self-regulatory development in each of these sub-dimensions of practice as integral to the focus of the model on ensuring student access to assessment and feedback and their agentic engagement with it. The quality of assessment design and a supportive institutional context are important in providing the conditions to support SRAF development for students and academics, respectively. The relational dimension of SRL involves being able to utilize one's own skills effectively, and gain support from others in the realization of one's learning goals. Agency and engagement are identified as essential in supporting SRL skill development and achievement (Boud and Molloy, 2013; Evans, 2013). Our approach recognizes the combined influence of individual dispositions, metacognitive, cognitive, and affective strategies, and contextual affordances and barriers in impacting learners' management of assessment and feedback (Vermunt and Verloop, 1999).

3.2 SRAF skills development

Our SRAF approach considers how learners acquire competencies, the importance of individuals' and teams' conceptions and beliefs on this process (Bembenutty et al., 2015), and awareness of the different ways in which learners process information (Waring and Evans, 2015). The importance of explicit teaching of SRL skills is intrinsic to this approach, while also acknowledging that some individuals are capable of higher level SRL skills development than others, especially in



relation to metacognitive flexibility (Kozhevnikov et al., 2014). Emphasis is also on supporting quality and conditional use of strategies; using strategies effectively and selecting the most appropriate ones for a given task (Dinsmore, 2017).

From a self-regulatory process perspective, key metacognitive skillsets required in managing assessment tasks include *accuracy in interpreting the requirements of a task* and *meta-memory in ascertaining what you know*, and how you can use this knowledge to support task completion. In planning an appropriate approach to manage assessment *the quality and nature of goals* (Dent and Koenka, 2016) and *contextual regulation* (being able to read the context well in knowing where and who to get support from and how to use such support well) are important. *Monitoring accuracy* is dependent on *effective use of cues* coming from the task itself, the task context, from cognitive processing fluency, and from a learner's affective states and self-concept (van Merriënboer and de Bruin, 2019). Metacognitive skills are required in *accurate monitoring* of progress, and in adapting strategies where necessary to support maintenance of effort (Panadero, 2017), and alignment of strategies to achieve goals (*adaptive control*). The ability to synthesize internal information and that from others in assessing one's own work accurately is emphasized in *self-evaluative capacity* which also includes *reflexivity* in being able to effectively 'step outside of oneself' to objectively review lessons learnt and to make adaptations in one's approach for the future.

In supporting SRAF development with academics we focused on high level metacognitive skillsets given that these skillsets are known to have the most impact on student learning outcomes (Dinsmore, 2017; Schneider and Preckel, 2017). This included firstly, a focus on *students' self-efficacy and goal-setting* given the tendency for higher education students to have better results when interventions are aimed at motivational and emotional aspects of learning (Panadero, 2017; Van der Zanden et al., 2019). Efficacy beliefs are positively related to effective self-regulated learning (SRL) processes (Pintrich and Zusho, 2007) and according to Pintrich (2004), a much better predictor of performance than task value. Addressing goals and self-efficacy is thought to be especially impactful given the strong connections between goal orientation, control (academic self-efficacy) and affect, as explained in Pekrun's control-value theory of achievement emotion (Pekrun et al., 2002, 2006).

Secondly, we looked at *metacognitive strategy instruction* in assessment and feedback which includes supporting students' (i) understanding of strengths and weaknesses in relation to the demands of a task; (ii) strategy choice and effective use of strategy; (iii) internalization of standards in recognizing what good work is in supporting accuracy of monitoring and evaluation of work; (iv) recognition of feedback opportunities (cues) and developing effective feedback strategy use (processing and application skills); (v) evaluation of the quality of approaches used, and in relation to accurate reading of context and task. This emphasis on SRL approaches combining metacognitive and motivational strategies is warranted given that they have the highest effects on student learning outcomes (Dignath et al., 2008). The importance of strategy instruction on student learning outcomes is established (Hattie et al., 1996; Schneider and Preckel, 2017). Metacognitive monitoring is essential in impacting outcomes (DiFrancesca et al., 2016). Donker et al. (2014) also found from meta-analytical research on 95 interventions that the effectiveness of strategy instruction on performance was enhanced when interventions included general metacognitive knowledge about

when, why, how, and which strategy to use, taught students how to plan, and addressed task value.

In attending to motivational aspects of learning and acquisition of high level SRL skills, and taking account of information processing and socio-cognitive aspects of learning, we considered key features of assessment design and the environment that could support the development of students' high level self-regulatory assessment and feedback skills drawing on EAT. SRL skills development takes place within specific contexts, and the extent to which the context enhances or reduces the potential impact of SRL strategy development on student performance is central to the EAT framework that we drew upon in this research.

3.3 The role of assessment design in supporting SRAF

The quality of assessment design impacts the efficacy of academics' and students' SRL skills development (Hawe and Dixon, 2017; Evans et al., 2021). It is important to address academics' and students' starting points, and their beliefs and conceptions about assessment in supporting SRAF (Evans and Waring, 2021). Essential elements of assessment design that support SRAF, drawing on EAT, Evans (2016, 2022), include: (i) engagement of students in working with academics to develop shared understandings of SRAF; (ii) embedding SRAF in all aspects of assessment design to support students' progressive development of core knowledge, understanding, and skills; (iii) ensuring the balance and distribution of assessment activities is conducive to deep approaches to learning (e.g., positioning feedback so that it can be used to improve work), (iv) training students in what constitutes quality so they can gain an appreciation of quality for themselves; (v) supporting students as active agents of assessment and feedback change with clear roles and responsibilities, and opportunities to engage fully in all aspects of the assessment process as part of team ownership; (vi) understanding how a course as a whole is engineered, and how different assessment elements fit together (Bass, 2012), and (vii) ensuring learning outcomes are focused on student attainment of high level SRL skills (Brown et al., 2016). To create the conditions to support SRAF, cognitivist information processing, and socio-cognitivist perspectives on SRL were considered (See Table 1).

Supporting students' accurate interpretation of tasks, requires an emphasis on making the requirements of the task explicit supported by clear signposting of information to reduce cognitive load (i.e., the amount of resource that a learner can devote to dealing with one task given the limits of working memory capacity) (Sweller et al., 2011), and providing early opportunities to address learners' assessment conceptions and poor use of strategies (DiFrancesca et al., 2016). To support deep understanding of assessment requirements, students need frequent opportunities to discuss and interrogate the meaning of assessment tasks in order to come to a consensus as to what counts as quality. Understanding of students' starting points and their previous experiences of success are important in tailoring SRL skills development (Douglas et al., 2016; Kim and Shakory, 2017).

In assisting students' planning and goal-setting, emphasis should be placed on making the requirements of the task explicit, explaining the rationale of the task to support buy-in and shared goals, and

TABLE 1 Developing students' self-regulatory skills within assessment design.

EAT	To what extent do students...	To what extent do academics....	SRL constructs supporting.....
AL1	Have an accurate understanding of the task and are able to set appropriate goals?	• Make task requirements explicit? • Engage students in developing assessment criteria? • Provide opportunities to clarify what good is?	• Task analysis • Goal-setting • Planning • Meta-memory
AL2	Have a clear understanding of course requirements and the relationships between them?	• Show how elements of the course fit together? • Clarify the relationships between assessment tasks for the course?	• Task discrimination and management • Planning regulation of task
AL3	Have a clear understanding of their role and confidently engage with academics on assessment and feedback?	• Make the student role in assessment explicit? • Scaffold learning to build confidence and support students' engagement in assessment?	• Co-regulation with a more knowledgeable other (person / resource) • Agentic engagement • Self-efficacy
AL4	Have a clear understanding of what knowledge and skills are valued within the discipline and how to master them?	• Signpost key knowledge and skills? • Focus on student understanding of threshold concepts? • Embed skills training throughout a course? • Make what it is 'to think, act and be' in a discipline explicit?	• Contextual regulation • Adaptive control
AF1	Distinguish what is valuable feedback, how to get it and apply it?	• Provide training in how to recognize cues? • Focus feedback on higher level concerns? • Check student understanding of feedback?	• Cue consciousness • Information filtering • Emotional regulation
AF2	Make best use of opportunities to test their understanding?	• Provide early opportunities for students to test their understanding? • Focus activities to learner needs?	• Cue consciousness • Self-monitoring and evaluation
AF3	Use peer learning opportunities effectively?	• Train students in how to seek, give, and use peer feedback well? • Ensure peer activities are authentic?	• Shared regulation • Relational skills -noticing
AF4	Accurately evaluate the quality of their work?	• Embed self-assessment activities throughout the course?	• Self-evaluation • Reflexivity
AD1	Understand assessment regulations?	• Engage students in marking and moderation?	• Internalization of standards • Monitoring accuracy
AD2	Know what a deep approach to learning is and how to realize it?	• Ensure tasks require student ownership? • Challenge students to adapt ideas and apply to new contexts?	• Metacognitive skills in strategy selection and quality of use
AD3	Advocate effectively to ensure their needs are met?	• Embed inclusivity in assessment design? • Ensure accessibility of all resources? • Reduce cognitive load?	• Self-advocacy and self-determination skills • Cognitive processing
AD4	Engage in developing assessment and feedback practice with academics?	• Embed opportunities in courses for students to feedback on the quality of assessment design? • Ensure co-creation embedded in design?	• Critical reflection • Agentic engagement

exploring academics' and students' beliefs and conceptions about their roles in assessment. Academics working with students to agree goals that support their perceptions that a task is manageable and doable is important in relation to supporting student self-efficacy and agency in the assessment process. Autonomy supportive approaches where students are encouraged to question their understandings, where the "rules of the game are laid bare", and where students are enabled a degree of ownership of the assessment process with academics are impactful (Panadero and Alonso-Tapia, 2013; Kumar et al., 2018; Evans, 2022).

In supporting students' operationalization and effective monitoring and completion of assessment and feedback tasks, early opportunities to test their understanding, and explicit demonstration and modeling of effective strategies with them are important. Students need opportunities to practice, implement and evolve their metacognitive strategy use, and within relevant contexts (Zimmerman, 2000). Ensuring feedback is placed effectively to enable students the time to internalize and apply it, and ensuring feedback is focused on how students can enhance their skills development with examples of how to do so, are important. Similarly, facilitating students' self-evaluation skills requires opportunities for students to test their understanding throughout their courses through being actively involved in activities which require them to exemplify their understandings (e.g., writing of practice and final tests; marking and moderation of work, constant comparison of work) to establish the merits and limitations of different approaches (Nicol, 2022). Eva and Regehr (2011, p. 327) argued the importance of creating situations for learners [and academics] to experience the limits of their competence in the presence of feedback with improvement strategies tailored to those experiences rather than self-assessment alone. Emphasis is therefore placed on supporting learners to assess their own strengths and weaknesses and to adapt their strategies according to task needs.

4 Aims

In working with academics, a key aim of our research was to support the translation of SRAF into practice in higher education through the following objectives as outlined below.

- Objective 1: To undertake a pilot study to clarify the factor structure of the SRAF scale.
- Objective 2: To ascertain academics' perceived use of SRAF practice and professional development needs, and the relationship between use and needs.
- Objective 3: To explore the relevance of our findings for professional development of SRAF in higher education.

4.1 Development of the SRAF scale items

Research was undertaken with colleagues at four higher education institutions in Spain, Portugal, and the UK (two UK universities) to develop and implement a SRAF approach using the EAT framework (Evans, 2016, 2022). A multi-step methodological approach comprising the following elements was implemented:

- *Identification of SRL variables that demonstrated maximum impact on student learning.* An extensive narrative review of the literature on SRL was undertaken to explore the relative effectiveness of self-regulation variables on student learning outcomes (Evans et al., 2021).
- *Emphasis was placed on high-level metacognitive self-regulatory skills* drawing on Dinsmore's (2017) notions of conditional use (selection of appropriate strategies) and quality (using strategies well) aligned with Schneider and Preckel's (2017) analysis which identified that the most successful students were those who were discerning in what they attended to in learning (Evans and Waring, 2021, 2023a). The interrelationships between metacognitive, cognitive, and affective dimensions of self-regulation in assessment and feedback were acknowledged (Vermunt and Verloop, 1999; Dinsmore, 2017).
- *Use of frameworks and tools to support understanding of SRAF*
 - EAT was used with academics to explore the self-regulatory skills needed to be successful in managing the requirements of assessment and feedback in all 12 sub-dimensions of EAT (Evans et al., 2022a; Evans, 2022).
 - A *SRL skills framework* evolved from EAT was used to support academics' in thinking about the metacognitive skills required at each stage of a typical self-regulatory process (forethought, planning and goal-setting, performing a task and monitoring progress in relation to goals, and evaluating the extent to which goals had been met, and future actions) (Dinsmore, 2017; Seufert, 2018). Table 1 provides a summary of the SRL skills framework aligned with the sub-dimensions of EAT.
- Project leads and their teams in four institutions, as part of the wider project work on supporting SRAF skills development, engaged in two initial *core SRAF training sessions* each (eight in total) to explore approaches to using SRAF, with follow up work with project teams which provided important information on contextual affordances and barriers.
- Development of *reward and recognition frameworks* and online resources to support and recognize academics' achievements (Evans et al., 2022b).

4.2 Participants

The online SRAF survey was distributed via project leads in the UK, Spain, and Portugal to academic colleagues in their institutions and their wider networks to ascertain the SRAF support academics' wanted (support required), and perceived frequency of use of SRAF activities (practice frequency). This work is important given the lack of research exploring the gaps between academics' knowledge of SRAF and implementation of it, and the need for robust measures to assist understanding of academics' experiences of learning about and applying SRAF in practice.

Our initial sample size for analysis was $n=207$. We removed observations from 4 participants who we considered to have submitted erroneous responses. Academics from 25 countries, including 115 higher education institutions contributed to this research. Most responses were from Portugal ($n=49$, 24%), UK ($n=36$, 18%), and Spain ($n=28$, 13.7%) where lead partners were based. There were 103 (50.5%) males, 95 females (46.6%), and 6 academics (2.94%) not

reporting their gender. Other key countries represented in the data included Greece ($n=29$, 14.2%), and Brazil ($n=20$, 9.8%), with the remaining 20% of respondents coming from individual associates of core partners from 20 countries. There was a broad distribution of respondents from across disciplines with 72 (35.3%) from STEM, 50 (25.5%) from medicine and related disciplines, 42 (20.6%) from social sciences, 35 (17.2%) from arts and humanities, and two colleagues whose roles were across disciplines. One hundred and eighteen academics (57.8%) identified their primary role was teaching, and 86 (42.16%) participants identified their main role was research. In relation to years of experience in higher education the profile of respondents was skewed toward those who had more experience in higher education. One hundred and thirty-three (65%) of respondents had 16 years or more, 27 (13.3%) had 11–15 years, 23 (11.3%) had 6–10 years, 15 (7.4%) had 2–5 years, and 6 (3%) had less than two years' experience.

Ethical approval for the collection and use of data was obtained from the School Research Ethics Committee of the School of Biosciences, Cardiff University, UK, in accordance with institutional ethics policy and partner institutions ethical clearance arrangements and in relation to General Data Protection Requirements (GDPR). The purposes of the data collection were made clear to all potential respondents in line with ethical consent procedures, and all participants had the right to have their data withdrawn at any time.

4.3 The self-regulatory assessment and feedback scale

We were keen to identify participants' perceptions of the support they required in developing SRAF, and against a marker of what SRAF practices they felt they currently used frequently in their practice.

All participants were asked to complete two versions of the questionnaire scale, one asking academics what support they required in SRAF (SR), and the other asking them about their perceived practice frequency of SRAF (PF). Participants were asked to score items on a five point likert scale. For example, for SR (personal needs for training: 0 = not needed, 1 = very low to 5 = most needed) and for PF (frequency of use of SRAF approaches: 0 = not used, 1 = used very rarely to 5 = used very often).

The SRAF scale comprised 21 items generated from the EAT Framework and research on high level self-regulatory skills (Dinsmore, 2017; Evans and Waring, 2021). The questions highlight the importance of addressing cognitive, affective, and metacognitive aspects of self-regulation. For example, (i) clarifying how assessment elements fit together and facilitating student access to concepts by making core concepts explicit, thereby reducing cognitive load (cognitive); (ii) explaining the rationale underpinning assessment design, and the role of the student in assessment and feedback (affective), and (iii) ensuring opportunities for students to test their understanding through repeated opportunities to engage actively in assessment processes so as to support internalization of learning processes (Sadler, 2009; Nicol, 2022) (metacognitive aspects).

In developing the SRAF scale items consideration was also given to the metacognitive skills needed at each stage of the self-regulatory process (Pintrich, 2004) to include planning and goal-setting, including activating perceptions of a task, and one's role in it, utilizing strategies to complete the task including ongoing monitoring of progress, and evaluation of the extent to which goals have been met.

Self-regulatory assessment practices targeted included academics' support of students' (i) planning and goal setting, (ii) self-efficacy, (iii) internalization of standards, (iv) dispositions in encouraging a mastery approach to learning, (v) ability to adapt and transfer learning to new contexts, (vi) management of feedback, (vii) metacognitive skills regarding their self-awareness of their strengths and weaknesses, and (viii) ability to accurately judge the quality of their own work.

In working with academics we explored the high level self-regulatory skills required to support effective assessment and feedback and how these could be applied in different cultural contexts (Table 1) drawing on the 12 sub-dimensions of EAT (Evans, 2022). Importantly, we intentionally focused on participatory approaches in how academics work *with* students in partnership to support SRL development. Participants' responses to the 21 items comprising the scale in relation to support required are depicted in Table 2.

5 Data analysis

5.1 Establishing the factor structure of the SRAF questionnaire

All data analyses were conducted using R (version 4.3.1, R Core Team, 2023). The SRAF scale comprised 21-items.

The SRAF scale survey was distributed online to academics who were asked about which of the 21 items they most wanted professional development support in, and which of the 21 items they perceived they used most frequently in their teaching.

We anticipated that factors arising from the underlying concepts would be correlated, hence we performed iterative exploratory factor analysis (EFA) with oblique (Promax) rotation. The EFA was undertaken to evaluate the dimensional structure and internal consistency of the SRAF scale, and reliability analysis was undertaken for academics' perceptions of support required (SR) and practice frequency (PF). We explored mean absolute difference (MAD) to compare the differences in academics' responses to the items on the support required (SR) and practice frequency (PF).

First, we undertook initial data screening of our 21 items. Following Evans and Zhu (2023), we considered items for elimination if (i) absolute skew values were > 2.0 and absolute kurtosis values were < 7.0 (Kim, 2013), (ii) items had a low average inter-item correlation (< 0.3), (iii) items had very high average inter-item correlation suggesting multicollinearity (> 0.9), and (iv) a low inter-total correlation (< 0.3).

Descriptive statistics for each item were calculated using the *descriptives* function from the *psych* package (Revelle, 2023). The MAD was calculated by taking the mean of the absolute difference between PF and SR for each respondent. Inter-item correlations were calculated using the *corr* package (Kuhn et al., 2022); and item-total correlations were calculated using the *performance* package (Lüdtke et al., 2021).

We deemed items suitable for EFA if (i) Kaiser-Meyer-Olkin (KMO) factor adequacy score was > 0.7 (Kaiser, 1974), (ii) a Bartlett's test of sphericity returned a significant result ($p < 0.05$), and (iii) the determinant of the correlation matrix was > 0.00001 (Yong and Pearce, 2013). To determine the maximum number of factors to explore in each EFA, we considered multiple sources of evidence: (i) the number of eigenvalues exceeding Kaiser's criterion (> 1) (Kaiser, 1974), (ii) visual inspection of scree plots (Ledesma et al., 2015), (iii)

TABLE 2 Descriptive statistics for 21 original items of SRAF (SR) scale items.

Related constructs		SRAF items	M	SD	Skewness	Kurtosis
Prior knowledge	1	I review data on students' starting points and regularly review their progress on assessment tasks to check what it is working well or not, and for whom.	3.0	1.18	−0.66	0.1
Meta/cognitive strategies	2	I explain how the assessment tasks in the course I am teaching on relate to other courses students are taking as part of their program.	2.73	1.34	−0.26	−0.85
Cognitive (Cues)	3	I signpost the key skills students need to learn in their course.	2.69	1.30	−0.22	−0.81
Cognitive (Load)	4	I carefully consider how I introduce new ideas to students so as to not overload them with too much complex information at one point.	2.75	1.29	−0.14	−0.90
Internalization of standards	5	I embed self-assessment activities throughout a course so students get opportunities to test their levels of understanding for themselves.	3.16	1.19	−0.60	−0.35
Feedback utilization	6	I time feedback opportunities carefully so that they have maximum impact in supporting students' development of knowledge and skills for future work.	3.0	1.21	−0.61	−0.33
Affective (motivation) and cognitive	7	I explain the rationale underpinning the design of assessment with students.	2.73	1.35	−0.36	−0.77
Shared regulation	8	I design assessments that reward students' ability to work collaboratively to achieve shared goals.	3.11	1.17	−0.65	−0.19
Agency and autonomy	9	I encourage students to take responsibility for their own learning.	3.06	1.45	−0.45	−0.8
	10	I actively involve students during the course in providing feedback on the quality of learning activities.	3.10	1.31	−0.55	−0.41
Planning and Goals	11	I place emphasis on supporting students' planning skills (how they identify the requirements of a task and plan for managing the successful completion of it).	3.04	1.16	−0.67	0.18
	12	I work with students to help them identify and agree goals for their learning.	3.02	1.20	−0.43	−0.35
Self-efficacy	13	I explore with students their beliefs in their ability to do well and how they can enhance their confidence in their learning.	3.09	1.20	−0.62	−0.21
Internalization of standards	14	I engage students in developing marking criteria for assessments.	3.02	1.25	−0.57	−0.35
	15	I work with students to help them understand the marking criteria for assessments.	2.87	1.30	−0.43	−0.50
Deep approach	16	I encourage students to explore the meaning behind ideas for themselves, and to think about how they can apply what they have learnt to create new understandings.	2.99	1.30	−0.48	−0.48
Feedback regulation	17	I provide guidance to students on how to recognize and seek different sources of feedback, and to use feedback effectively to enhance performance on subsequent tasks.	3.14	1.26	−0.57	−0.17
Shared and co-regulation – relational skills	18	I train students in how to work effectively together and to support each other's learning.	3.09	1.22	−0.51	−0.31

(Continued)

TABLE 2 (Continued)

Related constructs		SRAF items	M	SD	Skewness	Kurtosis
Metacognition reflexivity	19	I work with students to enable them to have a better understanding of what their strengths and weaknesses are in relation to the core knowledge and skills required in the course, and how to address these.	3.18	1.17	−0.49	0.01
	20	I share data with students so that they can see how certain approaches to learning may be more effective than others.	3.10	1.27	−0.56	−0.34
Self-evaluative judgment	21	I work with students to develop their monitoring and evaluation skills so that they are able to accurately critically appraise how well they are doing.	3.19	1.18	−0.53	−0.14

parallel analysis using both principal components and common factor analysis extraction methods (Hayton et al., 2004), (iv) Minimum Average Partial (MAP) tests (Velicer, 1976), sequential chi-square model tests (Auerwald and Moshagen, 2019) and empirical Kaiser criterion scores (Braeken and van Assen, 2017).

We examined EFA results in the context of the percentage cumulative variance explained (Costello and Osborne, 2005), and according to factor loadings. Specifically, we eliminated items with factor loadings < 0.45 (Hair et al., 2010) or with cross-loadings on two or more factors without a difference of > 0.3. Following EFA, reliability analysis was conducted to determine internal consistency of items loading onto their associated factors. This was done using Cronbach's Alpha (α) with items deemed reliable if $\alpha > 0.7$ (Taber, 2018).

6 Results

6.1 Confirming the factors underpinning the SRAF scale

Descriptive statistics for individual items of the SRAF survey for Support Required (SR) are presented in Table 2. The 21 SRAF scale items entered the first EFA using data from 173 participants; there were 30 missing cases. EFA resulted in elimination of four items (items 1, 10, 15, 16) due to low loadings < 0.45; two items (5 and 14) were borderline, and a decision was made to retain these.

The final scale with the remaining 17 items yielded a Kaiser MSA value of 0.93 and a significant Bartlett's test of sphericity ($\chi^2(136) = 2102.00, p < 0.001$). These results verified that the SRAF (SR) sample was suitable for factor analysis. Two components had eigenvalues over 1. Inspection of the scree plot further recommended a two-factor solution.

The final two-factor solution (shown in Table 3) accounted for 57% of the overall variance with 95% reliability: factor 1 containing nine items (31%) and factor 2 containing eight items (26%). Internal reliabilities for the two factors suggest each subscale as a reliable measure ($\alpha = 0.94$ for factor one with item-total correlation ranging from 0.53 to 0.65; and $\alpha = 0.9$ for factor two, with item-total correlation ranging from 0.49 to 0.59). From review of the loadings on the two factors, factor 1 represented *Supporting Students' SRAF Skills Development*, and factor two represented *Creating the Conditions for SRAF*. According to the component correlation matrix there was a

strong positive correlation between the two factors ($r = 0.75$) which was expected given the highly interconnected nature of the constructs we were exploring. The same two factor solution was verified in running iterative ERA on academics' responses to practice frequency items with two items having eigenvalues over 1. However, four questionnaire items (questions 2, 9, 11, 18) were removed as the loadings were below 0.45 for the practice frequency questions.

6.2 Academics' perceptions of support required in developing SRAF approaches

The means and standard deviations for the 17 items comprising the SRAF Support Required (SR) scale are provided in Table 2. Overall, academics wanted most support with students' metacognitive strategy development, and least support with assessment literacy and supporting students' cognitive skills (e.g., managing cognitive load). Academics most wanted assistance with supporting students' monitoring and evaluation skills, their self-awareness of strengths and weaknesses in relation to course demands. In *Creating the Conditions for SRAF* academics most wanted support with how to embed self-assessment within assessment design.

6.3 The relationship between support required and reported frequency of use of SRAF

Using the approach used by Dinsmore et al. (2024), we calculated the mean absolute difference (MAD) to explore the gap between the SRAF approaches academics reported wanting most support with, and those they reported using most (Table 4). A larger MAD represented a bigger discrepancy between the score for practice frequency and support required. MAD was calculated for the 13 items that loaded above 0.45 on both sets of SRAF questions (practice frequency (PF) and support required (SR)).

With the exception of item ten (embedding self-assessment within assessment design), academics' reported giving most attention to items comprising *Creating the Conditions for SRAF* with emphasis on supporting students' assessment literacy which is reflective on the emphasis there has been on this in research for last ten years (Zhu and Evans, 2022). Academics reported greatest focus on supporting

TABLE 3 SRAF (SR) summary of exploratory factor analysis with Cronbach's alpha ($n = 173$).

Rotated factor loadings		
SRAF (SR) items	Factor 1	Factor 2
2		0.74
3		0.85
4		0.9
5		0.5
6		0.69
7		0.82
8		0.54
9		0.57
11	0.67	
12	0.64	
13	0.71	
14	0.52	
17	0.65	
18	0.77	
19	0.97	
20	0.74	
21	0.97	
% of variance explained	31%	26%
Internal reliability (Cronbach's α)	0.94	0.90

Item loadings < 0.45 are suppressed.

students' cognitive skills (e.g., access to assessment and feedback by reducing cognitive load, signposting key skills, and explaining the rationale underpinning assessment). From an assessment design perspective, academics' focused efforts on the placement of feedback to maximize support for student learning and on rewarding collaborative practices. An emphasis on *Supporting Students' SRAF Skills Development* was less evident, with academics' reporting least attention being placed on engaging students in developing assessment criteria, supporting monitoring and evaluation skills, and agreeing goals for learning.

Figure 2 illustrates the relationship between PF and SR for each item of SRAF that could be compared across the two SRAF surveys (13 items in total). Three clusters were identified from the data from a possible four combinations (Evans and Waring, 2023a).

- Cluster 1: high use (PF) and high interest (SR) (items 17, 8)
- Cluster 2: low use (PF) and high interest (SR) (items, 5, 12, 13, 14, 19, 20, 21)
- Cluster 3: low use (PF) and low interest (SR) (no items)
- Cluster 4: high use (PF) and low interest (SR) (3, 4, 6, 7)

Perceived high usage and high interest items (Cluster 1) relate to supporting students' feedback skills, and abilities to work collaboratively in developing co- and shared regulatory practices with peers. High usage and low interest items (Cluster 4) relate to areas that academics feel are embedded in their practice and do not need more support with; these include, for example, supporting students'

cognitive access to assessment and aspects of assessment design to ensure that feedback feeds forward. Low usage and high interest items (Cluster 2) form the largest group in our findings and are largely focused on academics' metacognitive skills development and enabling the embedding of such within assessment design. These items include the need to support students' goal-setting, engagement in co-creation of assessment criteria; use of data with students, and monitoring and evaluation skills; areas reported as less frequently used in practice by academics.

In reviewing missing items (those that did not load at sufficient levels on either factor), Item 1 '*Awareness of students' starting points, and ongoing review of progress*' is an area that is known to be very important in self-regulated learning in impacting the effectiveness of instructional techniques (Fyfe and Rittle Johnson, 2016), however, academics' reported relatively low usage of, and low interest in getting more support in this area. Evans and Waring (2023a) highlight the importance of using SRAF tools with colleagues to surface the relevance of key constructs and to demonstrate how to integrate SRAF into practice in a manageable way that is relevant to context. Academics in training sessions integral to this research identified the main reason for not using certain SRAF approaches was due to not knowing about them in the first place, providing face validity for Evans and Waring's cluster 3 category.

7 Discussion

7.1 Confirming reliability, validity, and underpinning SRAF constructs

Construct validity was established through exploratory factor analysis (EFA). Our end product included a two-factor scale. Content validity and internal consistency reliability supported evidence of construct validity which was also supported by the theoretical underpinnings of the SRAF scales.

Two constructs *Supporting Students' SRAF Skills Development* and *Creating Conditions for SRAF* were established. Academics' placed most emphasis on supporting students' metacognitive skills development, and less attention on motivational aspects such as goal-setting, and planning aspects of self-regulation. This finding was congruent with academics' reported focus on *Creating the Conditions for SRAF* with emphasis on cognitive skills development. Our findings, in many respects, are similar to those of Dinsmore et al. (2024) in that academics reported greater use of cognitive strategies compared to metacognitive and motivational dimensions of learning. Identifying that these themes are common across very different samples suggests the potential generalizability of these findings which would need further verification across wider contexts. These results are not surprising given that research suggests less emphasis is being placed on developing students' goal-setting strategies compared to other aspects of self-regulation (e.g., feedback-using skills) in higher education (Evans and Waring, 2021, 2023a,b). This finding is congruent with evidence suggesting that much emphasis has been placed on reflection on feedback on performance on a task at the expense of time spent on supporting students' planning and goal setting in assessment and feedback (Farrell et al., 2017). This matters because of the importance of planning skills and goal development in impacting student

TABLE 4 Mean Absolute Difference between responses to frequency of practice and support required.

F	SRAF ITEMS	Practice Frequency		Support required		MAD	SD	MAD	Category
	Factor	M	Rank	M	Rank	M		Rank	
F2	Factor 2								
1	Reviewing students starting points								
2	Showing how assessment tasks link together			2.73	15				
3	Signposting key skills	3.72	2	2.69	17	1.47	1.32	3	PF High SR Low
4	Managing cognitive load	3.99	1	2.75	14	1.49	1.39	2	PF High SR Low
5	Embedding self-assessment activities	3.17	10	3.16	3	1.26	1.3	8	PF Low SR High
6	Placing feedback to maximize impacts	3.39	4	3.00	13	1.16	1.17	12	PF High SR Low
7	Explaining the rationale underpinning assessment	3.65	3	2.73	15	1.52	1.37	1	PF High SR Low
8	Rewarding collaborative work to support shared goals	3.36	5	3.10	5	1.14	1.08	13	PF High SR High
9	Student responsibility for learning			3.06	9				
10	Gaining student feedback on the quality of learning activities								
F1	Factor 1								
11	Emphasis on planning skills, task recognition, and strategy			3.04	10				
12	Agreeing goals for learning	3.11	11	3.02	11	1.28	1.24	6	PF Low SR High
13	Academic self-efficacy	3.26	7	3.09	7	1.23	1.16	10	PF Low SR High
14	Student engagement in developing marking criteria	2.43	13	3.02	11	1.28	1.24	6	PF Low SR High
15	Helping students to understand criteria								
16	Encouraging a deep approach								
17	Feedback guidance	3.35	6	3.14	4	1.38	1.29	5	PF High SR High
18	Training students to work collaboratively			3.09	7				
19	Metacognitive strategy	3.22	8	3.18	2	1.23	1.14	10	PF Low SR High
20	Using data with students	3.21	9	3.10	5	1.44	1.32	4	PF Low SR High
21	Monitoring and evaluation	3.01	12	3.19	1	1.24	1.19	9	PF Low SR High

outcomes, and suggests an important gap between practice and research that needs to be addressed (Panadero, 2017).

Similarly, academics who reported high usage of items loaded on *Creating Conditions for SRAF* were likely to report lower usage on *Supporting Students' SRAF Skills Development*. To be most effective SRAF requires both aspects of SRAF to work in unison (Evans, 2013). The findings may reflect the stage of professional development that academics are at, in that staff identified the need for support in facilitating SRAF skills development with students.

7.2 Strengths and areas for development

7.2.1 Scale considerations

One of the greatest strengths of the SRAF scale was in its practical use as a powerful heuristic to guide discussions on effective SRAF with academics. A common criticism of self-rating scales is the degree of discrepancy between actual and perceived behaviors (Chrystal et al., 2019; Uher, 2023). The SRAF scale focuses on perceived training needs and estimates of frequency of use of SRAF. The scale was useful

in supporting academics to identify high level SRL skills and in showing them how to implement SRAF using EAT. It provided a valuable mechanism to support discussions about what effective SRAF practice looked like in different contexts. A core aspect of building SRAF competency is in unpacking conceptions and beliefs about what constitutes good practice and why.

In scrutinizing the properties of the SRAF scale it demonstrated strong internal reliability. The sample size was adequate for preliminary EFA but needed a larger sample in order to perform second stage confirmatory factor analysis. This initial pilot was valuable in identifying the strength of the scale but also indicated areas where it could be further refined.

While the same two underpinning factors were identified in questions focusing on the support academics' wanted and their perception of practice frequency of SRAF, the discrepancy between the number of items that loaded on questions about support and those that loaded on frequency of use of SRAF was a concern. Some of the pilot SRAF items that would have been expected to load on the two identified dimensions did not have loadings above 0.45, which was our cut off point for further EFA, suggesting the need for further refinement of the items comprising the scale. In looking at academics' scores on some of these excluded items it is interesting to note that item one about reviewing data on students' starting points and ongoing checking of progress is integral to developing an inclusive culture to support SRAF. Effective use of data to enhance assessment design is a significant issue for higher education (Evans et al., 2019). Item 15 on working *with* students to support their understanding of assessment criteria is fundamental to students being clear about the expectations of assessment. Item 16 on supporting students' development of a deep approach to learning should be central to assessment design but it is a complex construct. Traditionally a deep approach is associated with the intention to understand, but it also requires understanding of the process of

learning within specific contexts (McCune and Entwistle, 2011), and discernment in knowing what the most appropriate strategies are to master a task (Evans and Vermunt, 2013). This construct needs further unpacking as it has many constituent parts. The complexity inherent in individual self-regulatory constructs is a key challenge in SRL skills research (Carless and Boud, 2019). For example, in looking at evaluative judgment, Luo et al. (2023) have identified five constructs involved including understanding of the context (i.e., assessment literacy) and the interplay of metacognitive, affective, and cognitive components which aligns with EAT (Evans, 2016, 2022). The key challenge is distilling the essential items that can best support academics' understanding of key factors at play within SRAF, and across contexts.

Given the complexities of self-regulatory constructs and the need to develop clear understandings of them, and within discipline contexts (Evans and Waring, 2023a), there is a need to refine these items to explore different facets of them. The SRAF (SR) scale inter-item correlations suggest especially for factor 1, *Supporting Students' SRAF Skills Development*, that the scale could be enhanced to capture a broader bandwidth of the construct (Piedmont, 2014).

Initial findings from this preliminary study are positive given alignment with comparable studies and testing of ideas with colleagues from very different cultural contexts (institution, country, discipline). Further work is needed to refine and test items with a larger sample that will permit further testing of the SRAF scale's properties through exploratory and confirmatory (CFA) factor analyses as to its suitability for use with different samples. Our results to date are promising in this respect, given the similar findings in Dinsmore et al. (2024) when focusing on skills development (factor 1). In working collaboratively with academics and students it is possible to verify individual and team perceptions of strengths in areas of SRAF practice through peer feedback and open dialog

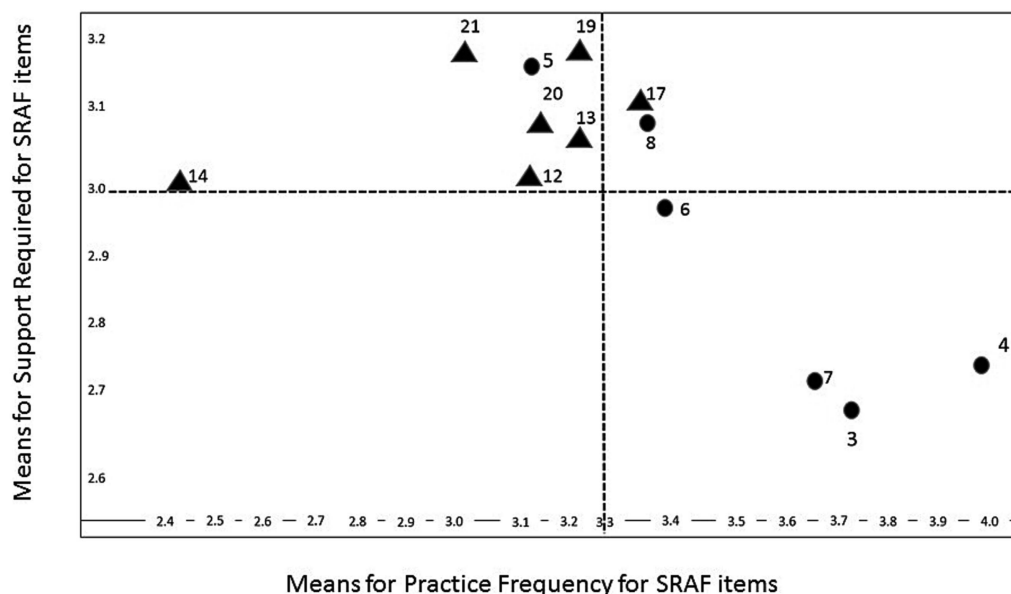


FIGURE 2
The relationship between practice frequency and support required for SRAF items.

around understanding of concepts, and evidence of effectiveness of SRAF approaches.

Subject to satisfactory CFA results, convergent validity can be explored through utilization of aligned frameworks and tools:

- (i) A relationship between Dinsmore et al.'s (2024) self-regulatory assessment scale and dimension 1 of SRAF: *Supporting Students' SRAF Skills Development* would be expected as they are both measuring self-regulatory skills use. Key differences are that Dinsmore et al. place greater emphasis on task value, whereas the SRAF scale, drawing on the EAT framework, places greater emphasis on partnership with students in supporting different phases of the self-regulatory cycle aligned to very specific SRAF practices, whereas Dinsmore et al.'s scale emphasizes broader metacognitive skills.
- (ii) A relationship would be expected between the assessment engagement scale (AES) of Evans and Zhu (2023), and *Creating the Conditions to Support SRAF* (factor 2) given that the AES is focused on the extent to which assessment design supports SRAF, suggesting there should be strong alignment.
- (iii) Predictive validity can be explored through academics' perceived engagement in SRAF, perceived self-efficacy in ability to implement SRAF, in impacting the quality of assessment design, and the extent to which students' perceive that assessment design enables them to engage in SRAF (using the Assessment Engagement Scale (student version), Evans and Zhu, 2023).

7.2.2 Wider methodological strengths and limitations

In developing the SRAF scale, a key strength of our sample was that it was representative of the higher education academic community in that it comprised international academics from a wide range of disciplines, research and teaching roles, and was well balanced with respect to gender. However, the breadth of the sample limited certain types of analyses at the individual institution level.

The testing of SRAF concepts with colleagues across different cultural contexts was effective in maximizing the utility and relevance of SRAF tools for an international audience, supporting translation of ideas into practice.

Focusing attention on academics' perceptions of their use of SRAF and the professional development they wanted in SRAF was powerful in supporting the reframing of professional development activities to focus on key SRAF knowledge and skills gaps in specific contexts. Our research draws attention to the importance of exploring how academics assess the quality of their SRAF practice, and what evidence informs this process. A key question arising from this research was how those leading SRAF training are supported in bridging SRAF knowledge and practice gaps. In this article, our focus was purely on academic's perceptions of this process. Further work is recommended on the perceptions of professional development staff in relation to how they perceive affordances and barriers in supporting the quality of SRAF professional development training aligned with the SRAF skillsets required within specific disciplines.

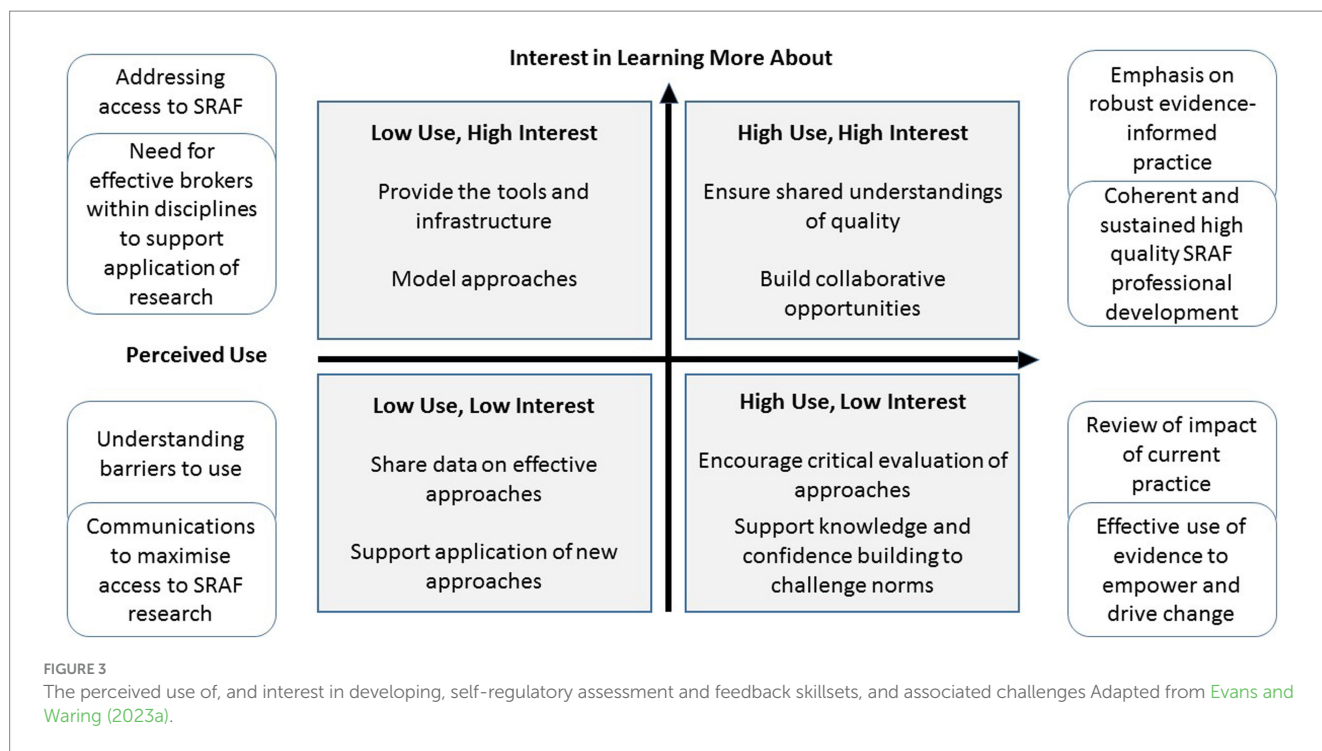
7.3 Implications of academics' reported use of, and interest in, SRAF in supporting the professional development of SRAF

Academics reported greater use of cognitive strategies compared to metacognitive ones as also identified by Dinsmore et al. (2024) in a very different context. In contrast to Dinsmore et al. our sample of academics demonstrated high interest in learning more about how to support students' goal-setting and academic self-efficacy. This finding may be related to the fact that our sample of academics was purposeful in that they were engaged in networks where we had been promoting the importance of attending to affective and motivational dimensions of self-regulation to include self-efficacy, goal-setting, and planning.

SRAF requires discernment in knowing which strategies to use in any given context, and how to use them well (Dinsmore, 2017); this is especially pertinent to SRAF professional development in higher education (Evans and Waring, 2023a). Dinsmore et al. (2024) argue that the nature of strategies used to support academics' professional development in SRAF is dependent on academics' use and interest in SRAF. Expectancy value theory is relevant to Dinsmore et al.'s argument (Wigfield and Eccles, 2000), in that to invest in SRAF training, academics need to have a reasonable expectation that such training will benefit them and their students.

Evans and Waring (2023a) argue that valuing of a task is insufficient in itself to gain engagement of academics in SRAF, drawing on the role of control value theory of achievement emotions in this (Pekrun et al., 2006). In supporting academics' engagement in SRAF they highlight the importance of academics' perceptions of competency (e.g., expectancy of successful outcomes, productive relationships with students), and support from others (colleagues, department, institution). The interaction of these variables impacts academics' choice of metacognitive, cognitive, and affective strategies (e.g., help-seeking and managing one's environment), with impacts on performance, satisfaction, and motivations, which also affect emotions and perceptions of competency, task value and goal orientation (Evans and Waring, 2021, p. 462).

Figure 3, adapted from Evans and Waring (2023a) and drawing on Dinsmore et al., highlights that professional development strategies should take account of academics' perceived use and interest in learning more about SRAF. There are a range of challenges in managing SRAF professional development dependent, for example, on academics' dispositions, interests, and the contexts in which they work. For example, colleagues may report high usage of a particular strategy but ensuring shared understanding of what constitutes quality is difficult to achieve without an ongoing, co-ordinated and high quality SRAF professional development offer; an area in great need of attention in higher education (Ruiz and Panadero, 2023). Alternatively, academics may report high use of SRAF practices and little need for further development in them. Challenging ingrained positions on practice is difficult and requires a strong evidence-based approach to convince and empower individuals to make changes to established ways of working. Alternatively where low usage of SRAF is reported, barriers to access need to be addressed and the importance of brokers within disciplines to support change is imperative. Academics involved in SRAF networking activities highlighted that low use of SRAF was often related to lack of awareness of it and the strategies to support implementation of SRAF (Evans et al., 2019; Evans et al., 2021). In this respect we argue the importance of a coherent institution-wide communications strategy that supports networking and sustainability of SRAF through dissemination of effective research



strategies to evaluate the relative value of using SRAF approaches to build a sustainable research and practice SRAF community.

Through working in practice with academics and using the exploratory tools described in this article, it was possible to identify key challenges impacting use of SRAF; these align closely with those found in previous studies (Evans et al., 2019, 2021). In Figure 4, these factors are grouped into individual and organizational factors that work in unison to impact knowledge of, engagement in, and successful application of SRAF. The individual factors closely align with Winne's (1996) identification of five key factors implicated in self-regulated learning (i.e., global dispositions, domain knowledge, knowledge of tactics and strategies, performance and regulation of tactics and strategies).

An emphasis is needed on academics' self-regulation of assessment and feedback if they are to be best supported in developing these practices with their students (Russell et al., 2022). Using SRAF requires both a cognitive shift in academics' understanding of how best to support students' acquisition of SRL skills within a specific domain (Simper, 2020) and a seismic cultural shift in reconceptualizing assessment as a participatory process with a different role for the students in this process (Faherty, 2015). Simper (2020) aligns academics' changes in thinking about assessment with the notion of threshold concepts (Meyer and Land, 2003). Changing one's thinking about assessment is a challenging process which often involves changes in one's ontological positioning (Land et al., 2005), which may also be in conflict with other colleagues' views on assessment and the institution view of assessment. SRAF requires academics and students to reposition themselves and their roles in relation to each other (Chan and Chen, 2023), where assessment is no longer "done unto students", and where students, while not ultimate authorities in assessment (Cook-Sather, 2014), have valid input into assessment (Evans, 2013, 2016). The challenge for academics is in supporting students to take on a number of different roles in assessment (input into assessment design, feedback, and marking), which requires

developing focused training for students in how to take on these roles, and to understand the specific requirements associated with different types of roles.

The challenges impacting academics' development and use of SRAF in practice drawing on information processing and socio-cultural perspectives are highlighted in Figure 4. At the individual level, in supporting SRAF three core areas from our work with academics have been identified relating to access to concepts, openness to new approaches, and perceived political capital in leveraging SRAF with their peers and their students (Evans et al., 2019). We argue that SRAF training needs to attend to these different areas, and to explore the relationships between them. While understanding of individual differences in learning could be encapsulated within pedagogical expertise given the need to focus training on this area, we have created a separate category for it.

Myrre et al. (2022) highlight the importance of addressing teacher self-efficacy. Academics' perceptions of their agency and advocacy in leveraging change were key factors mentioned in this research in discussions around challenges in implementing SRAF. Academics mentioned difficulties in accessing SRAF concepts that were totally new to them in many cases, and needing access to the language and theoretical framing underpinning concepts and help in seeing how these ideas could be applied within their discipline. The EAT framework was useful in providing a concrete routemap of how to apply SRAF to practice, and through explicit labeling of key self-regulatory processes implicated in assessment (Table 1).

Figure 4 highlights the importance of institutional alignment in supporting academics' implementation of SRAF through policy and strategy emphasizing students' meaningful engagement in assessment underpinned by evidence-informed practice. A coherent, integrated and sustainable assessment strategy must take account of the roles of academics, professional services, technical support teams, wider stakeholders and students in assessment and feedback activities. The importance of effective infrastructure that takes away the "heavy

Building SRAF Capacity

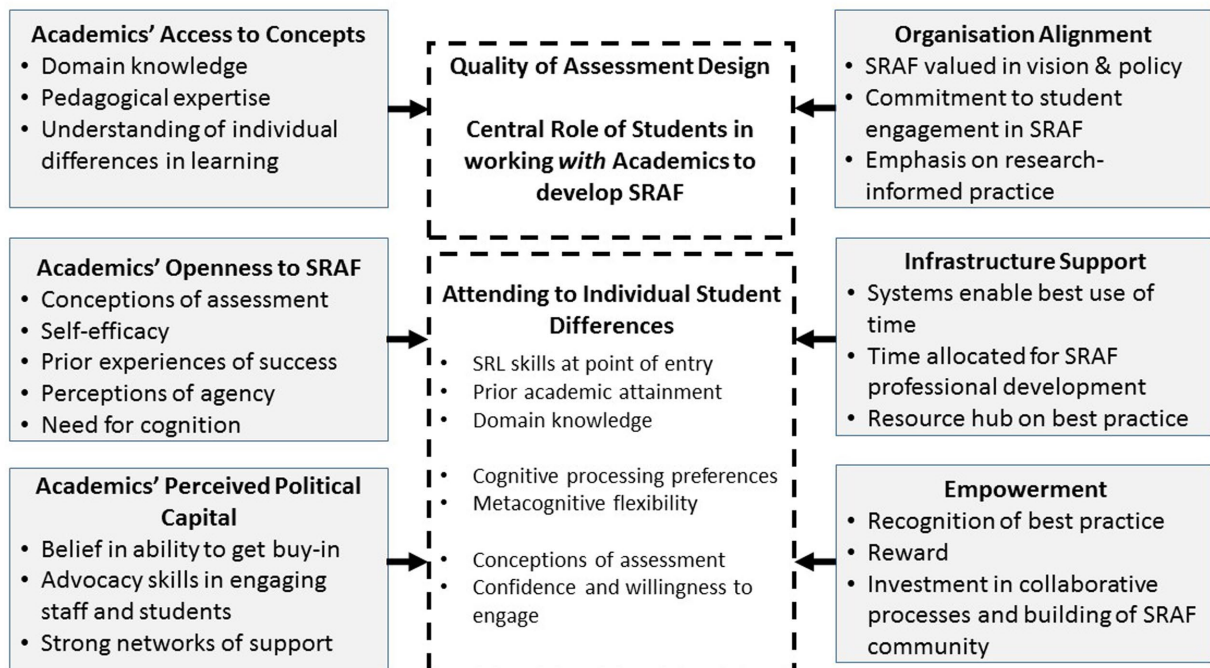


FIGURE 4
Building SRAF capacity (Evans and Waring, 2023b).

lifting" of assessment (e.g., through automation of basic functions, agile policy to enable dynamic change in assessment, efficient marking and moderation systems) is emphasized. Prioritizing time for academics to work on SRAF embedded assessment designs and resources is seen as essential to ensure aligned assessment processes focused on supporting the progressive development of students' self-regulatory skills. Empowering academics through recognizing and rewarding SRAF, and in supporting the building of collaborative communities that enable the sustained development of effective SRAF are important (Evans et al., 2022a,b). Integral to Figure 4 and central to it, is attending to students' engagement in SRAF which parallels key constructs identified as central for academics (e.g., domain knowledge, processing styles, conceptions of assessment and confidence and willingness to engage). Greater understanding of the attributes that students bring into higher education is essential to complete the SRAF learning cycle.

8 Conclusions: implications for evolving SRAF research and practice

This article makes an important contribution to advancing assessment and feedback practice in higher education by highlighting the importance of supporting academics' SRAF development if they are to effectively facilitate their students' SRL skills development. This focus on SRAF is essential in supporting students' learning in higher education. In bridging the research-practice divide, this article outlines conceptual and practical frameworks and tools to support the translation of SRAF concepts into practice. A considered and research-informed approach to academics' professional development in SRAF is advocated to support academics in evaluating their practice, and in

enabling focused attention on what matters in assessment and feedback as part of a self-regulatory approach.

In advancing understanding of SRAF, we identified two factors underpinning the SRAF scale: *Supporting Students' SRAF Skills Development* and *Creating the Conditions for SRAF*. The strong internal reliability of the scales supported its use with academics although further work is needed to fully capture the high level SRL skills we were focusing on given the complexity of the SRL construct, and the need to test the scale items on larger samples. In this pilot study we focused on those self-regulatory behaviors known to have greatest impact on learning. Data captured from academics through this initial data gathering stage will be used to refine the scale items to capture greater breadth of SRAF.

One of the greatest benefits of the SRAF scale was in its use as a practical learning tool; a heuristic to guide academics in exploring high level SRL skills with their students. The SRAF scale was a valuable measure to explore academics' views on the areas in which they perceived they needed most help in developing SRAF, and in comparison to their reported frequency of use of SRAF. The conceptual and practical tools developed to support SRAF implementation were powerful in raising awareness of the importance of developing students' metacognitive skills, as evidenced in academics' preference for training in this area, and in promoting a shift to a more evidence-informed approach to supporting students' SRAF. Our findings highlight the importance of effective dissemination of information about core SRAF practices, and how to implement them in practice.

Further work is needed to better understand the processes involved in supporting academics' understanding and use of SRAF. Figure 4 highlights a range of factors impacting academics' use

of SRAF which need consideration in the design of professional development to support academics' understanding of SRAF.

A key challenge in supporting SRAF research and practice in higher education is in the complex interplay between the numerous self-regulatory concepts and processes involved in interaction with individuals and the contexts in which they are working. Cassidy (2011) argued that it is the aggregated effects of many components that determine the efficacy of the self-regulation process, and Jansen et al. (2019) argued that there may be many different models of how to support self-regulation that may be equally valid. A key priority in supporting SRAF with academics is well designed methodologies to enable exploration of how the different elements of self-regulation come together to impact outcomes for academics and their students in specific contexts.

Individual differences are implicated in the effectiveness of SRAF (Dörrenbächer and Perels, 2016). Academics need better understanding of the role of individual differences in supporting effective self-regulation (Panadero, 2023). Further research is required on how students' self-regulatory profiles impact their engagement in SRAF and the strategies that they use, and how best to support them, as integral to SRAF professional development. Greater focus is also needed on collaborative self-regulatory approaches. In reality, regulating oneself, being supported by others (co-regulation), and regulating together (shared regulation) are all present in many aspects of SRAF, and need consideration in training to support the most appropriate use of different regulation strategies in relation to the nature of the task.

Investing in coherent and sustained programs of SRAF professional development is important in supporting high quality and efficient assessment design that benefits academics' and students' mastery of assessment and feedback. In this article we have highlighted how the EAT framework provides a useful structure to facilitate conversations about how to actualize SRAF, but needs brokers on the ground that can translate the work to a specific disciplinary context as to which SRL skills are prioritized for development, and for whom. Extensive opportunities are needed for dialog to support shared understandings and effective use of SRAF pedagogies underpinned by high quality research. To support academics in implementing effective SRAF focus needs to be placed on supporting them in understanding their own self-regulatory behaviors if they are to be best placed to support their students' acquisition of such skills.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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Ethics statement

The studies involving humans were approved by the School Research Ethics Committee of the School of Biosciences, Cardiff University, UK. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

CE core work included Conceptualization, Writing, Formal analysis, Methodology, Resources, and Visualisation. WK core work included Data Curation, Software, Formal analysis, Visualisation, Writing, SR, SA-D, RdMG, and KD core work included the Research and Investigation process.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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