frontiers | Frontiers in Computer Science

TYPE Curriculum, Instruction, and Pedagogy
PUBLISHED 02 September 2025
DOI 10.3389/fcomp.2025.1593889

Check for updates

OPEN ACCESS

EDITED BY
Yu-Chun Kuo,
Rowan University, United States

REVIEWED BY
Sereyrath Em,
University of Cambodia, Cambodia
Jose Daniel Azofeifa,
Institute for the Future of Education,
Tecnologico de Monterrey, Mexico

*CORRESPONDENCE
Maria Wirzberger
✉ maria.wirzberger@iris.uni-stuttgart.de

RECEIVED 14 March 2025
ACCEPTED 12 August 2025
PUBLISHED 02 September 2025

CITATION
Schmitz-Hübsch A, Bareiß L, Jahn E and Wirzberger M (2025) eduScrum meets focUS: a computer-assisted training to promote self-regulation skills in higher education. *Front. Comput. Sci.* 7:1593889. doi: 10.3389/fcomp.2025.1593889

eduScrum meets focUS: a computer-assisted training to promote self-regulation skills in higher education

Alina Schmitz-Hübsch[1], Laura Bareiß[1], Eva Jahn[1] and Maria Wirzberger[1,2]*

[1]University of Stuttgart, Department of Teaching and Learning with Intelligent Systems, Stuttgart, Germany, [2]University of Stuttgart, Interchange Forum for Reflecting on Intelligent Systems, Stuttgart, Germany

Given the ever-evolving demands of the professional world, higher education plays a vital role in equipping students with strategies for self-organized and sustainable skill development. This enables students to quickly and independently adapt to new knowledge and skills throughout their careers. Therefore, it is of the essence to integrate methods that enhance self-regulation skills into our study programs, alongside the instruction of specific subject-matter expertise. Addressing these demands, we introduce a focused training that embeds the assistive software tool focUS into a structured seminar concept, leveraging eduScrum elements and accompanying learning communities. After introducing the results of a pilot evaluation with a small group of interdisciplinary doctoral students, we discuss possibilities of technical and conceptual integration in course curricula and learning counseling in higher education. Taken together, our approach indicates value for empowering future professionals across various domains to unleash their full potential.

KEYWORDS

self-regulation, metacognitive feedback, higher education, computer-assisted interventions, agile learning

1 Skill development in the face of distractions: a core challenge in higher education

Imagine that you are a student in higher education and face a situation like this: An exam is approaching, your main focus should be on preparing for the included topics, but you have a hard time concentrating on your study materials. Instead, your mind keeps wandering to the funny online video your friend had sent you earlier, which seems far more interesting and worthwhile at that moment, and tempts you to spend your time procrastinating. Although in the long run, a successfully completed exam has a much more beneficial impact on your career trajectory. Situations like this underline that we face self-regulation demands, such as keeping our attention focused or sticking to the goals we set for ourselves, continuously in our daily lives.

With constantly changing professional requirements, higher education has the crucial responsibility to support students in acquiring strategies that promote self-organized and sustainable skill development. That way, students can easily adapt to relevant knowledge and skills and build them quickly and independently throughout their future career path. This emphasizes the necessity to embed approaches for strengthening self-regulation skills in our study programs, in addition to teaching specific subject-matter knowledge.

But how exactly can we promote strong self-regulation skills in higher education? And how can we leverage the potential of computer-assisted interventions to systematically guide students in this endeavor? What advice can we provide for students to reflect on possible sources of distraction, insufficient learning techniques, learning difficulties, or resource overload, thereby enabling them to develop and refine supportive strategies?

Addressing the outlined questions, we introduce a dedicated training framework to support self-regulation skills in academic settings. It embeds an assistive software tool (Wirzberger et al., 2024) into a structured seminar concept, which leverages eduScrum elements (Wijnands and Stolze, 2019) and accompanying learning communities (Wilson et al., 2023).

2 Achieving academic goals: goal setting, feedback, and social support as pathways to self-regulated learning and working

Self-regulation forms a crucial prerequisite for achieving individual and joint academic goals. It encompasses a wide range of processes that steer individuals' goal-directed behavior, including cognitive, metacognitive, and motivational activities (Schunk and Greene, 2017; Sitzmann and Ely, 2011). According to the cyclic model of self-regulation (Zimmerman, 2000), related processes emerge from a continuous loop of (a) task planning (pre-actional phase), (b) monitoring (actional phase), and (c) self-reflection (post-actional phase). Within this dynamic cycle, cognitive self-control specifically refers to the ability to suppress distracting impulses and focus attention on information relevant to one's goals (Hofmann et al., 2012). Research has shown that these skills can also reduce the impact of potentially harmful distractions in computer-based learning and work environments (e.g., Wirzberger and Rey, 2018). Thereby, strategic goal setting forms a crucial prerequisite for goal-directed management of cognitive, metacognitive, and social resources, emphasizing the importance for learners to acquire and utilize related learning strategies.

Generally, learning strategies can be categorized into four domains: cognitive strategies, metacognitive strategies, internal, and external resource management strategies (Wild and Schiefele, 1994). Cognitive strategies involve processes that aid in the immediate acquisition, processing, and storage of information. These strategies are further divided into three components: repetition, elaboration, and organization (Wild and Schiefele, 1994). Metacognitive strategies refer to the immediate control mechanisms used during learning, such as planning learning steps, self-monitoring progress, and adjusting learning behavior based on that progress (Pintrich, 1989; Wild and Schiefele, 1994). Another aspect of learning involves managing resources to support learning or protect it from external distractions. This includes creating a conducive learning environment, effectively planning study time, and engaging in self-motivation. Wild and Schiefele (1994) distinguish between internal and external resources, where internal resources involve managing one's effort, time, and focus, while external resources include utilizing the learning environment, consulting additional literature, or collaborating in study groups.

Within the previously described continuous loop of self-regulation (Zimmerman, 2000), feedback forms an essential mechanism to steer goal-directed behavior. Building on vested theories, feedback can be described as one of the most powerful and effective tools to foster successful learning and achievement (Hattie and Timperley, 2007). With the help of feedback, learners can evaluate their progress to consequently derive information on required changes to future performance (Henderson et al., 2019). According to Hattie and Timperley (2007), feedback information is provided by an agent and targets a learner's understanding or performance. Thereby, not only can relevant stakeholders such as teachers, parents, or peers act as agents; also, self-feedback, experiences, books, or software can support learners to achieve their goals (Hattie and Timperley, 2007). Moreover, there exist different types of feedback: As an example, a learner can receive feedback provided as corrective information, as an alternative (solution) strategy, or further helpful information to gain a learning goal (Hattie and Timperley, 2007). Finally, the effectiveness of feedback depends on (a) the type of feedback and (b) the way it is given (e.g., Cannon and Witherspoon, 2005; Hattie and Timperley, 2007; Khizar et al., 2023). The powerful impact of feedback in educational contexts has been demonstrated on a wide range of dimensions such as learners' self-efficacy (e.g., Johannes and Haase, 2022; Rakoczy et al., 2019), learning process quality (e.g., Wisniewski et al., 2020), motivation (e.g., Khizar et al., 2023), cognitive and motor skills outcomes (e.g., Wisniewski et al., 2020), interest (e.g., Harks et al., 2014; Rakoczy et al., 2019), and performance achievements (e.g., Harks et al., 2014; Hattie and Timperley, 2007; Kluger and DeNisi, 1996; Valdez, 2012). However, its impacts can be both positive and negative (Hattie and Timperley, 2007; Wisniewski et al., 2020) and often depend on the perceived usefulness of the feedback (Harks et al., 2014; Rakoczy et al., 2019).

Also leveraging the power of feedback with the goal to promote self-regulated learning and working, agile approaches in education put learners' needs in the center and follow a project-oriented, student-teacher collaborative, feedback-driven process (Salza et al., 2019). In the project-management-inspired approach of eduScrum (Wijnands and Stolze, 2019), learners' self-organization and responsibility is fostered by a set of characterizing elements: small groups as working units, dedicated roles assigned in the learning process, and structured time-limited working phases called "sprints" to break up and structure the entire workflow. Core roles comprise the product owner (usually adopted by the teacher), responsible for deciding learning goals, monitoring learning processes, and evaluating students' progress, the eduScrum master (usually chosen by the product owner or the class), serving as facilitator to ensure process quality and progress, and the student team, jointly creating and evaluating desired learning outcomes iteratively and incrementally (Salza et al., 2019). Characteristically, sprints in educational settings involve a set of core events: initial sprint planning to define goals and tasks and assign responsibilities, daily stand-ups to continuously monitor the process, past sprint review to discuss learnings, and sprint retrospective to improve and prepare future sprints (Salza et al., 2019; Wijnands and Stolze, 2019). Due to its inherently collaborative nature, eduScrum has been demonstrated to increase not only learning outcomes but also intrinsic motivation and personal growth (Wijnands and Stolze, 2019). Thereby, personal development is particularly fostered by trust, communication, involvement, and accountability as core building blocks.

On a related note, social constructivist theory (Vygotsky, 1978) already acknowledged the socially situated nature of learning, which is described to be a process of active joint knowledge construction and sharing (Brouwer et al., 2022). A crucial requirement for authentically expressing one's own thoughts and concerns, however, is mutual trust among learners (Zamiri and Esmaeili, 2024). It can emerge in so-called learning communities that provide a safe space for peers with common interests or goals. Consequently, peers can engage in shared reflection on experiences and challenges, which allows them to co-create ideas for collective improvement (Wilson et al., 2023). Learning communities emerge broadly across educational contexts ranging from classroom-based settings to project-based collaborative teams, communities of practice, corporate learning communities, student organizations, and communities for lifelong learners (Otto et al., 2015). They have also been implemented in various forms in higher education to provide stabilizing peer networks that support students' transition from secondary education to university (Brouwer et al., 2022).

3 eduScrum meets focUS: a computer-assisted training for self-regulated learning and working in higher education

By combining the previously outlined approaches, our developed training focuses on two primary learning objectives: (1) enhancing learners' self-regulation, particularly their self-control, and (2) improving their use of learning strategies. Especially the combination of goal setting and feedback can result in improved performance (Latham and Locke, 1991); hence, the training centers around a software that incorporates both approaches. In more detail, the software focUS (Wirzberger et al., 2024) supports metacognitive skills related to goal setting, goal pursuit, and self-reflection across the entire lifecycle of self-regulation (Zimmerman, 2000). In the pre-actional phase, it relates to planning target activities to the level of required programs and websites. Breaking down the workflow into periods of focused work that alternate with short breaks enables a systematic healthy break management (Biwer et al., 2023).

Formative feedback, which is provided accompanying the work or study process during the actional phase, allows learners to monitor their invested resources and (re-)adjust to their target activities when they lost their attentional focus due to a distracting stimulus (e.g., a funny online video). Building on the principle of reward shaping from reinforcement learning (Ng et al., 1999), the metacognitive feedback conveys the expected value of cognitive control in relation to the value of the previously defined goal (Callaway et al., 2022; Shenhav et al., 2013). Summative feedback is provided after completing a defined period of focused work to finalize the process-related outcomes. Conveyed in the post-actional phase, it gives an overview of individuals' attentional focus over the just-completed working or learning phase in comparison to previous achievements. Dedicated self-reports and summarizing user dashboards (see Figure 1) indicate, for instance, the number and duration of distractions and allow thorough reflection on individual improvements in self-regulation skills.

Providing a first evaluation, Wirzberger et al. (2024) were able to demonstrate the power of feedback within the computer-assisted training. They compared the use of the software with optimal feedback (experimental condition) with a version without any feedback (control group) and thereby could show the benefits and power of optimal attentional feedback: it increased behavioral focus, self-control, and task motivation, resulting in successful goal achievement.

As Figure 2 shows, software use is embedded in two accompanying in-person seminars with a four-week self-learning phase in between. Thereby, the first seminar introduced the overall training topic, the underlying structure, and the focUS software. Furthermore, individual seminar goals are defined based on the self-determination theory (Ryan and Deci, 2000) and SMART goals (Doran, 1981). Additionally, different time management methods such as Kanban (Ohno, 1982), the Eisenhower method (Covey, 1989), the Pomodoro technique (Cirillo, 2018), the "Eat the Frog" method (Tracy, 2017), and the strategy of „Time boxing "(Martin, 1991) are introduced to help learners select the strategies that works best for them individually. Furthermore, in our exemplary case of doctoral student support, common obstacles of dissertation writing, time optimization, and personal experiences of the participants already employing successful strategies were addressed.

During the autonomous self-working phase, learners focus on different tasks aligned with their individual learning goals and reflect on their progress weekly, thereby implementing elements of an eduScrum approach (Wijnands and Stolze, 2019). As depicted in Figure 2, they are provided with worksheets resembling a "daily log" to track their work and progress, along with a "weekly reflection" on their development. They can upload their worksheets to a learning management system, which creates fixed deadlines to increase accountability, motivation, and focus. Weekly meetings allow learners to check in with their peers about their progress and challenges. Since the previously outlined eduScrum roles have been primarily designed for classroom settings in school, we adapted them for our purposes. While the role of product owner is assumed by individual learners themselves, defining their individual learning goals and monitoring and evaluating progress towards them, the role of eduScrum master is jointly assumed by the instructor and individual learner (see Figure 2). Both are guiding and facilitating progress towards the individually chosen goals by teaching or applying strategies to support self-regulated academic working. Given that each learner works on their individual goals, the student team merely assumes a supportive role, thereby implementing a learning communities approach.

The second seminar reviews the first seminar's content and offers a chance for learners to share experiences. It focuses on reflecting on the self-working phase, discussing software, writing processes, strategies, initial goals, and future improvements. Additionally, the cyclic model of self-regulation (Zimmerman, 2000), the concepts of growth vs. fixed mindsets (Dweck, 2006), and the role of emotions in learning (Gross, 1998) are explored. The seminar concludes with a positive outlook for learners' futures.

4 Potential for skill improvement: pilot evaluation of the computer-assisted seminar concept

The training, consisting of the multi-part seminar and the embedded use of the software tool focUS, was evaluated in a pilot study with $N = 5$ doctoral students from the University of Stuttgart

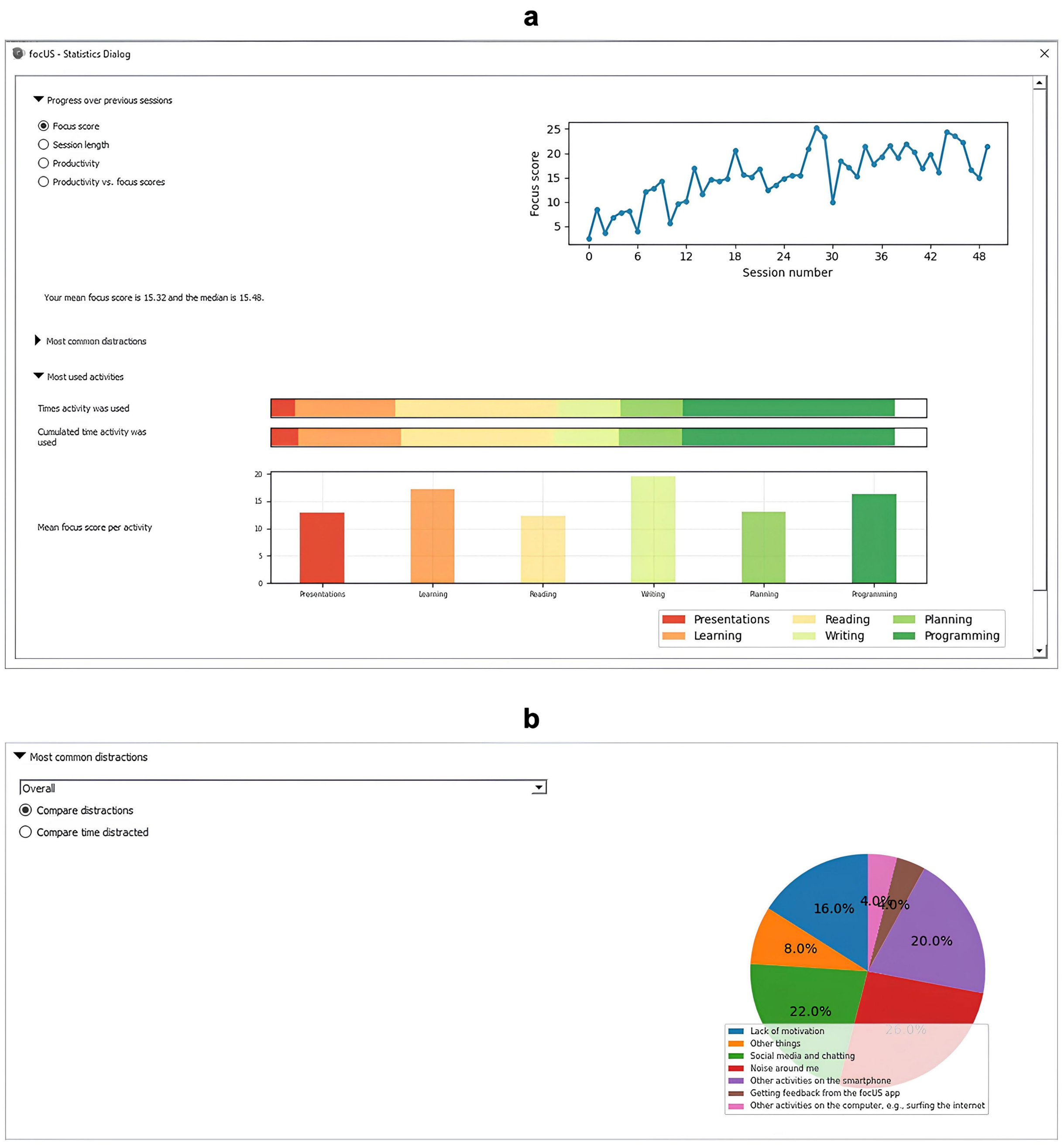

FIGURE 1
Dashboard providing insights on **(a)** skill development over time and **(b)** frequent reasons for distraction during focus sessions.

representing diverse academic backgrounds. The participants' ages ranged from 29 to 45 years ($M = 32.6$, $SD = 6.2$), with $n = 3$ being female and $n = 2$ being male. We collected informed consent from all participating doctoral students and performed our research following the relevant guidelines and regulations outlined in Standard 8 of the Ethical Principles and Code of Conduct for Psychologists (American Psychological Association, 2017).

In a pre-post comparison, goal achievement, self-control, learning strategies, as well as resource management strategies were assessed via online surveys prior to and after the intervention. Additionally, the usability of the software was examined as part of an online survey following the intervention. Due to the limited number of participants, we only conducted descriptive analyses as opposed to methods of inferential statistics.

4.1 Goal achievement, self-control, learning strategies, and resource management strategies

To evaluate goal achievement through the intervention, participants were initially asked to define a goal they wished to accomplish during the seminar. Of these goals, 40% focused on staying on a single task as opposed to getting distracted, while 60% involved

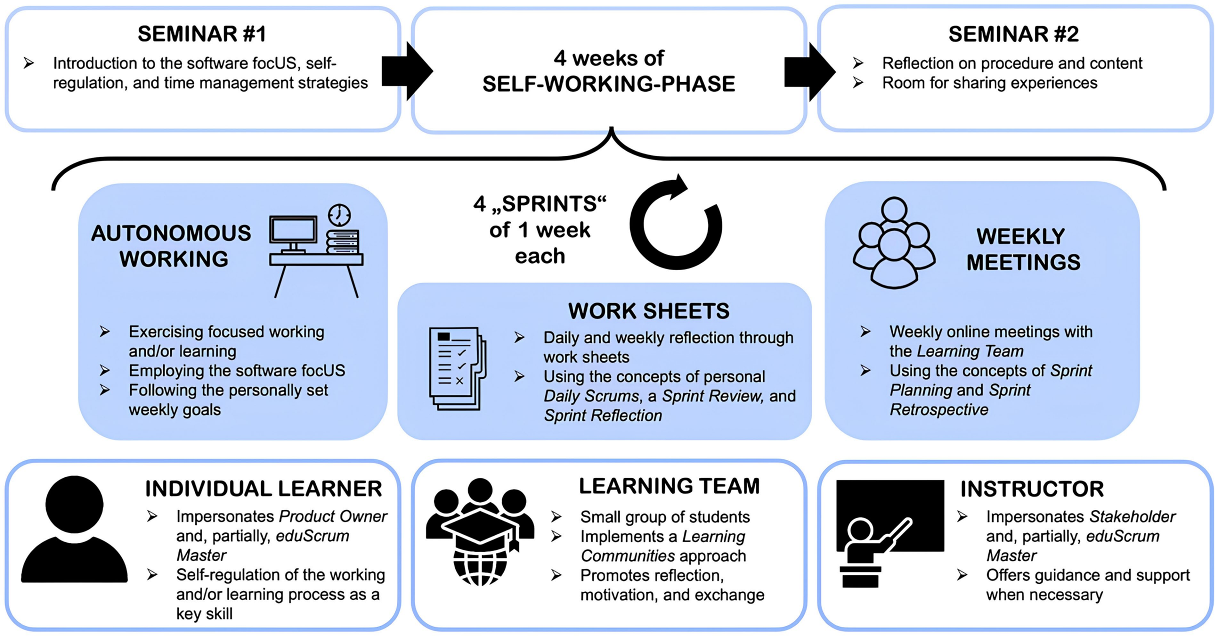

FIGURE 2
Structured seminar concept to support self-regulated learning and working in higher education.

working on a scientific paper. After the intervention, participants rated their goal achievement on a scale ranging from 0 to 100%. On average, the goal achievement rating reported was 60.0% (*SD* = 13.9%).

To measure changes in self-control, participants completed the Brief Self-Control Scale (Tangney et al., 2004), both before and after the intervention. This questionnaire includes 13 items, such as "I wish I had more self-discipline" or "I am able to work effectively toward long-term goals," to be rated on a 7-point Likert scale ranging from "not at all" (1) to "very much" (7). Although the post-test results show a slight increase in the level of self-control, the difference is small (see Figure 3).

The LIST-K questionnaire (Klingsieck, 2018) was utilized to evaluate the intervention's impact on learning and resource management strategies. This questionnaire includes 39 items, divided into four categories: 12 items on cognitive strategies (e.g., "I relate what I learn to my own experiences"), 9 on metacognitive strategies (e.g., "I do not plan my approach to learning"), 9 on internal resource-oriented strategies (e.g., "When I study, I am easily distracted"), and 9 on external resource-oriented strategies (e.g., "I work on texts or assignments with my peers") to be rated on a 5-point Likert scale ranging from "very rarely" (1) to "very often" (5).

Figure 4 presents the pre- and post-intervention results, thereby indicating that cognitive and external resource management strategies showed similar outcomes between pre- and post-tests. However, a marked increase was noted in metacognitive strategies, and a slight increase was observable in internal resource management strategies.

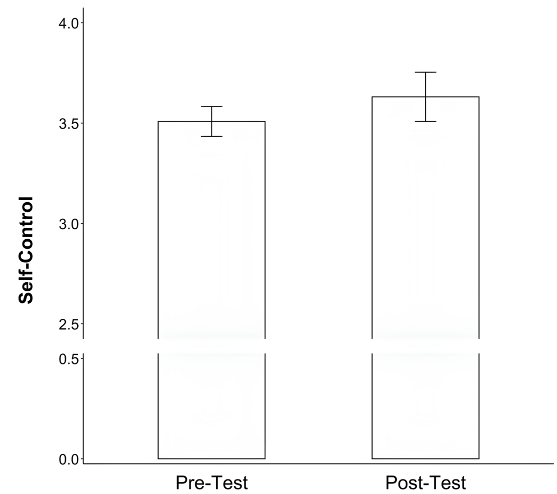

FIGURE 3
Pre- and post-intervention results of self-control. Error bars indicate standard errors.

4.2 Software usability

In order to quantitatively assess the usability of the software, we administered the System Usability Scale (SUS; Brooke, 1996). This questionnaire consists of 10 items, such as "I thought the system was easy to use.," rated on a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). The SUS provides a percentile score ranging from 0 to 100. Lewis and Sauro (2018) suggested benchmarks of 68 (average) and 80 (above average) for overall SUS scores. The focUS software received a mean rating of 63.5% (*SD* = 18%), suggesting usability was slightly below average.

Furthermore, the test subjects were asked to rate the software concerning various criteria, for example, motivating effects of included features, practical value for work or learning tasks, or comprehensibility. Figure 5 shows the criteria to be evaluated following the prompt "Please rate to what degree…" and the average

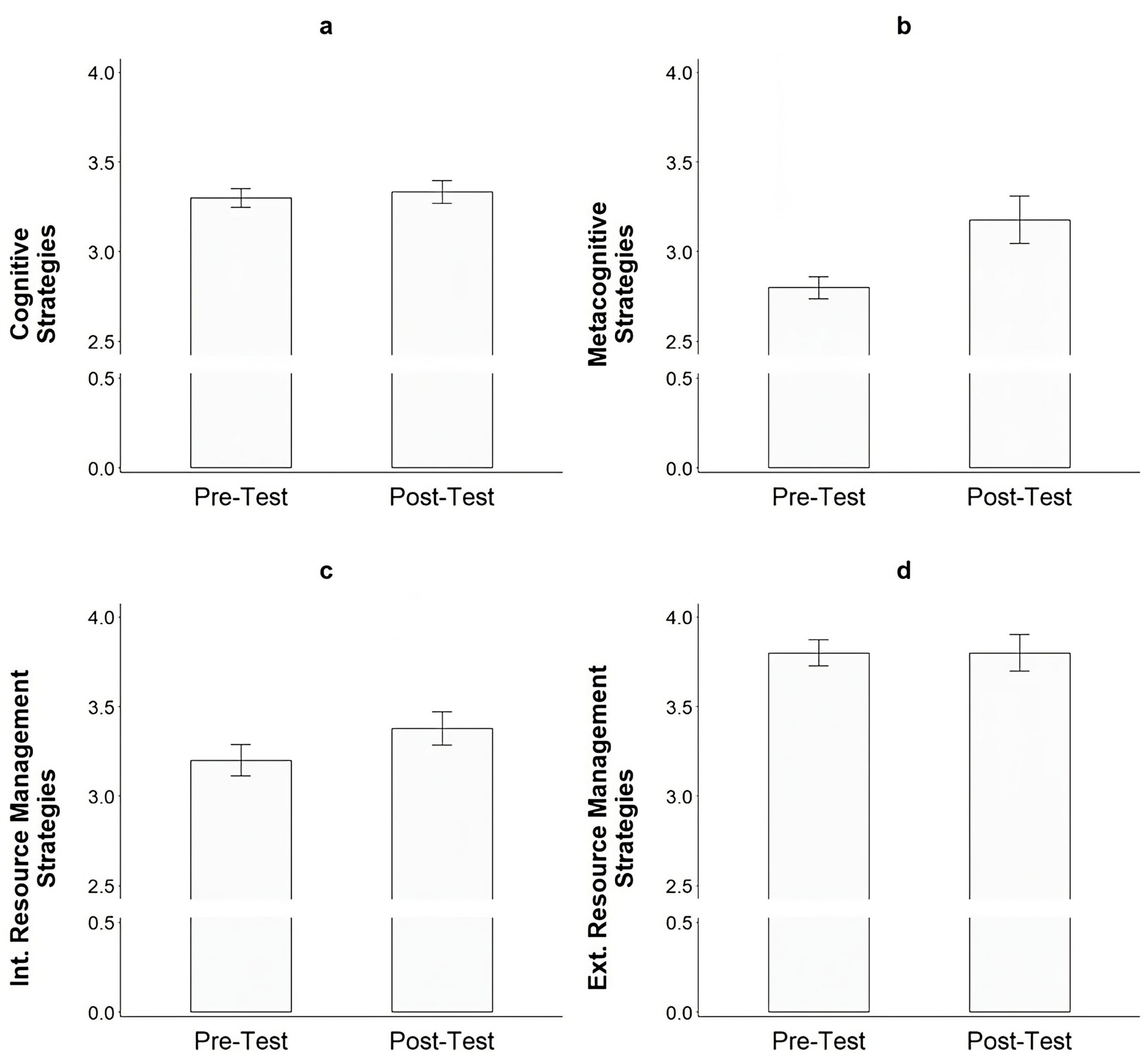

FIGURE 4
Pre- and post-intervention results of **(a)** cognitive and **(b)** metacognitive learning strategies, and **(c)** internal and **(d)** external resource management strategies. Error bars indicate standard errors.

rating, which had to be provided on a 7-point Likert scale ranging from "not at all" (1) to "very much" (7). Scale values were transformed to a range of 0 to 6 for visualization purposes.

Finally, subjects were asked to suggest improvements to the software. Responses included a self-assessment of performance after each session and a planning function that helps users to record their tasks, problems, projects, and divide them into actionable work items with known time limits.

5 Embedding skill-building for self-regulation in higher education: practical implications and lessons learned

The present results showed mixed evidence. Average goal achievement ratings of 60% indicate that the seminar concept contributed to students achieving their goals; however, there is potential for enhancement. The high standard deviation in goal achievements implicates high inter-individual differences: For some students, the seminar concept has proven more helpful than for others, indicating that there has been value in the approach for several students. Implementing more sophisticated software features, such as a planning function that participants suggested, might also engage those students who did not profit as much. Possibly, low usability ratings have contributed to the reported lack of goal achievement in some cases as well. It is also unclear what workload the students had to manage during the seminar period. The achievement of goals may have been confounded by this variable.

Although self-control increased in the post-test, the descriptively observed improvement was only small. One possible explanation is the time-stable nature of the construct of self-control. Hirschi and Gottfredson (1995) proposed that self-control is developed in childhood and remains stable throughout life. Arneklev et al. (1998)

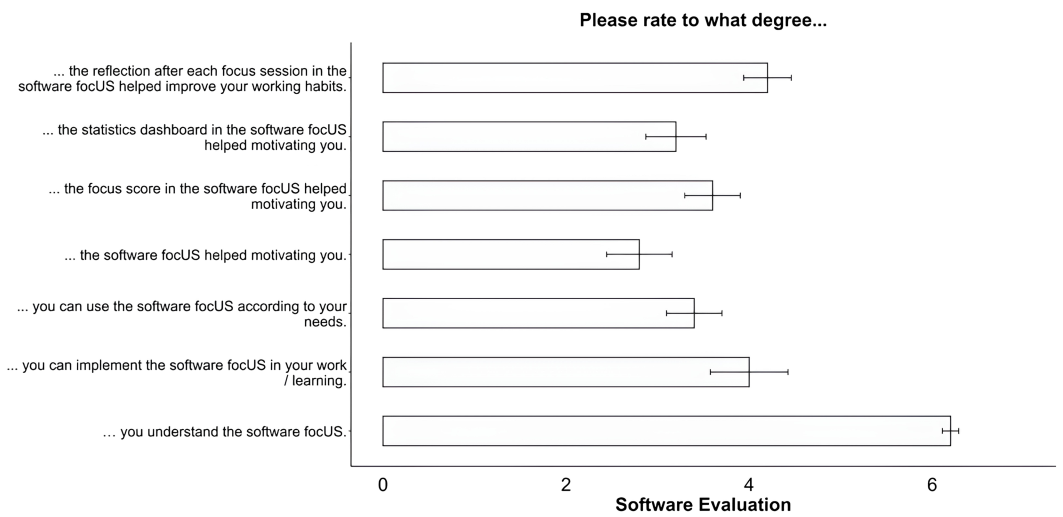

FIGURE 5
Software evaluation ratings. Error bars indicate standard errors.

investigated self-control in 175 college students during one semester and found evidence for the hypothesis postulated by Hirschi and Gottfredson (1995). However, a longitudinal study by Turner and Piquero (2002) on individuals aged 5 to 21 observed changes in self-control over time. These findings suggest that changes in self-control may require more time than the seminar allowed. Thus, a final evaluation of the seminar's and software's effects would likely necessitate a longer period of applying the techniques and using the software.

Regarding learning strategies, the results showed no change in cognitive strategies in the pre-post comparison. This outcome aligns with expectations, as neither the seminar nor the software specifically targets the three components of cognitive strategies: immediate acquisition, processing, and storage of information. However, there was a visible increase in metacognitive strategies, indicating that the concept positively influences the control mechanisms used during learning. The use of metacognitive strategies, such as self-monitoring, plays a crucial role in effective learning. For instance, Dunlosky et al. (2005) demonstrated that self-monitoring enhances learning performance across individuals with different abilities and various types of material. Therefore, applying the seminar concept could significantly improve the learning performance of students in higher education, helping them to fully realize their potential. There was also a slight increase in the internal resource management strategies, indicating that the seminar concept has a positive effect on managing one's effort, time, and focus. In contrast, there was no change in external resource management strategies in the pre-post comparison. Since aspects like learning environment or consulting additional literature are not addressed by this training concept, this outcome was anticipated.

Overall, the seminar concept seems to have a positive effect on the use of metacognitive learning strategies and internal resource management strategies. This suggests that integrating the concept into course curricula could benefit a larger number of students across different degree levels, helping them improve their time and self-management skills, which would aid in managing their diverse responsibilities. Insights from the seminars held showed that the indicated structure could be successfully implemented. Participants' reflections on their initial seminar goals confirm that the chosen topic and focus points have relevance to the working and learning environment. All participants indicated the goal to improve their skills in working and learning focused, as well as inhibiting distractions and efficiently working on different projects side by side. They also showed interest in structuring tasks and making plans, focused on working independently of location, improving their efficiency, and motivation. While filling out reflection forms each week was perceived as challenging by some participants, they highly benefited from verbally discussing their experience during the weekly meetings. These were used to identify working strategies, share constructive feedback on overcoming challenges, and enhance individually applied strategies.

Nevertheless, the results of the evaluation also reveal opportunities for improvement, particularly regarding the usability and functionality of the focUS software. Usability was rated as below average, which suggests that the interface and interaction should be rethought and revised, for example, using the human-centered design process as described in International Organization for Standardization (2020). Verbal feedback provided during the seminar further emphasized the wish for design changes and entertaining features to improve the usability and motivational scope of the software. Additionally, incorporating feedback from participants, such as introducing a planning function, could enhance the software's effectiveness. Such an improved version could be evaluated in future studies, and it would be valuable to investigate whether the observed effects on metacognitive strategies were due to the seminar, the software, or a combination of both. Finally, future research should involve a larger sample size to enable inferential statistical analysis.

6 Room for improvement: limitations and future directions

Even though the benefits of our training approach became evident, it comes with an inherent conceptual limitation: Facing one's procrastination tendencies might be uncomfortable for some participants. In consequence, they might refrain from engaging in such training at all. However, unleashing the full potential of our approach requires commitment to self-awareness and related critical self-reflection, which are competencies that only develop over time (Goupil and Kouider, 2019; Koh and Wang, 2012). In addition, as using assistive software for skill improvement formed a core part of our training, participants were required to use it to gain the full benefits of the developed approach. To overcome hesitation and promote technology acceptance, existing evidence shows the requirement to highlight performance gains (Wirzberger et al., 2025). Yet, it might not always be obvious for tasks with a more long-term perspective, such as the ones participants worked on during our pilot evaluation. Therefore, the scope of intervention might benefit from embedded modules dedicated to building and honing both self-reflection and technology acceptance as important individual prerequisites. Future implementations should also integrate user-centered design principles to further improve usability and acceptance. In this regard, gamified elements (e.g., progress bars, leaderboards, or avatars providing motivational feedback) could offer additional incentives to engage with the software tool and sustain long-term commitment towards staying focused.

Moreover, we need to consider that the eduScrum approach itself has been designed primarily for mandatory classroom settings hence, it might not be fully adaptable to the voluntary context of a university seminar for doctoral students. While the general process structure of sprints and related events (i.e., planning, daily stand-ups, review, and retrospective) is generally applicable, the roles need refinement to incorporate the extended scope of self-responsibility of the target group. Additionally, the period of the sprints during the self-working phase has been relatively short due to the overall seminar duration and requirements. Future iterations might benefit from more and/or extended sprints, providing sufficient time to test different strategies, compare their impacts on future improvements, and implement and evaluate strategy refinements. Additional benefits might arise by incorporating more eduScrum elements in the training framework, for instance, the narrative element of stories in learning or the importance of "why" (Wijnands and Stolze, 2019). To increase the impact of eduScrum in voluntary and self-regulated learning contexts, future work should include a more systematic and structural adaptation of the framework. This includes a clearer definition of roles, flexible sprint structures, and integration of reflective practices that align with the needs and autonomy of students in Higher Education.

Finally, a core concern relates to the small sample size during the pilot evaluation, which resulted from difficulties in recruitment. The target group of doctoral students is typically already busy with various obligations such as working on scientific projects, teaching, and publishing, making it difficult to find time for additional activities. Furthermore, the evaluation took place in an academic environment where doctoral students are required to take non-subject-related courses, which this offer could not be a part of. Therefore, students could not be awarded credits for participation, further complicating the recruitment process. Additionally, the sample investigated may not entirely represent the target group of doctoral students who struggle with time management and procrastination. Those in the target group might have been unable to find the time to participate in the seminar at all, leading to a self-selection bias (e.g., Heckman, 1979) towards students with an already more organized working style. Consequently, the added benefits of our computer-assisted training were only small, but positive effects might have had a larger potential to unfold with a more diverse sample. To address this limitation, future studies should include additional implementation phases with larger and more representative samples, ideally supported by structural incentives (e.g., by being awarded ECTS) and targeted outreach to students who may be less self-organized. Moreover, future evaluations should include rigorous statistical testing, including significance tests and related effect sizes, to validate the observed trends and obtain robust evidence. In addition, isolating the effects of individual training components (e.g., eduScrum structure, assistive software, reflective learning communities) through controlled comparisons would allow for more precise conclusions regarding their specific contributions and interactions.

7 Conclusion: a promising way towards equipping future professionals for upcoming challenges

In conclusion, the presented evidence illuminates the potential of an eduScrum-based, computer-assisted training to promote essential self-regulation skills within higher education. Integrating the focUS software in a structured training framework, this approach demonstrates promise in helping students adopt effective goal setting, self-regulation, and time management skills – vital competencies in both academic and professional environments. The observed improvements in metacognitive strategies and internal resource management among participants underscore the effectiveness of targeted feedback and reflective self-assessment in fostering self-regulated learning. While the pilot evaluation revealed areas for enhancement, particularly in usability and feature breadth, these findings also provide constructive insights for refining the software's design and extending the intervention's reach across diverse student groups. This study advances our understanding of how computer-assisted self-regulation training, when combined with eduScrum-based elements and supported by metacognitive software, can be effectively integrated into higher education settings to meet the adaptive demands of an evolving professional landscape. The preliminary findings serve as a foundation for ongoing development, providing valuable guidance for educators and instructional designers in their mission to empower students to become independent, self-regulated learners poised for success in their careers.

Data availability statement

The raw data supporting the conclusions of this article as well as the software and seminar materials reported are available via https://osf.io/akhdu/.

Ethics statement

The study and the plan for data collection and analysis were approved by the Committee for Responsibility in Research (Ethics Committee) at the University of Stuttgart (approval number Az. 22-025). The reported research was conducted in accordance with the local legislation and institutional requirements. The participants provided their informed consent to participate in this study.

Author contributions

AS-H: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. LB: Conceptualization, Methodology, Project administration, Writing – original draft, Writing – review & editing. EJ: Conceptualization, Methodology, Visualization, Writing – original draft, Writing – review & editing. MW: Conceptualization, Funding acquisition, Project administration, Resources, Software, Supervision, Visualization, Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This research was supported by the Federal Ministry of Education and Research (BMBF) and by the state of Baden-Württemberg (MWK) as part of the IKILeUS project (grant number 16DHBKI041).

Acknowledgments

The authors thank Adrian Stock and Christian Dittrich for preparing and revising the focUS software, Sarah Hall for her support with seminar planning and delivery, and Jule Kembitzky for her support with manuscript preparation.

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.

Generative AI statement

The authors declare that Gen AI was used in the creation of this manuscript. During the preparation of this work the authors used DeepL and Microsoft Copilot to improve the quality of language in the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

American Psychological Association (2017). Ethical principles of psychologists and code of conduct. Washington, DC: American Psychological Association.

Arneklev, B. J., Cochran, J. K., and Gainey, R. R. (1998). Testing Gottfredson and Hirschi's "low self-control" stability hypothesis: an exploratory study. *Am. J. Crim. Justice* 23, 107–127. doi: 10.1007/BF02887286

Biwer, F., Wiradhany, W., oude Egbrink, M. G. A., and de Bruin, A. B. H. (2023). Understanding effort regulation: comparing 'Pomodoro' breaks and self-regulated breaks. *Br. J. Educ. Psychol.* 93:52. doi: 10.1111/bjep.12593

Brooke, J. (1996). "SUS: A 'quick and dirty' usability scale" in Usability evaluation in industry. eds. P. W. Jordan, B. Thomas, I. L. McClelland and B. Weerdmeester (London: CRC Press), 189–194.

Brouwer, J., De Matos Fernandes, C. A., Steglich, C. E., Jansen, E. P., Hofman, W. A., and Flache, A. (2022). The development of peer networks and academic performance in learning communities in higher education. *Learn. Instr.* 80:101603. doi: 10.1016/j.learninstruc.2022.101603

Callaway, F., Jain, Y. R., van Opheusden, B., das, P., Iwama, G., Gul, S., et al. (2022). Leveraging artificial intelligence to improve people's planning strategies. *Proc. Natl. Acad. Sci.* 119:e2117432119. doi: 10.1073/pnas.2117432119

Cannon, M. D., and Witherspoon, R. (2005). Actionable feedback: unlocking the power of learning and performance improvement. *Acad. Manag. Perspect.* 19, 120–134. doi: 10.5465/ame.2005.16965107

Cirillo, F. (2018). The Pomodoro technique: The acclaimed time-management system that has transformed how we work. New York: Crown Currency.

Covey, S. R. (1989). The seven habits of highly effective people. New York: Simon & Schuster.

Doran, G. T. (1981). There's a SMART Way to write management's goals and objectives. *Manag. Rev.* 70, 35–36.

Dunlosky, J., Hertzog, C., Kennedy, M., and Thiede, K. W. (2005). The self-monitoring approach for effective learning. *Cogn. Technol.* 9, 4–11.

Dweck, C. S. (2006). Mindset: The new psychology of success. New York: Ballantine Books.

Goupil, L., and Kouider, S. (2019). Developing a reflective mind: from core metacognition to explicit self-reflection. *Curr. Dir. Psychol. Sci.* 28, 403–408. doi: 10.1177/0963721419848672

Gross, J. J. (1998). The emerging field of emotion regulation: an integrative review. *Rev. Gen. Psychol.* 2, 271–299. doi: 10.1037/1089-2680.2.3.271

Harks, B., Rakoczy, K., Hattie, J., Besser, M., and Klieme, E. (2014). The effects of feedback on achievement, interest and self-evaluation: the role of feedback's perceived usefulness. *Educ. Psychol.* 34, 269–290. doi: 10.1080/01443410.2013.785384

Hattie, J., and Timperley, H. (2007). The power of feedback. *Rev. Educ. Res.* 77, 81–112. doi: 10.3102/003465430298487

Heckman, J. J. (1979). Sample selection bias as a specification error. *Econometrica* 47:1. doi: 10.2307/1912352

Henderson, M., Ajjawi, R., Boud, D., and Molloy, E. (2019). "Identifying feedback that has impact" in The impact of feedback in higher education: Improving assessment outcomes for learners. eds. M. Henderson, R. Ajjawi, D. Boud and E. Molloy (Cham: Springer Nature), 15–34.

Hirschi, T., and Gottfredson, M. G. (1995). Control theory and life-course perspective. *Stud. Crime Crime Prev.* 4, 131–142.

Hofmann, W., Förster, G., Baumeister, R. F., and Vohs, K. D. (2012). Everyday temptations: An experience sampling study of desire, conflict, and self-control. *J. Pers. Soc. Psy.* 6, 1318–1335. doi: 10.1037/a0026545

International Organization for Standardization (2020). DIN EN ISO 9241-210:2020–03, ergonomics of human-system interaction part 210: Human-centred design for interactive systems (ISO_9241–210:2010). Berlin: DIN Media GmbH.

Johannes, C., and Haase, A. (2022). The impact of feedback mode on learning gain and self-efficacy: a quasi-experimental study. *Act. Learn. High. Educ.* 25, 391–407. doi: 10.1177/14697874221131970

Khizar, A., Anwar, M. N., and Asghar, R. (2023). The power of feedback in improving secondary students' learning motivation and achievement. *Int. J. Learn. Divers. Identities* 30, 102–110.

Klingsieck, K. B. (2018). Kurz und knapp – die Kurzskala des Fragebogens "Lernstrategien im Studium" (LIST) [short and sweet – the short scale of the questionnaire "learning strategies during studies" (LIST)]. *Z. Padagog. Psychol.* 32, 249–259. doi: 10.1024/1010-0652/a000230

Kluger, A. N., and DeNisi, A. (1996). The effects of feedback interventions on performance: a historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychol. Bull.* 119, 254–284. doi: 10.1037/0033-2909.119.2.254

Koh, J. B. K., and Wang, Q. (2012). Self-development. *Wiley Interdiscip. Rev. Cogn. Sci.* 3, 513–524. doi: 10.1002/wcs.1187

Latham, G. P., and Locke, E. A. (1991). Self-regulation through goal setting. *Organ. Behav. Hum. Decis. Process.* 50, 212–247. doi: 10.1016/0749-5978(91)90021-K

Lewis, J. R., and Sauro, J. (2018). Item benchmarks for the system usability scale. *J. Usability Stud.* 13, 158–167.

Martin, J. (1991). Rapid application development. London: MacMillan Publishing Company.

Ng, A. Y., Harada, D., and Russell, S. (1999). Policy invariance under reward transformations: theory and application to reward shaping, in Proceedings of the 16th annual international conference on machine learning, ed. Bratko, I., and Dzeroski, S. (San Francisco, CA: Morgan Kaufmann), 278–287.

Ohno, T. (1982). "The origin of Toyota production system and Kanban system," in Proceedings of the international conference on productivity and quality improvement, (Atlanta, GA: Industrial Engineering and Management Press), 3–8.

Otto, S., Evins, M. A., Boyer-Pennington, M., and Brinthaupt, T. M. (2015). Learning communities in higher education: best practices. *J. Stud. Success Retent.* 2, 1–20.

Pintrich, P. R. (1989). "The dynamic interplay of student motivation and cognition in the college classroom" in Advances in motivation and achievement: Vol. 6. Motivation-enhancing environments. eds. C. Ames and M. L. Maehr (Greenwich, CT: JAI Press), 117–160.

Rakoczy, K., Pinger, P., Hochweber, J., Klieme, E., Schütze, B., and Besser, M. (2019). Formative assessment in mathematics: mediated by feedback's perceived usefulness and students' self-efficacy. *Learn. Instr.* 60, 154–165. doi: 10.1016/j.learninstruc.2018.01.004

Ryan, R. M., and Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am. Psychol.* 55, 68–78. doi: 10.1037/0003-066X.55.1.68

Salza, P., Musmarra, P., and Ferrucci, F. (2019). "Agile methodologies in education: a review" in Agile and lean concepts for teaching and learning. eds. D. Parsons and K. MacCallum (Singapore: Springer Nature), 25–45.

Schunk, D. H., and Greene, J. A. (2017). Handbook of self-regulation of learning and performance. *2nd* Edn. New York, NY: Routledge.

Shenhav, A., Botvinick, M. M., and Cohen, J. D. (2013). The expected value of control: an integrative theory of anterior cingulate cortex function. *Neuron* 79, 217–240. doi: 10.1016/j.neuron.2013.07.007

Sitzmann, T., and Ely, K. (2011). A meta-analysis of self-regulated learning in work-related training and educational attainment: what we know and where we need to go. *Psychol. Bull.* 137, 421–442. doi: 10.1037/a0022777

Tangney, J. P., Baumeister, R. F., and Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *J. Pers.* 72, 271–324. doi: 10.1111/j.0022-3506.2004.00263.x

Tracy, B. (2017). Eat that frog!: 21 great ways to stop procrastinating and get more done in less time. *3rd* Edn. Oakland, CA: Berrett-Koehler Publishers.

Turner, M. G., and Piquero, A. R. (2002). The stability of self-control. *J. Crim. Just.* 30, 457–471. doi: 10.1016/S0047-2352(02)00169-1

Valdez, A. (2012). Computer-based feedback and goal intervention: learning effects. *Educ. Technol. Res. Dev.* 60, 769–784. doi: 10.1007/s11423-012-9252-7

Vygotsky, L. S. (1978). Mind in society: the development of higher psychological processes. Cambridge, MA: Harvard University Press.

Wijnands, W., and Stolze, A. (2019). "Transforming education with eduScrum" in Agile and lean concepts for teaching and learning. eds. D. Parsons and K. MacCallum (Singapore: Springer Nature), 95–114.

Wild, K.-P., and Schiefele, U. (1994). Lernstrategien im Studium: Ergebnisse zur Faktorenstruktur und Reliabilität eines neuen Fragebogens [Learning strategies of university students: Factor structure and reliability of a new questionnaire]. *Z. Differ. Diagn. Psychol.* 15, 185–200.

Wilson, L., Hawkins, M., French, M., Lowe, T., and Hesselgreaves, H. (2023). New development: learning communities—an approach to dismantling barriers to collective improvement. *Public Money Manag.* 43, 374–377. doi: 10.1080/09540962.2022.2116179

Wirzberger, M., Bareiß, L., Herbst, V., Stock, A., and Kembitzky, J. (2025). Performance expectancy benefits acceptance towards digital support for self-regulation. *Act. Psy.* 258:105273. doi: 10.1016/j.actpsy.2025.105273

Wirzberger, M., Lado, A., Prentice, M., Oreshnikov, I., Passy, J. C., Stock, A., et al. (2024). Optimal feedback improves behavioral focus during self-regulated computer-based work. *Sci. Rep.* 14:3124. doi: 10.1038/s41598-024-53388-3

Wirzberger, M., and Rey, G. D. (2018). Attention please! Enhanced attention control abilities compensate for instructional impairments in multimedia learning. *J. Comput. Educ.* 5, 243–257. doi: 10.1007/s40692-018-0106-0

Wisniewski, B., Zierer, K., and Hattie, J. (2020). The power of feedback revisited: a meta-analysis of educational feedback research. *Front. Psychol.* 10:3087. doi: 10.3389/fpsyg.2019.03087

Zamiri, M., and Esmaeili, A. (2024). Methods and technologies for supporting knowledge sharing within learning communities: a systematic literature review. *Adm. Sci.* 14:1. doi: 10.3390/admsci14010017

Zimmerman, B. J. (2000). "Attaining self-regulation: a social cognitive perspective" in Handbook of self-regulation. eds. M. Boekaerts, P. R. Pintrich and M. Zeidner (San Diego, CA: Academic Press), 13–39.