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Support for information processing, information acquisition, and age as factors influencing self-regulated learning in adolescent girls

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Introduction: Students have adopted a more active role in their learning process, which has facilitated the implementation of strategies aimed at enhancing their academic outcomes. The literature shows that these strategies help explain self-regulated learning, although some demonstrate a higher predictive capacity than others. Within this framework, the present study aims to identify the model that most accurately explains self-regulated learning.
Materials and methods: A quantitative, cross-sectional explanatory study with non-probabilistic sampling was conducted. The sample consisted of 249 female adolescents from first to fifth year of secondary education in Lima, Peru. The Self-Regulated Learning Questionnaire and the ACRA Scale were administered.
Results: Model 3 was significant, with an adjusted R^2 of 0.603. The variables information-processing support, information acquisition, and age significantly explained self-regulated learning, although age showed a lower explanatory weight.
Discussion: The results confirm that information-processing support has the greatest influence on self-regulated learning, whereas age is not a determining factor. Additionally, for this study, information acquisition ranked second in influence. These findings guide educational institutions in providing more targeted interventions focused on strategies for information-processing support and information acquisition, achieving better outcomes when applied from the early stages of secondary education for adolescent girls. Nevertheless, the study's limitations should be considered, as it was conducted on a sample of females with specific characteristics from Lima, Peru.

KEYWORDS

self-regulated learning, learning strategies, adolescent girls, information processing, information acquisition, age

Introduction

The Peruvian educational system has evolved in parallel with social and political transformations; throughout this trajectory, access to literacy was historically restricted, and the incorporation of women into schooling advanced only gradually (Bernardo, 2021; Beatriz, 2020). Despite these advances, authoritarian practices persist in classrooms,

centered on rote memorization and with limited adoption of participatory methodologies (Ministerio de Educación del Perú, 2023). Even after a decade of modernization and decentralization—which included the incorporation of ICT and active learning approaches—recent assessments continue to reveal deficits in higher-order skills such as critical and creative thinking. This suggests that innovations have not been sufficiently translated into sustainable changes in teaching practice [Organisation for Economic Co-operation Development (OECD), 2024; Ministerio de Educación del Perú, 2025]. Furthermore, gender differences in academic performance remain: boys tend to outperform in mathematics and science, whereas girls demonstrate stronger performance in reading comprehension (Ministerio de Educación, 2022).

Within this context, it is pertinent to focus on self-regulated learning (SRL) as a proximal pedagogical resource that does not rely exclusively on structural reforms, which are often slow to implement. Defined as the integration of goal setting, monitoring, and strategic adjustment of one's own learning, SRL contributes to the development of cognitive and metacognitive skills and enhances academic engagement (Xu et al., 2023; Guntur and Purnomo, 2024). Evidence also indicates sex-differentiated profiles: girls report relatively higher levels of self-regulation, self-efficacy, and motivation, while boys tend to emphasize specific strategies such as self-assessment and metacognitive regulation (Fernández de Castro et al., 2024; Ramírez et al., 2025). This pattern opens opportunities for gender-sensitive interventions that both leverage existing strengths and address persistent gaps.

Following this rationale, the present study focuses on two sets of learning strategies and one developmental factor. First, *support for processing*—organizing, elaborating, and connecting information—which moves students beyond rote memorization toward deeper processing and is consistently associated with academic achievement (Ruiz-Martín et al., 2024). Second, *information acquisition*—searching, selecting, and encoding relevant content—which structures note-taking, summarization, and the identification of key ideas as a foundation for knowledge construction (Argentieri et al., 2019). Finally, age is included as a developmental factor, since prior research shows evolutionary differences in learning self-regulation and motivation across adolescence (Katsantonis, 2024). These three variables function as educational "levers" susceptible to explicit instruction and deliberate classroom practice.

It is worth noting that during the pandemic, capacity-building initiatives aimed at promoting SRL and the use of learning strategies yielded heterogeneous outcomes. Among the limitations identified in recent years were feelings of isolation, academic overload, and stress associated with digital divides, along with a marked dependence on the teacher as a central figure—a particularly detrimental dynamic in secondary education in areas such as science and mathematics (Blanco and Blanco, 2021; Ortega and Oyanedel, 2021; Bekova et al., 2021; Contreras-Bravo and Tarazona-Bermúdez, 2021). These findings reinforce the need to prioritize processes directly tied to learning: systematically fostering support for processing and information acquisition, while incorporating scaffolding that facilitates the strategic adjustments characteristic of SRL.

In sum, the challenge is not merely one of access or technological provision, but of the quality of the cognitive and metacognitive processes activated in the classroom. Accordingly, this study aims to: (a) identify the most suitable model for explaining self-regulated learning in adolescent girls; (b) analyze the frequency with which they employ learning and self-regulation strategies; and (c) examine the relationship between these variables and age.

Materials and methods

Design

This study corresponds to a basic-level investigation with a quantitative approach, employing a non-experimental, cross-sectional design with an explanatory scope (León and Montero, 2020). Its purpose is to generate scientific evidence regarding self-regulated learning rather than to intervene in the participants' reality, which explains the absence of experimental treatments.

Although cross-sectional designs present the limitation of not being able to establish causal relationships—since measurement occurs at a single point in time (Adrija et al., 2025; Savitz and Wellenius, 2023)—methodological literature acknowledges that their utility extends beyond the estimation of prevalence. In fact, they allow the identification of associations between variables and the assessment of their explanatory power through multivariate analyses, provided that their inferential boundaries are made explicit (Wang and Cheng, 2020; Pérez-Guerrero et al., 2024). Specifically, the cross-sectional design can incorporate procedures such as multiple or hierarchical regression and multicollinearity analysis to evaluate the relative weight of different predictors on a given phenomenon.

In the present study, these procedures were applied to determine which variables—*support for processing*, *information acquisition*, and *age*—most strongly explain self-regulated learning in a group of female students. There is prior evidence supporting this approach: recent investigations have employed explanatory cross-sectional designs to provide evidence on complex psychological and educational processes, without assuming causality but identifying relevant explanatory patterns (Bordbar et al., 2025; Zorlu and Ünver, 2022; De la Fuente-Mella et al., 2022).

In this sense, the choice of an explanatory cross-sectional design is pertinent, as it enables the analysis of the explanatory structure of self-regulated learning based on previously validated theoretical models. It also provides empirical evidence on the variables involved in its development, while remaining within the inferential limits inherent to this design.

Participants

A non-probabilistic purposive sampling strategy was employed, recruiting exclusively female secondary school students from two single-sex educational institutions in Metropolitan Lima that authorized the implementation of fieldwork. The inclusion criteria

TABLE 1 Sociodemographic characteristics of the participants.

Characteristic	$n = 249$	%
Sex		
Female	249	100%
Age		
12–13 age	44	17.67%
14–16 age	177	71.08%
17 age	28	11.25%
Educational Level		
1st year of secondary school	23	11.24%
2nd year of secondary school	49	19.68%
3rd year of secondary school	58	23.29%
4th year of secondary school	57	22.89%
5th year of secondary school	62	25.90%
Type of Institution		
Public	199	79.92%
Private	50	50.08

were: (a) enrollment in secondary education during the 2023 academic year and (b) provision of signed informed consent from the mother, father, or legal guardian, in addition to the student's assent. Cases with incomplete instruments or invalid responses were excluded.

The initial sample consisted of 252 adolescents; three were excluded due to incomplete data, resulting in an analytic sample of 249 participants. Ages ranged from 12 to 17 years ($M = 14.87$; $SD = 1.37$). Table 1 presents the grade distribution: 10.45% (1st year), 18.91% (2nd year), 22.89% (3rd year), 24.38% (4th year), and 23.38% (5th year). The selection of institutions was based on logistical feasibility and administrative authorization, while also seeking heterogeneity in terms of type of educational center and grade level (Waechter et al., 2023).

It is acknowledged that the non-probabilistic nature of the sampling introduces limitations regarding representativeness. Accordingly, the inferences derived from this study are analytical in nature, oriented toward identifying associations and estimating the explanatory power of the variables, rather than producing statistical generalizations to the entire adolescent population of Lima or Peru. Instead, the findings are considered transferable to urban school contexts with similar socioeconomic characteristics (medium income and private management), which aligns with the rationale of explanatory studies in education that prioritize internal validity over population representativeness.

Instruments

Self-regulated learning questionnaire

The Self-Regulated Learning Questionnaire developed by Torre (2006) was employed in this study. This instrument consists of 20 items rated on a five-point polytomous scale, where participants indicate their level of agreement with each statement. Structurally, the questionnaire is organized into four factors: Active Metacognitive Awareness, Control and Verification, Daily Effort in Task Completion, and Active Processing during Classes.

To minimize potential cultural bias and enhance the psychometric quality of the instrument for its application in Peru, a cross-cultural adaptation process was conducted, following the methodological framework proposed by Balluerka et al. (2007). Although this questionnaire has been used in several studies with Peruvian samples (Alegre, 2014; Cosi et al., 2023; Vicuña and Sanjinés, 2018; Gómez and Zevallos, 2025), it was deemed necessary to ensure its cultural relevance and improve measurement precision within the local context. Because the instrument was originally developed in Spanish, linguistic translation was not required. However, several items contained terms that were uncommon in Peruvian Spanish. Consequently, lexical and grammatical adjustments were introduced to improve comprehension without altering the theoretical meaning of the constructs.

These modifications were subjected to expert judgment involving eight professionals (teachers and psychologists residing in Lima), who confirmed that the adaptations maintained conceptual equivalence and did not compromise the content, clarity, or conceptual coherence of the items.

Subsequently, a pilot study was conducted to gather empirical evidence regarding the performance of the adapted version. Construct validity was examined using an independent sample of 257 secondary school students (both male and female) from an educational institution in Metropolitan Lima, yielding satisfactory goodness-of-fit indices (CFI = 0.946; TLI = 0.938; RMSEA = 0.0511, 90% CI [0.0402–0.0617]). Reliability was assessed using Cronbach's alpha, obtaining an overall coefficient of $\alpha = 0.95$. At the dimensional level, the coefficients were as follows: Active Metacognitive Awareness ($\alpha = 0.841$), Control and Verification ($\alpha = 0.799$), Daily Effort in Task Completion ($\alpha = 0.768$), and Active Processing during Classes ($\alpha = 0.681$).

ACRA—learning strategies scale

The Learning Strategies Scale proposed by Román and Gallego (1994) was employed. This instrument consists of 119 items on a polytomous scale ranging from 1 to 4, where participants respond according to the frequency with which they use each strategy. The scale assesses four dimensions: Information Acquisition Strategies, Information Coding Strategies, Information Retrieval Strategies, and Support for Processing Strategies.

Although this instrument had previously been used in research with Peruvian populations (Cabana-Caceres et al., 2021; Gonzales, 2020), in the present study a cross-cultural adaptation was carried out in order to avoid cultural bias and ensure its relevance in the local context, following the methodological phases proposed by Balluerka et al. (2007).

Within these phases, the translation and back-translation stage was formally considered. However, since the original questionnaire was developed in Spanish, a literal linguistic translation was not required. Instead, this phase focused on a lexical and grammatical

review, aimed at identifying expressions that were uncommon in the Spanish used in Peru. The modifications introduced sought to improve the clarity and comprehension of the items, while maintaining the conceptual equivalence of the factors. To ensure this, eight expert judges—teachers and psychologists residing in Metropolitan Lima—evaluated the modifications and confirmed that the changes did not compromise the content, clarity, or conceptual coherence of the items.

Subsequently, a pilot study was conducted with the aim of obtaining empirical evidence regarding the functioning of the adapted version. Construct validity was analyzed using an independent sample of 257 secondary school students (male and female) from an educational institution in Metropolitan Lima. The results showed acceptable fit indices (CFI = 0.917; TLI = 0.891; RMSEA = 0.0513, 90% CI [0.0391–0.0631]). Likewise, reliability was assessed using Cronbach's alpha, yielding an overall coefficient of $\alpha = 0.97$. At the dimensional level, the coefficients were as follows: Information Acquisition Strategies ($\alpha = 0.865$), Information Coding Strategies ($\alpha = 0.939$), Information Retrieval Strategies ($\alpha = 0.910$), and Support for Processing Strategies ($\alpha = 0.944$).

Ethical considerations and procedure

The research was conducted in accordance with bioethical principles, ensuring the wellbeing of participants at every stage and avoiding any potential risks. Furthermore, the instruments used did not contain items that could cause emotional distress, as both were exclusively designed to assess academic development. The study was also reviewed and approved by the Ethics Committee of Universidad Peruana Cayetano Heredia.

Prior to the data collection phase, the instruments used—the "Self-Regulated Learning Questionnaire" and the "ACRA Learning Strategies Scale"—underwent a validation process. This began with an evaluation by expert judges, who lexically and grammatically reviewed and adapted both instruments. Subsequently, internal structure validation and reliability estimation were performed, using an independent sample of secondary school students of both sexes.

As a form of compensation for their participation in this phase, each classroom was offered a workshop on learning strategies and self-regulated learning. This activity was led by the principal investigator, who designed a session based on the needs and priorities expressed by the director of the respective educational institution.

Once the instruments were validated, authorization was requested from the principals of the two participating educational institutions. After receiving their approval, schedules were coordinated for the administration of the questionnaires, as well as the distribution and collection of parental informed consent forms and student assent forms.

The research team consisted of a principal investigator, who holds a master's degree in Psychology and clinical experience, and five secondary researchers: three professionals with master's degrees in Psychology specializing in clinical and educational psychology, and two fifth-year undergraduate Psychology students.

During data collection, approximately 40 min were allocated per classroom. In each session, students were informed about the purpose of the study, the procedures involved, and the voluntary nature of their participation. They then signed their assent forms. The administration was conducted collectively, with two administrators per classroom. The instruments, which were administered by an interviewer, were presented by the administrators, who also answered questions and ensured the responses were properly recorded.

As an additional benefit after participation, students were offered a two-session workshop aimed at developing learning strategies and skills to strengthen self-regulated learning. These workshops were conducted in both educational institutions and were led by the principal investigator, together with two secondary researchers, both fifth-year undergraduate Psychology students.

Finally, the collected data were coded and entered into a database for subsequent statistical analysis.

Data analysis

Analyses were conducted in R (RStudio). For descriptive objectives, frequencies and percentages of sociodemographic variables were reported; regarding the main variables, means and standard deviations were calculated, as well as percentile cut-off points to classify scores as low (<p25), medium (p25–p75), and high (>p75). Normality was assessed using the Kolmogorov–Smirnov test, with deviations observed from the normal distribution; consequently, correlations between variables and dimensions were estimated using Spearman's rho (ρ). A significance level of 0.05 was adopted, and the magnitude of correlations was interpreted following conventional criteria (very high: 0.80–1.00; high: 0.60–0.79; moderate: 0.40–0.59; low: 0.20–0.39; null: 0).

To examine the joint influence of predictor variables on self-regulated learning, hierarchical linear regression was applied across three successive models. This technique allowed evaluation of the incremental contribution of predictor blocks and determination of the relative importance of each variable in explaining the dependent variable. Standardized coefficients (β) were reported to facilitate comparison across predictors, along with adjusted R^2 values and effect sizes. The latter were estimated through the unique contribution to R^2 (Img) with 95% confidence intervals obtained via bootstrap (1,000 replications), as well as the squared semi-partial correlation (sr^2).

Regression assumptions were verified with particular attention to collinearity. Indications of collinearity were considered at tolerance < 0.20 and Variance Inflation Factor (VIF) values greater than 5 (Chennamaneni et al., 2016; Kalnins and Praitis Hill, 2023).

As a complementary and descriptive analysis, a hierarchical correlation tree was constructed from the Spearman's rho (ρ) matrix of Age, Information Acquisition, Support for Processing, and Self-Regulated Learning. Distance was defined as $d = 1 - |\rho|$ and clustering was performed using average linkage (UPGMA). Additionally, a regression decision tree (CART) was implemented (method = "anova"), with cross-validation (xval = 10) and complexity control (initial cp = 0.001; minsplit = 20). The final

TABLE 2 Descriptive statistics and level distribution in the dimensions of self-regulated learning and learning strategies (ACRA).

Variable	Mean	DE	Levels		
			Low < 25	Medium (25 < 75)	High
Self-regulated learning questionnaire					
Active metacognitive awareness	3.420	0.919	71 (28.5%)	117 (47%)	61 (24.5%)
Control and verification	3.610	0.841	59 (23.7%)	111 (44.6%)	79 (31.7%)
Daily effort in task completion	3.360	0.958	75 (30.1%)	119 (47.8%)	55 (22.1%)
Active processing during classes	3.370	0.968	67 (26.9%)	128 (51.4%)	54 (21.7%)
Self-regulated learning (total)	3.460	0.821	64 (25.7%)	125 (50.2%)	60 (24.1%)
Learning strategies scale (ACRA)					
Information acquisition	2.520	0.554	124(49.8%)	123(49.8%)	2(0.8%)
Information coding	2.310	0.549	62(24.9%)	125(50.2%)	62(24.9%)
Information retrieval	2.610	0.618	62(24.9%)	130(52.2%)	57(22.9%)
Information processing support	2.650	0.618	64(25.7%)	127(51.%)	58(23.3%)
Learning strategies (total)	2.480	0.535	62(24.9%)	125(50.2%)	62(24.9%)

tree was pruned by applying the 1-SE rule on the complexity table, in order to reduce the risk of overfitting.

Results

Descriptive statistics

To present the descriptive scores of the variables Self-Regulated Learning and Learning Strategies, Table 2 is provided: *"Descriptive statistics and distribution of levels in the dimensions of Self-Regulated Learning and Learning Strategies (ACRA)."* This table reports measures of central tendency (mean) and standard deviation.

For Self-Regulated Learning, the highest mean was observed in the factor *Control and Verification*, whereas the lowest mean was found in the factor *Daily Effort in Task Performance*. To determine the levels of Self-Regulated Learning among adolescents, three cut-off points were established for each factor using the 25th and 75th percentiles. The results show that most adolescents reach a medium level across the four factors of Self-Regulated Learning. However, when considering low levels, the factor *Daily Effort in Task Performance* comprises a considerable proportion of participants (30.1%). Conversely, at the high level, the factor *Control and Verification* includes the largest percentage of participants (31.7%).

Regarding the variable Learning Strategies, the highest mean was recorded in the dimension *Support to Information Processing*, whereas the lowest mean was observed in the dimension *Information Encoding*. To determine the levels of Learning Strategies among adolescents, three cut-off points were established for each factor, using the 25th and 75th percentiles. The results indicate that most adolescents reach a medium level in three factors of Learning Strategies, specifically in *Information Encoding*, *Information Retrieval*, and *Support to Information Processing*. However, the factor *Information Acquisition* comprises a considerable proportion of participants at the low level (49.8%).

TABLE 3 Normality test of the variables.

Variable	Kolmogorov	*p*-value
Learning strategies		
Information acquisition	0.059	0.037
Information coding	0.033	0.200
Information retrieval	0.052	0.098
Information processing support	0.033	0.200
ACRA (total)	0.035	0.200
Self-regulated learning questionnaire		
Active metacognitive awareness	0.975	0.005
Control and verification	0.962	< 0.001
Daily effort in task completion	0.975	0.003
Active processing during classes	0.964	< 0.001
Self-regulated learning (total)	0.977	< 0.001

Correlational analysis

Table 3, *"Normality test of the variables,"* presents the results of the Kolmogorov–Smirnov test. It can be observed that all dimensions of both variables follow a normal distribution, except for the Information Acquisition dimension of the Information Strategy variable. Consequently, the correlational objectives were analyzed using Spearman's non-parametric statistic.

Accordingly, in Table 4, *"Correlation between dimensions,"* it can be observed that the Information Encoding strategy is positively and strongly correlated with Active Metacognitive Awareness ($\rho = 0.64, p < 0.001$); the Information Retrieval strategy shows a positive and moderate correlation with Control and Verification ($\rho = 0.576$, $p < 0.001$); the Support for Information Processing strategy is positively and strongly correlated with Daily

TABLE 4 Correlation of variables and dimensions.

Dimensions	D1	D2	D3	D4	ACRA
ACRA (learning strategies)					
D1. Information acquisition	—				
D2. Information coding	0.807***	—			
D3. Information retrieval	0.688***	0.757***	—		
D4. Information processing support	0.701***	0.742***	0.758***	—	
Self-regulated learning					
F1. Active metacognitive awareness	0.605***	0.640***	0.586***	0.730***	0.719***
F2. Control and verification	0.626***	0.605***	0.576***	0.721***	0.702***
F3. Active processing during classes	0.512***	0.520***	0.480***	0.590***	0.585***
F4. Daily effort in task completion	0.531***	0.530***	0.462***	0.607***	0.596***

Correlations are significant at the 0.001 level (***).

TABLE 5 Hierarchical regression.

Predictor	β (Model 1)	β (Model 2)	β (Model 3)	lmg [IC 95%] (M3)	sr^2 (M3)
Information acquisition	0.192*	0.188**	0.233*	0.229 [0.170, 0.292]	0.026
Information coding	0.054	0.061	–	–	–
Information retrieval	0.027	0.023	–	–	–
Information processing support	0.553*	0.556**	0.591*	0.371 [0.300, 0.443]	0.168
Educational level	0.122	–	–	–	–
Age	−0.209*	–	−0.094	0.008 [0.001, 0.034]	0.009
F	54.81***	91.52***	126.41***		
Adjusted R^2	0.605	0.593	0.603		
N	249	249	249		

In the final model (M3), no indications of collinearity were observed (minimum tolerance = 0.48; maximum VIF = 2.08; condition index = 2.5). Effect sizes are reported as **lmg** (unique contribution to R^2, 95% CI via 1,000 bootstrap replications) and **sr²** (squared semi-partial correlation).
*p < 0.05; **p < 0.01; ***p < 0.001.

Effort in Task Performance ($\rho = 0.607$, $p < 0.001$); and the Information Acquisition strategy is positively and moderately associated with Active Processing during Classes ($\rho = 0.512$, $p < 0.001$). It is worth noting that the lack of data normality did not affect the correlation coefficients.

Regression analysis

Table 5, *"Hierarchical regressions,"* presents the results of the hierarchical regression analysis, from which three multiple linear regression models were generated with the aim of explaining the variability of Self-Regulated Learning in a sample of female adolescents ($N = 249$).

In Model 1, all dimensions of Learning Strategies (ACRA) were included as predictors, along with the sociodemographic variables age and educational level. The model was statistically significant, $F_{(7,239)} = 54.81$, $p < 0.001$, with an adjusted R^2 of 0.605. Significant predictors were *Support to Information Processing* ($\beta = 0.553$***), *Information Acquisition* ($\beta = 0.192$*), and *Age* ($\beta = -0.209$*), jointly explaining approximately 61% of the variance in Self-Regulated Learning.

In Model 2, only the dimensions of Learning Strategies were included as predictors. This model explained 60% of the variance in Self-Regulated Learning [$F_{(4,244)} = 91.52$, $p < 0.001$, adjusted $R^2 = 0.593$]. Significant predictors were *Support to Information Processing* ($\beta = 0.556$**) and *Information Acquisition* ($\beta = 0.188$**).

In Model 3, only the variables that had shown significance in the two previous models were included. This model was also significant [$F_{(3,245)} = 126.41$, $p < 0.001$, adjusted $R^2 = 0.603$], explaining 60% of the variance in Self-Regulated Learning. The strongest predictors were *Support to Information Processing* ($\beta = 0.591$***), *Information Acquisition* ($\beta = 0.233$***), and *Age* ($\beta = -0.094$), the latter with a limited effect. Figure 1, *"Model 3β–Equation of the predictor variables,"* graphically represents this model.

Among the three models, Model 3 was selected due to its parsimony and explanatory capacity, as it retains only significant variables, maintains a robust level of prediction, and offers greater clarity in the interpretation of predictors.

Collinearity diagnostics indicated no relevant issues (tolerances ≥ 0.48; VIF ≤ 2.08; condition index = 2.5). Regarding effect sizes,

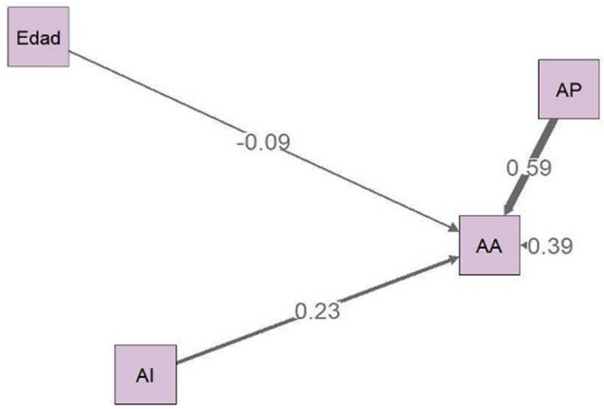

FIGURE 1
Model 3B: equation of the predictor variables information processing support, information acquisition, and age on self-regulated learning.

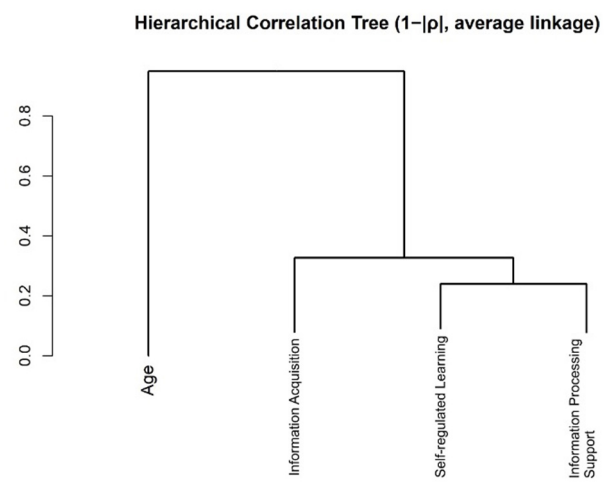

FIGURE 2
Hierarchical correlation tree among the study variables (distance 1 − |ρ|; average linkage/UPGMA). Closer branches indicate stronger absolute associations.

the lmg analysis with 95% CI showed that *Support to Information Processing* contributed the largest proportion to the total R^2 (0.371 [0.300, 0.443]), followed by *Information Acquisition* (0.229 [0.170, 0.292]) and *Age* (0.008 [0.001, 0.034]). The squared semi-partial correlation values (sr^2) were consistent with this pattern (0.168, 0.026, and 0.009, respectively), confirming that *Support to Information Processing* is the most relevant predictor.

Complementarily, the hierarchical dendrogram showed proximity between *Support to Information Processing* and *Self-Regulated Learning*, followed by *Information Acquisition*, whereas *Age* appeared as an independent branch. This pattern aligned with the effect sizes obtained in the final model (Figure 2). Likewise, the CART decision tree showed *Support to Information Processing* (2.6) as the first partition point, followed by additional splits in *Information Acquisition* (2.4–2.5) and in *Support to Information Processing* (3.1–3.6), reflecting a progressive gradient in the criterion variable (Figure 3).

Discussion

The main objective of this study was to identify the model that best explains self-regulated learning (SRL) in adolescent females. The results indicate that Model 3 is the most appropriate, as SRL is significantly influenced by information-processing support, information acquisition, and, to a lesser extent, by age, accounting for 60% of the variance. This finding is consistent with Barak (2010), who, based on his model of Self-Regulated Learning in Technological Education, emphasizes the interplay between metacognitive and motivational components as key determinants of SRL. Similarly, Araya-Piñones et al. (2023) highlight the role of strategies that support information processing as facilitators of learning in classroom contexts, fostering a positive environment for knowledge construction.

Furthermore, the results align with the interactive layer model proposed by Wirth et al. (2020), which conceptualizes SRL as the outcome of interactions among three layers: content, learning strategies, and metacognition. Within this framework, information-processing support corresponds to the strategic and metacognitive levels, as it entails the active use of cognitive resources to organize, transform, and consolidate information. In contrast, information acquisition relates to the content layer, referring to the initial engagement with learning materials and their subsequent processing and storage in long-term memory.

In contrast to studies such as Maldonado-Sánchez et al. (2019) and Medina and Nagamine (2019), where information encoding emerged as the main predictor of SRL, this variable did not reach statistical significance in any of the three models evaluated. This discrepancy may be attributed to differences in sample characteristics, as previous studies included both male and female participants, whereas the present study focused exclusively on female adolescents. The cognitive developmental stage of participants is also likely a relevant factor, given that this research primarily involved students in the early years of secondary education. Since encoding—understood as the process of structuring information and linking it to prior knowledge—tends to consolidate at later academic stages, it is reasonable that among students from first to third grade of secondary school, strategies more consistent with their developmental level prevail, such as metacognition, motivation to learn, and information recording.

Moreover, while Daura et al. (2022) argue that study hours predict self-regulation by associating greater time investment with higher commitment, the present findings suggest that study time constitutes a necessary but not sufficient resource. What truly determines performance is not the amount of time spent but the efficiency with which students apply their learning strategies.

With regard to age, although this variable is rarely incorporated into previous models, it showed a small yet consistent predictive effect in this study. This finding is in line with Williams et al. (2020), who advocate for the development of self-regulatory skills from early educational stages to strengthen cognitive competencies essential for higher education. Likewise, Panadero (2017) notes that younger students tend to show a greater inclination toward SRL

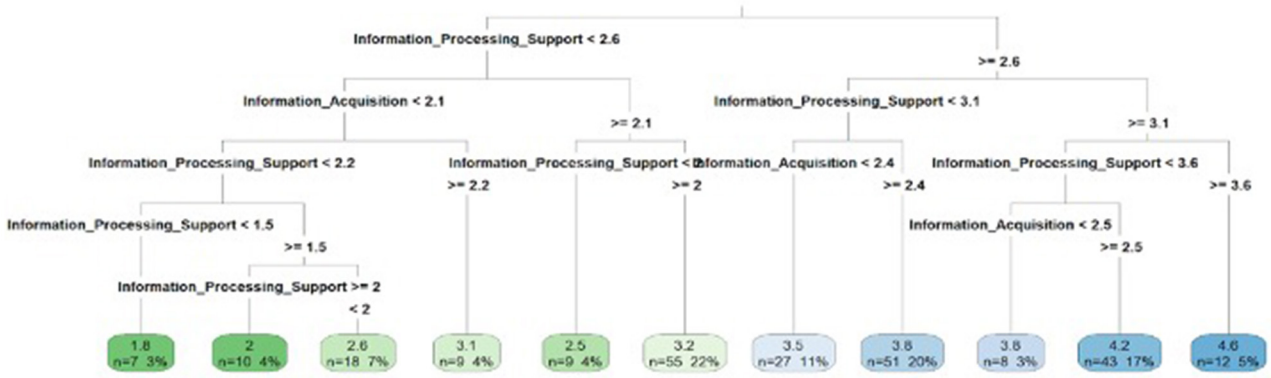

FIGURE 3
Decision tree (CART) for self-regulated learning.

when employing strategies that integrate emotional, attentional, and motivational dimensions.

Overall, these findings emphasize the importance of fostering self-regulatory skills across all educational contexts—both urban and rural—given their critical role in academic success and the reduction of structural inequalities. It is not sufficient to rely solely on basic learning strategies; it is essential to develop planning, monitoring, and self-evaluation competencies that enable effective management of one's own learning process (Seban and Urban, 2024; Elhusseini et al., 2022).

Regarding the first specific objective—to analyze the frequency with which self-regulated learning strategies and learning strategies are employed—the results indicate that adolescent female participants more frequently utilize self-regulated learning strategies focused on control and monitoring, which include planning, organization, and supervision of academic tasks. This finding demonstrates that participants tend to actively manage their own learning processes, reflecting favorable self-regulation. This outcome aligns with Kinnari-Korpela and Suhonen (2020), who argue that self-regulated control and monitoring strategies promote active engagement and the achievement of meaningful learning. Complementarily, Puerta-Vásquez and Suárez-Molina (2022) highlight that students with higher levels of learning control and adjustment exhibit more advanced academic self-regulation, reinforcing the consistency of the results obtained in this study.

However, the results contrast with those reported by Medina and Nagamine (2019), who found low levels of learning control and monitoring among students from rural areas. This discrepancy may be explained by the geographical and educational context of the samples. In this study, composed of adolescent females residing in urban areas, socioeconomic conditions and the availability of educational resources may have favored the development of more sophisticated self-regulated strategies. According to Mendoza-Ponce (2024), rural students face greater limitations in access to materials and pedagogical support, which may restrict the practice of self-regulation strategies. Nevertheless, as noted by Rojas-Apaza et al. (2024), context does not fully determine self-regulation, since personal habits and individual management of learning also play a relevant role in the use of control and management strategies.

Moreover, a limited use of sustained effort strategies—also considered part of self-regulated learning strategies—was identified. These strategies are related to the ability to maintain persistence and motivation when facing academic demands. These findings are consistent with Formento-Torres et al. (2023), who indicate that academic stress can affect continuity and motivation in adolescents, reducing their capacity to sustain effort and dedication to long-term learning. Similarly, Paladines-Jaramillo et al. (2020) point out that a lack of resources for emotional regulation during adolescence may limit frustration tolerance and, consequently, decrease learning motivation. While these emotional factors were not evaluated in the present study, they could be considered in future research examining how emotional variables influence the frequency and consistency of self-regulated strategy use.

The results also show that adolescent participants more frequently employ strategies that support information processing, reflecting an orientation toward the use of cognitive, metacognitive, and socio-affective resources that facilitate active comprehension of academic content. This finding aligns with Kwarikunda et al. (2022), who argue that females tend to more frequently use elaboration and organization strategies associated with deep learning. Complementarily, Ortega-Torres et al. (2020) demonstrate that support for processing enhances planning and continuous monitoring of learning, promoting self-reflection and academic self-management. In this regard, Nikčević-Milković (2019) explains that female proactivity in learning management may be associated with early development of metacognitive competencies, enhancing the ability to anticipate errors, adjust strategies, and evaluate performance.

Nonetheless, the use of learning strategies is not uniform among students. As Ismael (2022) notes, their application is modulated by contextual factors, such as educational opportunities and self-perception, which influence how adolescents face academic demands. In this sense, Hall and Eckert (2024) and Lieder et al. (2023) highlight the role of family and community environments in consolidating more elaborated processing strategies, as parental expectations regarding effort, autonomy, and responsibility directly impact learning engagement.

In contrast, a limited use of information encoding strategies was observed. These strategies are understood as those that allow knowledge to be organized, integrated, and given meaning for long-term consolidation. This finding suggests that, although participants are able to plan and organize their study, they still face challenges in deepening content understanding, which limits transfer and generalization of learning. As Camizán et al. (2021) warn, these strategies are essential for promoting meaningful learning, while Suárez and Suárez (2019) and Araya-Piñones et al. (2023) indicate that their use tends to increase with cognitive maturity and educational progression. Consequently, the lower employment of encoding strategies observed in this age group may reflect a developmental stage in which more instrumental and basic organizational strategies predominate.

Overall, these findings indicate that, while female students demonstrate adequate capacity to organize, plan, and regulate their learning processes, they still face limitations in deep information processing, which restricts the potential to generate meaningful, critical, and reflective learning outcomes.

Regarding the second specific objective, the relationship between the dimensions of learning strategies and the dimensions of self-regulated learning was examined. A significant relationship was identified between the Information Encoding dimension and Active Metacognitive Awareness, as noted by Knowlton and Castel (2022). Information encoding is grounded in the metacognitive strategy possessed by the student, which demonstrates that both cognitive processes are interrelated: the higher the level of encoding, the more resources the student has to reflect on their own thinking and learning process. Complementarily, Muljana et al. (2023) assert that metacognitive awareness—understood as knowledge about cognition and its regulation—is positively and significantly correlated with deep, organized, and reflective thinking skills, components that describe the ability for information encoding. This finding suggests that, in the studied sample, a higher level of metacognitive awareness is associated with a more effective use of encoding as a cognitive resource.

Specifically, the Information Processing Support dimension showed a positive and significant correlation with Daily Effort in Task Completion, highlighting its relevance in learning management. According to Barca-Lozano et al. (2012), information processing support strategies facilitate the assessment of one's own learning and promote the student's active disposition to complete academic tasks, reflected in greater effort, better time management, and more effective learning control. Complementarily, Tuononen et al. (2023) indicate that these strategies allow for organizing, reviewing, and structuring information; these skills, combined with the sustained effort of the student to maintain adequate performance in academic activities, foster goal setting, study planning, and an active role in learning. Therefore, Information Processing Support emerges as an essential resource that enhances Daily Effort in Task Completion, strengthening student self-regulation.

Overall, these results highlight the positive and significant relationship between the dimensions of learning strategies and those of self-regulated learning, reinforcing the relevance of information encoding, metacognitive awareness, as well as Information Processing Support and Daily Effort in Task Completion.

Although the contributions of this study aim to demonstrate that the variables of information-processing support, information acquisition, and age are those that best explain self-regulated learning in adolescent women, it is necessary to acknowledge the methodological limitations that condition the interpretation and generalization of the findings. Recognizing these limitations allows for contextualizing the scope of the results and guiding future research in the educational field.

First, the sample consisted exclusively of adolescent women, which restricts external validity of the population type, as the results cannot be generalized to mixed or male samples. This lack of heterogeneity limits the possibility of analyzing differential effects according to gender and reduces the model's ability to estimate variations in self-regulation patterns. Several authors (Seamans et al., 2021; Lamp and Mackinnon, 2024; Stangl and Brand, 2025; Duffy et al., 2020) have noted that homogeneous samples compromise the estimation of moderating effects and weaken the validity of explanatory models. Likewise, sample homogeneity can decrease data variance, which in turn affects the stability of regression coefficients and the statistical power of the analysis (Taylor et al., 2024; Sheieh, 2021).

Nevertheless, the decision to work with a single sample is supported by the scarcity of studies focused on women, particularly in Latin America, where research predominantly centers on men. From a methodological perspective, this delimitation responds to an empirical gap that allows for a deeper analysis of gender-specific characteristics in self-regulated learning (Gayanes et al., 2024; Krebsbach, 2022; Nguyen et al., 2022; Rondon et al., 2025; Bowles and Renate, 2024).

Furthermore, educational disparities among women reveal knowledge gaps regarding their learning and self-regulation strategies. Adolescent girls tend to employ more learning strategies but exhibit higher levels of academic anxiety (Benítez-Agudelo et al., 2025; Wu et al., 2022) and often rely on strategies that support information processing, control, and memorization (Almoslamani, 2022; Cann et al., 2022; Cen et al., 2025). In contrast, male students tend to use more motivational and affective strategies (Guerrero, 2025).

Consequently, although this delimitation restricts external validity, it represents a methodologically justified decision aimed at making a historically underrepresented group more visible and strengthening the understanding of educational models with a gender-sensitive approach.

Another limitation to be noted concerns the cross-sectional design employed in this study. The objective was to examine the influence of learning strategies on self-regulated learning and to generate an explanatory model. However, this design presents an inherent methodological constraint: as all variables are measured at a single point in time, temporal sequencing cannot be established, making it difficult to determine which variable precedes the other (Hajra et al., 2025; Ziauddin et al., 2023). Consequently, causal relationships between learning strategies and self-regulated learning cannot be inferred, since simultaneous measurement precludes determining the directionality of associations (Kim, 2024), such determination would only be possible in longitudinal or experimental designs (Cataldo et al., 2019).

Nonetheless, a cross-sectional explanatory design was adopted, whose aim was not to establish cause-and-effect relations but to

explore the influence or predictive capacity of learning strategies on self-regulated learning. In this regard, Pérez-Guerrero et al. (2024) highlights the relevance of analytical cross-sectional studies for identifying influence or prediction, provided that statistical rigor is ensured. In the present study, normality was examined, followed by multicollinearity tests (correlation and VIF), and subsequently, hierarchical regression analyses were conducted with confidence estimates obtained through bootstrapping. As noted by Wang and Cheng (2020) and Bartram (2021), this procedure is particularly appropriate for this type of design, as it allows estimation of the influence of multiple factors on a given phenomenon.

Although causality cannot be established, the results indicate that learning strategies—particularly support to information processing and information acquisition—as well as age, significantly predict and explain self-regulated learning. Accordingly, explanatory cross-sectional designs are suitable for constructing theoretical models based on relationships observed at a single point in time (Maier et al., 2023), as demonstrated in previous research (Boluarte-Carbajal et al., 2021; De la Fuente-Mella et al., 2022; Yi-Ying et al., 2024).

Finally, the use of a non-probabilistic sampling procedure constitutes another relevant limitation of the present study. This type of sampling is often questioned due to its lower control over extraneous variables, which may increase bias in the findings, particularly because of the researcher's reliance on specific criteria for sample selection. Consequently, the results may not accurately represent the target population (Turban et al., 2023; Bhadra and Nandram, 2024). As random selection was not applied, the researcher's choices may favor certain characteristics within the study group, thereby reducing data representativeness (Boonstra et al., 2021). This lack of randomization seriously limits the possibility of obtaining results with broad causal or predictive generalizability (Nobuo, 2024; Sen and Lahiri, 2024).

Nevertheless, within the context of this study, non-probabilistic sampling proved methodologically appropriate. Based on the explanatory cross-sectional design, the aim was to delve into a specific phenomenon within a clearly defined group: adolescent females. Several authors support the suitability of this type of sampling in explanatory research, as it allows focusing the analysis on populations of particular interest to the researcher, which is crucial when constructing theoretical models in specific contexts (Turban et al., 2023). Moreover, it facilitates the collection of large samples, enhancing the robustness of statistical analyses despite its non-random nature (Brick et al., 2022; Kalton, 2023).

Nonetheless, the findings of this study should be interpreted with caution, as they pertain exclusively to the specific characteristics of the sample analyzed, limiting their generalizability to other contexts or populations.

Conclusions

In this sample of adolescent girls, the model that best explains self-regulated learning (SRL) was Model 3, in which Support to Information Processing and Information Acquisition emerged as the main predictors, with Age contributing to a lesser extent (adjusted $R^2 = 0.603$). Descriptively, SRL was predominantly at a medium level; Control and Verification showed the highest scores (31.7% at the high level), whereas Daily Effort was the lowest (30.1% at the low level). Regarding learning strategies, Support to Information Processing had the highest mean, while Information Acquisition concentrated the largest proportion at the low level (49.8%).

Correlational and complementary analyses converge in showing that deep information processing and the strategic use of information are substantively related. In particular, the Information Encoding strategy is positively and strongly correlated with Active Metacognitive Awareness ($\rho = 0.64$, $p < 0.001$), whereas the Support for Information Processing strategy is positively and strongly correlated with Daily Effort in Task Performance ($\rho = 0.607$, $p < 0.001$).

Regarding limitations, the results reflect the analyzed sample and are not intended to be generalized, given that the study included only adolescent girls and used non-probability sampling. Moreover, the objective was to identify the learning strategies that best explain SRL without establishing causal relationships among variables, since an explanatory cross-sectional design was used.

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 Comité Institucional de Ética en Investigación (CIEI) – Humanos, Universidad Peruana Cayetano Heredia. 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

BA-S: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Validation, Writing – original draft, Writing – review & editing. RO-A: Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. RC-C: Conceptualization, Resources, Writing – original draft. MZ-O: Conceptualization, Investigation, Resources, Writing – original draft. JT-V: Conceptualization, Resources, Writing – original draft. JD-V: Conceptualization, Investigation, Methodology, 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 financial, commercial, or other relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that Gen AI was used in the creation of this manuscript. The authors used ChatGPT to translate certain fragments of the text originally written in Spanish into English, as well as to improve its grammar and clarity. The authors subsequently reviewed and adjusted the content as they deemed necessary, assuming full responsibility for the final content of the published article.

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References

Adrija, H., Binita, G., and Suryasnata, B. (2025). "Cross-Sectional Studies," in *Translational Cardiology*, eds. A. E. M. Eltorai, J. A. Bakal, and C. M. Gibson (Cambridge, MA: Academic Press), 221–225.

Alegre, A. (2014). Academic self-efficacy, self-regulated learning and academic performance in first-year university students. *Propósitos y Representaciones* 2, 79–120. doi: 10.20511/pyr2014.v2n1.54

Almoslamani, Y. (2022). The impact of learning strategies on the academic achievement of university students in Saudi Arabia. *Learn Teach High Educ Gulf Perspect.* 18, 4–18. doi: 10.1108/LTHE-08-2020-0025

Araya-Piñones, A., Campos-Castillo, C., Salas-Bravo, S., and Bakit, J. (2023). Estrategias de aprendizaje y rendimiento académico: un estudio exploratorio en estudiantes chilenos de enseñanza media. *Encuentros* 22, 164–182. doi: 10.15665/encuen.v22i01.2704

Argentieri, Á., Culacciati, C., Basterrechea, L., Squassi, A., Salgado, P., and Bordoni, N. (2019). Student learning strategies according to years spent studying for a degree in dentistry. Relación entre estrategias de aprendizaje y permanencia en el ciclo curricular en estudiantes de Odontología. *Acta odontológica latinoamericana* 32, 111–117. doi: 10.55786/aol.v32i2.38

Balluerka, N., Gorostiaga, A., Alonso-Arbiol, I., and Haranburu, M. (2007). La adaptación de instrumentos de medida de unas culturas a otras: una perspectiva práctica. *Psicothema* 19, 124–133. Available online at: https://www.redalyc.org/pdf/727/72719119.pdf

Barak, M. (2010). Motivating self-regulated learning in technology education. *Int. J. Technol. Des. Educ.* 20, 381–401. doi: 10.1007/s10798-009-9092-x

Barca-Lozano, A., Almeida, L. S., Porto-Rioboo, A. M., Peralbo-Uzquiano, M., and Brenlla-Blanco, J. C. (2012). Motivación escolar y rendimiento: impacto de metas académicas, de estrategias de aprendizaje y autoeficacia. *Anales de Psicología* 28, 848–859. doi: 10.6018/analesps.28.3.156101

Bartram, D. (2021). Cross-sectional model-building for research on subjective wellbeing: gaining clarity on control variables on control variables. *Soc. Indic. Res.* 155, 725–743. doi: 10.1007/s11205-020-02586-3

Beatriz, S. (2020). Educación femenina. Historia, poder y sociedad en el Perú. *Revista de Humanidades y Cultura* 1, 188–209. Available online at: https://www.surandinorevista.pe/wpcontent/uploads/2020/11/EDUCACION-FEMENINA.pdf

Bekova, S. K., Terentev, E. A., and Maloshonok, N. G. (2021). Educational Inequality and COVID-19 Pandemic: relationship between the family socio-economic status and student experience of remote learning. *Voprosy obrazovaniya / Educ. Stud. Moscow* 1, 74–92. doi: 10.17323/1814-9545-2021-1-74-92

Benítez-Agudelo, J. C., Restrepo, D., Clemente-Suárez, V. J. (2025). Gender differences in psychophysiological responses to stress and academic performance: the role of sleep, anxiety, and heart rate variability. *Physiol. Behav.* 1:114970. doi: 10.1016/j.physbeh.2025.114970

Bernardo, K. P. (2021). *Históricas precursoras de las aulas (exposiciones Bicentenario)*. San Borja: Proyecto Bicentenario del Perú.

Bhadra, D., and Nandram, B. (2024). Bayesian predictive inference for nonprobability samples with spatial poststratification. *Stat. Applications* 22, 361–399. Available online at: https://www.ssca.org.in/media/24_SA22122024_VKG_GE_DhimanBalgobin_10092024_FINAL_Finally_Bzd1r48.pdf

Blanco, M., and Blanco, M. (2021). Bienestar emocional y aprendizaje significativo a través de las TIC en tiempos de pandemia. *Revista Científica UNEMI* 14,21–33. doi: 10.29076/issn.2528-7737vol14iss36.2021pp21-33p

Boluarte-Carbajal, A., Navarro-Flores, A., and Villarreal-Zegarra, D. (2021). Explanatory model of perceived stress in the general population: a cross-sectional study in Peru during the COVID-19 context. *Frontiers* 12:673945. doi: 10.3389/fpsyg.2021.673945

Boonstra, P. S., Little, R. J. A., West, B. T., Andridge, R. R., and Alvarado-Leiton, F. (2021). A simulation study of diagnostics for selection bias. *J. Off. Stat.* 37, 751–769. doi: 10.2478/jos-2021-0033

Bordbar, S., Mirzaei, S., Bahmaei, J., Atashbahar, O., and Yusefi, A.R. (2025). Predicting students' academic performance based on academic identity, academic excitement, and academic enthusiasm: evidence from a cross-sectional study in a developing country. *BMC Med. Educ.* 25:73. doi: 10.1186/s12909-025-07374-6

Bowles, G., and Renate, R. D. (2024). "Theories of women's studies," in *Theories of Women's Studies, Vol. 3*. Routledge: Taylor & Francis.

Brick, M., Andrews, W. R., and Foster, J. (2022). A review of nonprobability sampling using mobile apps for fishing effort and catch surveys. *Trans. Am. Fish Soc.* 151, 42–49. doi: 10.1002/tafs.10342

Cabana-Caceres, M., Castro-Vargas, C., Andrade-Arenas, L., Romero-Valencia, M., and Castro-Vargas, H. (2021). Learning strategies and academic goals to strengthen competencies in electronics and digital circuits in engineering students. *Adv. Sci. Technol. Eng. Syst.* 6, 87–98. doi: 10.25046/aj060110

Camizán, H., Benites, L. A., and Damián, I. F. (2021). Estrategias de Aprendizaje. *Ecno Humanismo* 1, 1–20. doi: 10.53673/th.v1i8.40

Cann, N. M., García-Valcárcel, A., and Morales-Morgado, E. (2022). Argument analysis and self-regulated learning in university students. *Revista Electronica Interuniversitaria de Formacion del Profesorado* 25, 159–175. doi: 10.6018/reifop.528631

Cataldo, R., Aranciba, M., Stojanova, J., and Papuzinski, C. (2019). General concepts in biostatistics and clinical epidemiology: observational studies with cross-sectional and ecological designs. *Medwave* 19:e7698. doi: 10.5867/medwave.2019.08.7698

Cen, S., Zhao, M., Wang, F., and Tang, L. (2025). Gender differences in the relationship between mental health and academic performance among undergraduate students at a medical school in Shanghai: a cross-sectional study. *BMC Public Health* 25:21697. doi: 10.1186/s12889-025-21697-5

Chennamaneni, P. R., Echambadi, R., Hess, J. D., and Syam, N. (2016). Diagnosing harmful collinearity in moderated regressions: A roadmap. *Int. J. Res. Mark.* 33, 172–182. doi: 10.1016/j.ijresmar.2015.08.004

Contreras-Bravo, L. E., Tarazona-Bermúdez, G. M. y Rodríguez-Molano, J. I. (2021). Tecnología y analítica del aprendizaje: una revisión a la literatura. *Revista Científica* 41, 150–168. doi: 10.14483/23448350.17547

Cosi, E., Peña, C. A., Silarayan, L. A., Espinosa, E., and Cruz, A. A. (2023). Relación entre competencias emocionales y aprendizaje autorregulado en estudiantes de estudios generales de una universidad privada de Lima. *MENDIVE. Revista de Educación* 21:e3259. Available online at: https://mendive.upr.edu.cu/index.php/MendiveUPR/article/view/3259

Daura, F., Montserrat, M. I., and Barnin, C. (2022). Incidencia de las horas de estudio sobre los perfiles de aprendizaje autorregulado en estudiantes de nivel medio. *Revista Educación* 46, 1–15. doi: 10.15517/revedu.v41i2.21396

De la Fuente-Mella, H., Campos-Espinoza, R., Lay-Raby, N., Lamelés-Corvalán, O., Pino-Moya, M., and Ramírez-Molina, R. (2022). Multinomial cross-sectional regression models to estimate and predict the determinants of academic performance: the case of auditor accountant of the pontifical catholic University of Valparaíso. *Sustainability* 14:9232. doi: 10.3390/su14159232

Duffy, K. A., Ziolek, T. A., and Epperson, C. E. (2020). Filling the regulatory gap: potential role of institutional review boards in promoting consideration of sex as a biological variable. *J. Womens Health* 29, 868–875. doi: 10.1089/jwh.2019.8084

Elhusseini, S. A., Tischner, C. M., Aspiranti, K. B., and Fedewa, A. L. (2022). A quantitative review of the effects of self-regulation interventions on primary and secondary student academic achievement. *Metacogn. Learn.* 17, 1117–1139. doi: 10.1007/s11409-022-09311-0

Fernández de Castro, J., Hidalgo, C., and Heredia, N. (2024). Autorregulación del aprendizaje y su relación con el rendimiento académico en estudiantes de secundaria de México. *Revista Dilemas Contemporáneos: Educación, Política y Valores* 12:4389. doi: 10.46377/dilemas.v12i.4389

Formento-Torres, A.C., Quílez-Robres, A., and Cortés-Pascual, A. (2023). Motivación y rendimiento académico en la adolescencia: una revisión sistemática meta-analítica. *RELIEVE* 29, 2–23. doi: 10.30827/relieve.v29i1.25110

Gayanes, M., Herrero, E., and De-Marcoss, L. (2024). Gender differences in representation, citations, and h-index: an empirical examination of the field of communication across the ten most productive countries. *PLoS ONE,* 19:e0312731. *doi: 10.1371/journal.pone.0312731*

Gómez, F., and Zevallos, G. L. (2025). Relationship between digital skills, critical thinking and self-regulated learning in higher education students. *Revista INVECOM- Estudios Transdisciplinarios en Comunicación y Sociedad* 5:e502022. doi: 10.5281/zenodo.12813078

Gonzales, G. L. (2020). Escala de estrategias de aprendizaje ACRA: Adaptación psicométrica en estudiantes universitarios peruanos. *Psique Mag: Revista Científica Digital de Psicología* 9, 40–50. doi: 10.18050/psiquemag.v9i2.2741

Guerrero, F. E. B. (2025). Differences in the use of learning strategies in university education students. *Maskana* 6, 203–216. doi: 10.18537/mskn.16.01.13

Guntur, M., and Purnomo, Y. W. (2024). A meta-analysis of self-regulated learning interventions studies on learning outcomes in online and blended environments. *Online Learn.* 3, 563–584. doi: 10.24059/olj.v28i3.4025

Hajra, A., Ghosh, B., and Bhowmik, S. (2025). "Cross-sectional studies. translational cardiology," in *Translational Cardiology: Handbook for Designing and Conducting Clinical and Translational Research*, eds. J. A. Bakal, M. Gibson and A. E. M. Eltorai (Amsterdam: Elsevier), 221–225.

Hall, G., and Eckert, R. J. (2024). "The family perspective and experience: How the COVID-19 pandemic interrupted and impacted education," in *Challenges and Transitions in Education in Times of Crisis* (Palmdale, PA: IGI Global), 22–32.

Ismael, S. (2022). Women's informal learning in poor communities, social movements and virtual spaces. *Int Encyclopedia Educ Fourth Ed.* 2, 323–329. doi: 10.1016/B978-0-12-818630-5.08048-9

Kalnins, A., and Praitis Hill, K. (2023). The VIF score. What is it good for? Absolutely nothing. *Organ. Res. Methods* 28, 58–75. doi: 10.1177/10944281231216381

Kalton, G. (2023). Probability vs. nonprobability sampling: from the birth of survey sampling to the present day. *Stat. Trans, Ser.* 24, 1–22. doi: 10.59170/stattrans-2023-029

Katsantonis, I. (2024). Exploring age-related differences in metacognitive self-regulation: the influence of motivational factors in secondary school students. *Front. Psychol.* 15:1383118. doi: 10.3389/fpsyg.2024.1383118

Kim, J. H. (2024). "Cross-sectional study: the role of observation in epidemiological studies," in *Statistical Approaches for Epidemiology*, ed. A. K. Mitra (Berlin: Springer), 19–42.

Kinnari-Korpela, H., and Suhonen, S. (2020). "Active learning: how to promote it?," in *Engaging Engineering Education: SEFI 48th Annual Conference Proceedings* (Enschede: University of Twente), 908–916.

Knowlton, B. J., and Castel, A. D. (2022). Memory and reward-based learning: a value-directed remembering perspective. *Annu. Rev. Psychol.* 4, 25–52. doi: 10.1146/annurev-psych-032921-050951

Krebsbach, J. M. (2022). Women in academia: representation, tenure, and publication patterns in the STEM and social sciences fields. *J. Int. Women's Stud.* 24:5. doi: 10.31235/osf.io/yjbxw

Kwarikunda, D., Schiefele, U., Muwonge, C. M., and Ssenyonga, J. (2022). Profiles of learners based on their cognitive and metacognitive learning strategy use: occurrence and relations with gender, intrinsic motivation, and perceived autonomy support. *Human. Soc. Sci. Commun.* 9:337. doi: 10.1057/s41599-022-01322-1

Lamp, S., and Mackinnon, D. P. (2024). Correcting for collider effects and sample selection bias in psychological research. *Psychol. Methods* 30, 1169–1184. doi: 10.1037/met0000659

León, O., and Montero, I. (2020). *Métodos de Investigación en Psicología y Educación. Las tradiciones cuantitativa y cualitativa (4th ed.)*. Columbus, OH: McGraw-Hill.

Lieder, E. R., Nakazato, N., Ohtani, K., Ishii, R., and Fukuzumi, N. (2023). Children's study habits are predicted by their parents' learning strategy preferences. *Learn. Instr.* 88:101809. doi: 10.1016/j.learninstruc.2023.101809

Maier, C., Thatcher, J. B., Grover, V., and Dwivedi, Y. K. (2023). Cross-sectional research: a critical perspective, use cases, and recommendations for IS research. *Int. J. Inf. Manage.* 70:102625. doi: 10.1016/j.ijinfomgt.2023.102625

Maldonado-Sánchez, M., Aguinaga, D., Nieto-Gamboa, J., Shardin-Flores, L., and Cadenillas-Albornoz, V. (2019). Estrategias de aprendizaje para el desarrollo de la autonomía de los estudiantes de secundaria. *Propósitos y Representaciones* 7, 415–439. doi: 10.20511/pyr2019.v7n2.290

Medina, D., and Nagamine, M. M. (2019). Estrategias de aprendizaje autónomo en la comprensión lectora de estudiantes de secundaria. *Propósitos y Representaciones* 7, 134–159. doi: 10.20511/pyr2019.v7n2.276

Mendoza-Ponce, F.W. (2024). La calidad de la educación en el ámbito rural: Una revisión sistemática 2017–2023. *Revista Electrónica de Ciencias de la Educación, Humanidades, Artes y Bellas Artes* 7, 152–167. doi: 10.35381/e.k.v7i1.3727

Ministerio de Educación del Perú, Unidad de Medición de la Calidad [UMC]. (2023). *¿Qué factores se asocian con los aprendizajes de nuestros estudiantes? Resultados de la Evaluación Muestral de Estudiantes 2022*. San Borja: UMC–MINEDU.

Ministerio de Educación del Perú, Unidad de Medición de la Calidad (UMC). (2025). *Presentación de factores asociados – ENLA 2024 [Presentación]*. San Borja: MINEDU.

Ministerio de Educación. (2022). *El Perú en Programa para la Evaluación Internacional de Estudiantes 2018: Informe nacional de resultados.* San Borja: Oficina de medición de la calidad de los aprendizajes.

Muljana, P., Chitra, S., and Luo, T. (2023). Examining the relationships among self-regulated learning, homework timeliness, and course achievement: a context of female students learning quantitative topics. *J. Res. Technol. Educ.* 55, 143–162. doi: 10.1080/15391523.2021.1936703

Nguyen, H. M., Tran, T. H., Tran, T. T. L. (2022). "Gender differences in the scientific achievement of social sciences and impact factors: a survey study of researchers in the social sciences in Vietnam," in *Diversity and Discrimination in Research Organizations* (Leeds: Emerald Publishing), 259–286.

Nikčević-Milković, A. (2019). School achievement and school satisfaction considering personal characteristics, learning strategies and the use of digital media in learning. *Suvremena Psihologija* 22, 5–26. doi: 10.21465/2019-SP-221-01

Nobuo, O. (2024). Evaluating the practicality of causal inference from non-randomized observational data in small-scale clinical settings: a study on the effects of Ninjin'yoeito. *Cureus* 8:e55825. doi: 10.7759/cureus.55825

Organisation for Economic Co-operation and Development (OECD). (2024). *PISA 2022 results (Volume III): Creative minds, creative schools—Country Note: Peru*. Paris: OECD Publishing.

Ortega, J., and Oyanedel, C. (2021). Docentes y las tecnologías de la información y la comunicación: el nuevo rol en tiempos de pandemia por COVID-19. *Revista de Educación* 46, 1–12. doi: 10.15517/revedu.v46i1.47614

Ortega-Torres, E., Solaz-Portoles, J. J., and Sanjosé-López, V. (2020). Inter-relations among motivation, self-perceived use of strategies and academic achievement in science: a study with Spanish secondary school students. *Sustainability* 12:6752. doi: 10.3390/su12176752

Paladines-Jaramillo, F., Ordoñez-Camacho, D., Egas-Reyes, V., Salazar, J. P., Realpe, V., and Terceros, I. (2020). Using virtual reality to assess the frustration level and its coping mechanisms in university students," in *Communications in Computer and Information Science* (Berlin:Springer), 337–390.

Panadero, E. (2017). Una revisión del aprendizaje autorregulado: seis modelos y cuatro direcciones para la investigación. *Frontiers* 8, 1–28. doi: 10.3389/fpsyg.2017.00422

Pérez-Guerrero, E. E., Guillén-Medina, M. R., Márquez-Sandoval, F., Vera-Cruz, J. M., Gallegos-Arreola, M. P., Rico-Méndez, M. A., Aguilar-Velázquez, J. A., and Gutiérrez-Hurtado, I. A. (2024). Methodological and statistical considerations for cross-sectional, case-control, and cohort studies. *J Clin Med,* 13, 4005. doi: 10.3390/jcm13144005

Puerta-Vásquez, S.M., and Suárez-Molina, V. (2022). Estrategia didáctica mediada por el aprendizaje autorregulado para el desarrollo del pensamiento crítico en educación artística. *INNOVA Res. J.* 7, 38–58. doi: 10.33890/innova.v7.n1.2022.1979

Ramírez, A., Gutiérrez-Arenas, M.P., and Ruiz-Calzado, I. (2025). Redes sociales: influencia en el aprendizaje profundo de estudiantes de Educación Secundaria. *Digital Educ. Rev.* 46, 40–50. doi: 10.1344/der.2025.46.40-50

Rojas-Apaza, R., Paredes, R. P., Arpi, R., Quispe-Lino, C. N., and Chura-Zea, E. (2024). Urban-rural gap in education performance in Peruvian public institutions during 2018: an analysis using the Oaxaca-Blinder decomposition. *Front. Educ.* 9:1394938. doi: 10.3389/feduc.2024.1394938

Román, J. M., and Gallego, S. (1994). *Escala de Estrategias de Aprendizaje, ACRA*. Madrid: TEA Ediciones.

Rondon, L. R., Maciel, C., and Guzman, I. R. (2025). Women's academic leadership in STEM: a systematic literature review on challenges, opportunities and strategies. *Stud. High. Educ.* doi: 10.1080/03075079.2025.2511825. [Epub ahead of print].

Ruiz-Martín, H., Blanco, F., and Ferrero, M. (2024). Which learning techniques supported by cognitive research do students use at secondary school? Prevalence and associations with students' beliefs and achievement. *Cogn. Res. Princip. Implicat.* 9:5. doi: 10.1186/s41235-024-00567-5

Savitz, D., and Wellenius, G. (2023). Can Cross-Sectional Studies Contribute to Causal Inference? It Depends. *Am. J. Epidemiol.* 192,514–516. doi: 10.1093/aje/kwac037

Seamans, M. J., Hong, H., Ackerman, B., and Schmid, I. (2021). Generalizability of subgroup effects. *Epidemiology* 32, 389–392. doi: 10.1097/EDE.0000000000001329

Seban, P., and Urban, U. (2024). Examining the utilisation of learning techniques and strategies among pedagogy students: implications for self-regulated learning. *J. Pedag.* 15, 1–20. doi: 10.2478/jped-2024-0002

Sen, A., and Lahiri, P. (2024). Improving measurement error and representativeness in nonprobability surveys. *Submission Hist.* 21, 28. doi: 10.48550/arXiv.2410.18282

Sheieh, G. (2021). Probing categorical moderation under variance heterogeneity. *Psychol. Methods* 26, 315–326. doi: 10.1037/met0000346

Stangl, V., and Brand, A. (2025). Sex-specific diagnostics and treatment of cardiovascular diseases. *Herz* 50, 113–121. doi: 10.1007/s00059-025-05303-3

Suárez, S., and Suárez, J. M. (2019). Las estrategias de aprendizaje y las metas académicas en función del género, los estilos parentales y el rendimiento en estudiantes de secundaria. *Revista Complutense de Educación* 30, 167–184. doi: 10.5209/RCED.56057

Taylor, C. L., Said-Metwaly, S., Camarda, A., and Barbot, B. (2024). Gender differences and variability in creative ability: a systematic review and meta-analysis of the greater male variability hypothesis in creativity. *J. Pers. Soc. Psychol.* 126, 1161–1179. doi: 10.1037/pspp0000484

Torre, J. C. (2006). *La autoeficacia, la autorregulación y los enfoques de aprendizaje en estudiantes universitarios* [Tesis doctoral, Universidad Pontificia Comillas]. Repositorio Institucional de la Universidad Pontificia Comillas, Madrid.

Tuononen, T., Hyytinen, H., Räisänen, M., Hailikari, T., and Parpala, A. (2023). Metacognitive awareness in relation to university students' learning profiles. *Metacogn. Learn.* 18, 37–54. doi: 10.1007/s11409-022-09314-x

Turban, J. L., Almazan, A. N., Reisner, S. L., and Keuroghlian, A. S. (2023). The importance of non-probability samples in minority health research: lessons learned from studies of transgender and gender diverse mental health. *Transgender Health* 28, 302–306. doi: 10.1089/trgh.2021.0132

Vicuña, M. V., and Sanjinés, E. S. (2018). Habilidades de pensamiento y su relación con el aprendizaje autorregulado en estudiantes de educación de una universidad pública de Lima. *Revista de Investigación en Psicología* 21, 225–236. doi: 10.15381/rinvp.v21i2.15824

Waechter, N., Kalmus, V., Mascheroni, G., and Opermann, S. (2023). Large-scale comparative school-based survey research: challenges and solutions for sampling, fieldwork and informed consent. *Methods Data Analyses* 17, 303–304.

Wang, X., and Cheng, Z. (2020). Cross-sectional studies: strengths, weaknesses, and recommendations. *Chest* 158, S65–S71. doi: 10.1016/j.chest.2020.03.012

Williams, K. E., Savage, S., and Eager, R. (2020). Rhythm and Movement for Self-Regulation (RAMSR) intervention for preschool self-regulation development in disadvantaged communities: a clustered randomised controlled trial study protocol. *BMJ Open* 10:e036392. doi: 10.1136/bmjopen-2019-036392

Wirth, J., Stebner, F., and Trypke, M. (2020). An interactive layers model of self-regulated learning and cognitive load. *Educ. Psychol. Rev.* 32, 1127–1149. doi: 10.1007/s10648-020-09568-4

Wu, Y., Xie, F., and Jiang, R. (2022). Academic anxiety, self-regulated learning ability, and self-esteem in Chinese candidates for college entrance examination during the COVID-19 outbreak: a survey study. *Psychol. Res. Behav. Manag.* 29, 2383–2390. doi: 10.2147/PRBM.S360127

Xu, Z., Ma, L., and Wang, T. (2023). A meta-analysis of the efficacy of self-regulated learning interventions in online and blended learning. *Behav. Inf. Technol.* 42, 2147–2168. doi: 10.1080/0144929X.2022.2151935

Yi-Ying, H., Wei-Hsiang, H., and Chen-Yin, T. (2024).A cross-sectional study applying the PRECEDE model to explore factors influencing epidemic prevention behaviors among preschool educators. *BMC Public Health* 24:20865. doi: 10.1186/s12889-024-20865-3

Ziauddin, L., Krivicich, L. M., and Nho, S. J. (2023). "Cross-section study," in *Translational Sports Medicine* (Amsterdam: Elsevier), 191–193.

Zorlu, S., and Ünver, G. (2022). Predictive roles of self-regulatory learning strategies and self-efficacy beliefs on English language learning achievement. *Turk. J. Educ.* 11, 74–92. doi: 10.19128/turje.841709