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The Mediating Role of Metacognitive Awareness on the Relationship Between Teacher Classroom Assessment and Self-Regulated Learning in Secondary School Students

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A B S T R A C T

This study aimed to investigate the mediating role of metacognitive awareness in the relationship between teacher classroom assessment and self-regulated learning (SRL) among secondary school students. A correlational research design with a quantitative approach was employed, involving 351 secondary school students in Zanjan city, Iran. Data were collected using three standardized questionnaires: the Teacher Classroom Assessment Questionnaire, the Metacognitive Awareness Questionnaire, and the Self-Regulated Learning Questionnaire. The sample was selected through convenience sampling, and data analysis included descriptive statistics, Pearson correlation, and path analysis using SPSS-26 and LISREL software. The results revealed that teacher classroom assessment had a significant direct effect on both metacognitive awareness ($\beta = 0.568$, $p < 0.001$) and SRL ($\beta = 0.553$, $p < 0.001$). Additionally, metacognitive awareness mediated the relationship between teacher classroom assessment and SRL, with an indirect effect of $\beta = 0.159$ ($p < 0.001$), indicating its role as a mediating mechanism. The study highlights the critical role of metacognitive awareness in linking teacher classroom assessment to SRL, providing insights for educators to design assessments that promote self-reflection and metacognitive development. By enhancing metacognitive awareness, teachers can effectively support students in becoming self-regulated learners, ultimately improving academic outcomes and lifelong learning skills.

Keywords: *Teacher Classroom Assessment, Metacognitive Awareness, Self-Regulated Learning, Mediation, Secondary Education.*

1. Introduction

In the contemporary educational landscape, the cultivation of self-regulated learning (SRL) among students has emerged as a pivotal goal, given its profound impact on academic achievement, lifelong learning, and personal development. SRL, defined as the ability to actively manage one's cognitive, motivational, and behavioral processes during learning (Paz-Baruch, 2025; Xu & Wang, 2024), is increasingly recognized as a critical competency in both traditional and digital learning environments (Gao, 2024). However, the mechanisms through which SRL is fostered and sustained remain complex and multifaceted, necessitating a deeper exploration of the factors that influence its development. Among these factors, teacher classroom assessment practices and metacognitive awareness have garnered significant attention for their potential to shape students' learning behaviors and outcomes (Ariyan et al., 2024; Chiu, 2024; Zheng et al., 2023).

SRL is underpinned by several theoretical models, each emphasizing different components of the learning process. Panadero (2017) identifies six prominent models of SRL, including Zimmerman's cyclical model, which highlights the interplay between forethought, performance, and self-reflection phases (Panadero, 2017). Similarly, Winne and Hadwin's (1998) model emphasizes the role of cognitive tools and environmental contexts in facilitating SRL. These models collectively underscore the importance of metacognitive processes, such as planning, monitoring, and evaluating, in enabling learners to take control of their learning trajectories (Stebner et al., 2022). Empirical studies have further validated the significance of SRL, demonstrating its positive correlation with academic performance and adaptive learning strategies across diverse educational settings (Broadbent & Poon, 2015; Vosniadou et al., 2021).

Teacher classroom assessment practices play a pivotal role in shaping students' learning experiences and outcomes. Assessments that are formative in nature, focusing on providing feedback and fostering improvement rather than merely evaluating performance, have been shown to enhance students' engagement and motivation (Biwer et al., 2023). Such practices align with the principles of SRL by encouraging students to reflect on their learning processes and set meaningful goals (Beckers et al., 2023). However, the effectiveness of classroom assessment depends on teachers' ability to implement these practices in ways that promote metacognitive awareness and self-reflection (Dignath, 2021). Research by Enayati Shabkolai et al. (2023) highlights the importance of teacher competence in designing assessments that scaffold students' SRL skills, particularly in transitional phases such as the shift from primary to secondary education (Enayati Shabkolai et al., 2023).

Metacognitive awareness, defined as the knowledge and regulation of one's cognitive processes, is widely recognized as a cornerstone of SRL. Studies have consistently demonstrated that students with higher levels of metacognitive awareness are better equipped to plan, monitor, and evaluate their learning strategies, leading to improved academic outcomes (Balashov et al., 2021; Hassannejad Emamchay & Zabihi, 2024; Karna & Batthyany, 2025). For instance, Tian et al. (2018) found that metacognitive knowledge significantly mediates the relationship between self-efficacy and mathematics performance within an SRL framework (Tian et al., 2018). Similarly, Asdolahzadeh et al. (2021) revealed that metacognitive skills play a mediating role in the relationship between self-efficacy and the tendency to engage with cyberspace among gifted students (Asdolahzadeh et al., 2021). These findings suggest that metacognitive awareness acts as a bridge between external factors, such as teacher assessment practices, and internal learning processes, such as SRL.

While the individual contributions of teacher classroom assessment and metacognitive awareness to SRL are well-documented, the interplay between these factors remains underexplored. Research by Fan et al. (2022) emphasizes the need for multi-channel data to better understand the complex dynamics of SRL, including the role of external influences such as assessment practices (Fan et al., 2022). Similarly, Stebner et al. (2022) highlight the importance of examining how metacognitive skills are transferred across different learning contexts, particularly in response to instructional interventions (Stebner et al., 2022). This study builds on these insights by hypothesizing that metacognitive awareness mediates the relationship between teacher classroom assessment and SRL, thereby providing a more nuanced understanding of how assessment practices can be leveraged to foster SRL.

The present study is situated within the context of secondary education in Iran, where the national curriculum places a strong emphasis on academic achievement and standardized testing. In such a high-stakes environment, students often face pressure to perform, which can hinder the development of SRL skills (Nikpay et al., 2016). Previous

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research in Iran has explored the relationship between motivational beliefs, metacognitive skills, and SRL (Arami et al., 2016; Rezapour Mirsaleh & Shakeri, 2018), but few studies have examined the role of teacher assessment practices in this context. Furthermore, there is a paucity of research investigating the mediating role of metacognitive awareness in the relationship between teacher assessment and SRL, particularly among secondary school students.

This study aims to address these gaps by examining the mediating role of metacognitive awareness in the relationship between teacher classroom assessment and SRL among secondary school students in Iran.

2. Methods and Materials

2.1. Study Design and Participants

In the present study, a correlational research design was employed with a quantitative approach to investigate the mediating role of metacognitive awareness on the relationship between teacher classroom assessment and self-regulated learning among secondary school students. The statistical population consisted of all secondary school students in Zanjan city, Iran. A convenience sampling method, which is a non-probability sampling technique, was utilized to select participants. This method involves using respondents who are conveniently available to the researcher, without following a specific pattern. In this case, the respondents were secondary school students who were accessible to the researcher. The sample size was determined based on the recommended ratio of 5 to 10 participants per measured parameter in the model, ensuring a sufficient and appropriate sample size for reliable and generalizable results in structural equation modeling. Accordingly, a sample of 351 students was deemed adequate for statistical analysis.

Data collection involved a two-step process: a literature review to examine theoretical foundations and prior research, followed by a field study where questionnaires were distributed. After obtaining permission from the Zanjan Department of Education, the researcher visited selected schools (non-randomly chosen) and administered the questionnaires. Participants provided informed consent and voluntarily completed the surveys.

2.2. Measures

The Metacognitive Awareness Questionnaire, developed by Mokhtari and Reichard (2002), consists of 30 items assessing three components: global reading strategies, problem-solving strategies, and support reading strategies. Responses were recorded on a 5-point Likert scale ranging from "always" to "never." The validity of this questionnaire was well-established by its developers, and its reliability was confirmed with a Cronbach's alpha coefficient of 0.89.

The Teacher Classroom Assessment Questionnaire, designed by Yousefi Afrashteh and Sayami (2015), includes 8 items rated on a 5-point Likert scale. Higher scores indicate a greater tendency toward formative assessment practices by teachers. The reliability of this questionnaire was reported at 0.72, indicating acceptable internal consistency.

The Self-Regulated Learning Questionnaire, developed by Bouffard et al. (1995) and adapted by Kadivar (2001), consists of 14 items measuring motivational, cognitive, and metacognitive components. Responses were recorded on a 5-point Likert scale ranging from "strongly agree" to "strongly disagree." The total score ranges from 14 to 70, with higher scores indicating stronger self-regulation. The questionnaire's reliability, assessed via Cronbach's alpha, was reported as 0.71 by Kadivar (2001) and 0.76 in a subsequent study by Talebzadeh Noubarian et al. (2011). Factor analysis confirmed its construct validity, explaining 52% of the variance in self-regulated learning.

2.3. Data Analysis

Data analysis was conducted in two stages: descriptive and inferential statistics. Descriptive statistics included mean and standard deviation, while inferential statistics involved Pearson correlation matrix analysis and path analysis. The raw data were analyzed using SPSS-26 and LISREL software to examine the relationships among the variables and test the hypothesized model.

3. Findings and Results

The demographic characteristics of the participating secondary school students revealed a mean age of 13.58 years with a standard deviation of 0.94. In terms of parental education levels, 53% of parents had below diploma education, 32.2% held a diploma, 9.4% had a bachelor's degree, and 5.4% possessed a master's degree. The gender distribution showed that 31.9% of participants were boys, while 68.1% were girls. Regarding the grade level, 46.2% of students were in the seventh grade, 32.2% in the eighth grade, and 21.7% in the ninth grade.

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Table 1

Descriptive Statistics for Study Variables

Variable	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
Teacher Classroom Assessment	351	8	40	26.82	8.80	-0.629	-0.744
Metacognitive Awareness	351	28	137	86.94	29.40	-0.229	-1.17
Global Reading Strategies	351	11	54	32.50	12.18	-0.173	-1.22
Problem-Solving Strategies	351	8	40	26.52	9.26	-0.470	-0.947
Reading Support Strategies	351	9	45	27.91	10.12	-0.209	-1.25
Self-Regulated Learning	351	18	70	52.02	11.67	-0.009	0.631
Cognitive Strategies	351	5	25	19.25	4.51	-0.919	0.382
Motivational Strategies	351	3	15	11.08	3.35	-0.826	-0.247
Metacognitive Strategies	351	7	30	21.68	5.02	-0.668	-0.094

Descriptive statistics for the variables under study are presented in Table 1. The results indicate that teacher classroom assessment had a mean score of 26.82 (SD = 8.80), ranging from 8 to 40. Metacognitive awareness demonstrated a mean score of 86.94 (SD = 29.40), with scores ranging from 28 to 137. The subcomponents of metacognitive awareness, including global reading strategies (M = 32.50, SD = 12.18), problem-solving strategies (M = 26.52, SD = 9.26), and reading support strategies (M = 27.91, SD = 10.12), exhibited varying means and standard deviations. Self-regulated learning had a mean score of 52.02 (SD = 11.67), ranging from 18 to 70. Its subcomponents, cognitive strategies (M = 19.25, SD = 4.51), motivational strategies (M = 11.08, SD = 3.35), and metacognitive strategies (M = 21.68, SD = 5.02), also showed distinct distributions. Skewness and kurtosis values for all variables fell within the acceptable range, indicating normality in the data distribution.

Prior to conducting inferential analyses, several assumptions were tested to ensure the suitability of the data for the planned statistical procedures. The assumption of normality was assessed using skewness and kurtosis values, which fell within the acceptable range of ±2, indicating a normal distribution of the data. Linearity was confirmed through visual inspection of scatterplots, showing a linear relationship between variables. The assumption of homoscedasticity was verified by examining the consistency of variance across the range of predictor values. Multicollinearity was evaluated using the Variance Inflation Factor (VIF), with all values below 5, suggesting no significant collinearity issues. Lastly, independence of errors was confirmed through the Durbin-Watson statistic, which indicated no evidence of autocorrelation. These confirmed assumptions ensured the robustness and reliability of the subsequent inferential analyses.

Table 2

Factor Loadings for Study Variables

Item	Teacher Classroom Assessment	Metacognitive Awareness	Self-Regulated Learning
Question 1	0.84	-	-
Question 2	0.87	-	-
Question 3	0.92	-	-
Question 4	0.65	-	-
Question 5	0.67	-	-
Question 6	0.64	-	-
Question 7	0.84	-	-
Question 8	0.85	-	-
Global Reading Strategies	-	0.93	-
Problem-Solving Strategies	-	0.88	-
Reading Support Strategies	-	0.88	-
Cognitive Strategies	-	-	0.91
Motivational Strategies	-	-	0.87
Metacognitive Strategies	-	-	0.79

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The factor loadings presented in Table 2 demonstrate strong construct validity for all measured variables. Teacher Classroom Assessment items exhibited loadings ranging from 0.64 to 0.92, indicating robust representation of the construct. Similarly, Metacognitive Awareness subscales showed high loadings, with Global Reading Strategies at 0.93, Problem-Solving Strategies at 0.88, and Reading Support Strategies at 0.88. For Self-Regulated Learning, Cognitive Strategies (0.91), Motivational Strategies (0.87), and Metacognitive Strategies (0.79) also demonstrated strong loadings, confirming the validity of the measurement model.

Table 3

Cronbach's Alpha Reliability Coefficients

Variable	Cronbach's Alpha
Self-Regulated Learning	0.87
Metacognitive Awareness	0.91
Teacher Classroom Assessment	0.93
Global Reading Strategies	0.83
Problem-Solving Strategies	0.79
Reading Support Strategies	0.80
Cognitive Strategies	0.88
Motivational Strategies	0.91
Metacognitive Strategies	0.90

Table 3 reports the Cronbach's alpha coefficients for all study variables, indicating high internal consistency reliability. Teacher Classroom Assessment achieved the highest reliability at 0.93, followed by Metacognitive Awareness at 0.91. Self-Regulated Learning and its subcomponents also demonstrated strong reliability, with values ranging from 0.79 to 0.91. These results confirm that the instruments used in the study are highly reliable for measuring the intended constructs.

Table 4

Model Fit Indices

Fit Index	Value	Criterion	Interpretation
NFI	0.90	Between 0.90 to 0.95	Acceptable
RFI	0.89	Between 0.90 to 0.95	Relatively Acceptable
IFI	0.92	Between 0.90 to 0.95	Acceptable
CFI	0.92	Between 0.90 to 0.95	Acceptable
GFI	0.89	Between 0.90 to 0.95	Relatively Acceptable
AGFI	0.90	Between 0.90 to 0.95	Acceptable
SRMR	0.059	Less than 0.08	Acceptable

Table 4 presents the model fit indices for the structural equation model. The Normed Fit Index (NFI), Incremental Fit Index (IFI), and Comparative Fit Index (CFI) values were 0.90, 0.92, and 0.92, respectively, all falling within the acceptable range of 0.90 to 0.95. The Root Mean Square Residual (SRMR) value of 0.059 was below the threshold of 0.08, indicating a good fit. Although the Goodness of Fit Index (GFI) and Adjusted Goodness of Fit Index (AGFI) were slightly below 0.90, they were still considered relatively acceptable. Overall, these indices confirm that the proposed model adequately fits the data.

Table 5

Standardized Path Coefficients for Direct and Indirect Effects

Path	b	SE	T	P
Teacher Classroom Assessment → Self-Regulated Learning	0.553	0.056	9.82	0.000
Metacognitive Awareness → Self-Regulated Learning	0.281	0.052	5.33	0.000
Teacher Classroom Assessment → Metacognitive Awareness	0.568	0.053	10.69	0.000
Teacher Classroom Assessment → Metacognitive Awareness → Self-Regulated Learning	0.159	0.033	4.81	0.000

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Table 5 presents the standardized path coefficients for the direct and indirect effects in the structural model. The direct effect of Teacher Classroom Assessment on Self-Regulated Learning was significant ($\beta = 0.553$, $p < 0.001$), indicating a strong positive relationship. Similarly, Metacognitive Awareness had a significant direct effect on Self-Regulated Learning ($\beta = 0.281$, $p < 0.001$). The direct effect of Teacher Classroom Assessment on Metacognitive Awareness was also significant ($\beta = 0.568$, $p < 0.001$), highlighting a robust association between these variables. Additionally, the indirect effect of Teacher Classroom Assessment on Self-Regulated Learning through Metacognitive Awareness was significant ($\beta = 0.159$, $p < 0.001$), confirming the mediating role of Metacognitive Awareness in this relationship. All paths demonstrated high statistical significance, underscoring the validity of the hypothesized model.

Figure 1

Model with Factor Loadings

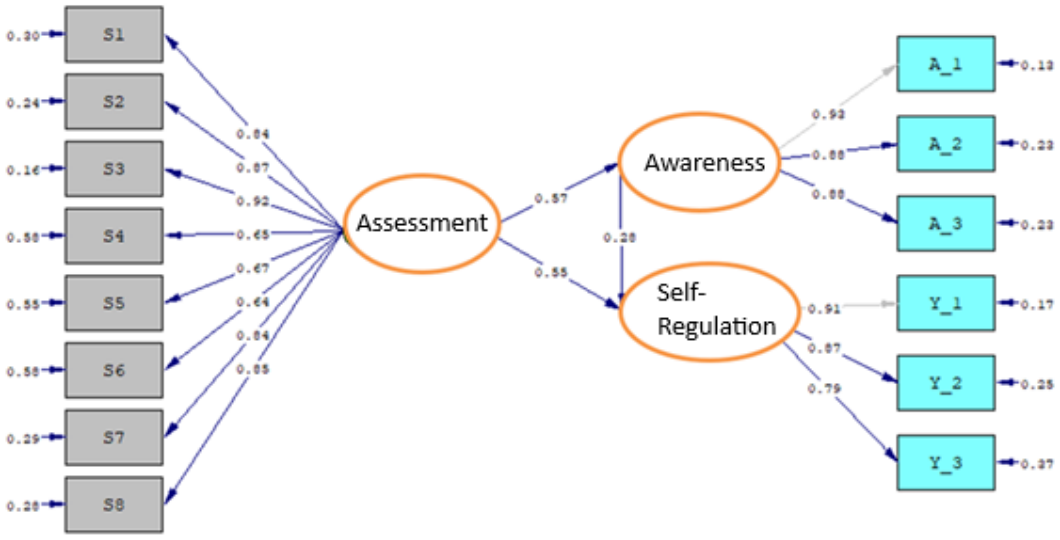
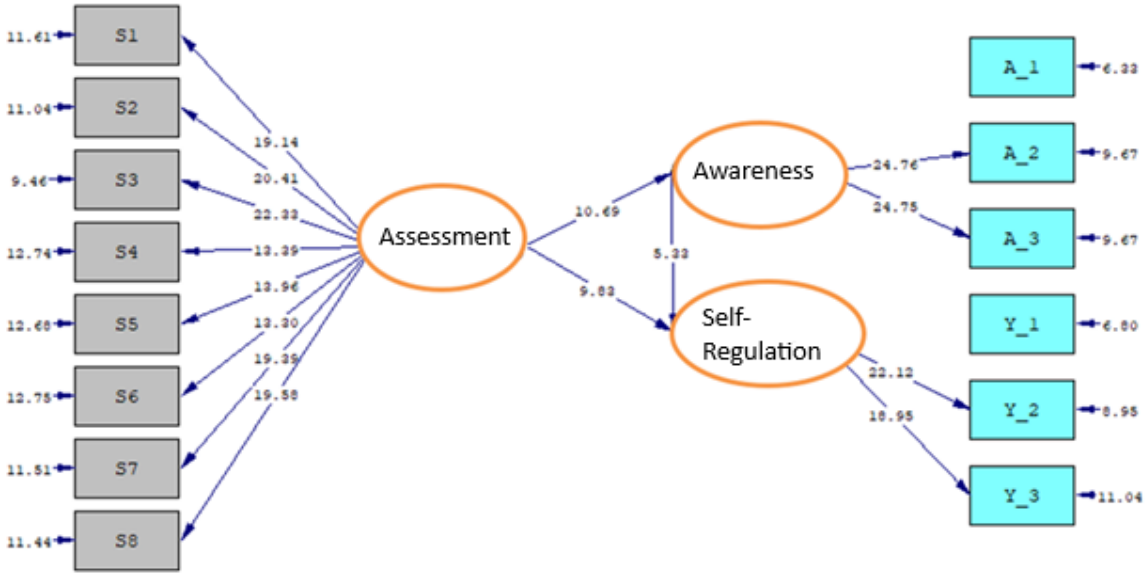


Figure 2

Model with T-Values



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4. Discussion and Conclusion

The findings of this study reveal significant relationships among teacher classroom assessment, metacognitive awareness, and self-regulated learning (SRL) among secondary school students. Consistent with the hypothesized model, teacher classroom assessment was found to have a direct and positive impact on both metacognitive awareness and SRL. Additionally, metacognitive awareness emerged as a significant mediator in the relationship between teacher classroom assessment and SRL. These results align with previous research emphasizing the critical role of teacher assessment practices in fostering students' learning strategies and outcomes (Biwer et al., 2023; Enayati Shabkolai et al., 2023). The direct effect of teacher classroom assessment on SRL underscores the importance of formative assessment practices that encourage students to reflect on their learning processes, set goals, and monitor their progress (Beckers et al., 2023). Such practices, when effectively implemented, can empower students to take ownership of their learning, a key component of SRL (Broadbent & Poon, 2015).

The mediating role of metacognitive awareness in the relationship between teacher classroom assessment and SRL is particularly noteworthy. This finding supports the theoretical framework posited by Flavell (1979) and subsequent research highlighting metacognition as a foundational element of SRL (Beckers et al., 2023; Stebner et al., 2022). Metacognitive awareness enables students to plan, monitor, and evaluate their learning strategies, thereby bridging the gap between external instructional practices and internal learning processes (Tian et al., 2018). The results of this study extend previous findings by demonstrating how teacher classroom assessment can serve as a catalyst for enhancing metacognitive awareness, which in turn promotes SRL. For instance, Zhang et al. (2022) found that metacognitive strategy use evolves in response to prior knowledge and motivation, suggesting that teacher assessment practices can create conditions conducive to the development of such strategies (Zhang et al., 2022).

The positive relationship between teacher classroom assessment and metacognitive awareness is further supported by studies emphasizing the role of feedback and reflection in metacognitive development (Dignath, 2021; Versteeg et al., 2021). When teachers employ assessment practices that provide constructive feedback and encourage self-reflection, students are more likely to develop an awareness of their cognitive processes and learning needs (Afshari et al., 2022). This, in turn, facilitates the adoption of effective learning strategies and enhances SRL (Rezapour Mirsaleh & Shakeri, 2018). The findings of this study also resonate with research by Vosniadou et al. (2021), who demonstrated that beliefs about self-regulation predict the use of cognitive and metacognitive strategies, ultimately influencing academic performance (Vosniadou et al., 2021). By fostering metacognitive awareness through assessment practices, teachers can help students internalize these beliefs and develop the skills necessary for SRL.

The direct effect of metacognitive awareness on SRL is consistent with a growing body of literature that highlights the centrality of metacognition in learning (Asdolahzadeh et al., 2021; Fan et al., 2022). Metacognitive awareness enables students to regulate their learning processes, adapt strategies in response to challenges, and maintain motivation over time (Babaei-Monqari et al., 2022). This study's findings reinforce the idea that metacognitive awareness is not merely a byproduct of SRL but a critical mechanism through which SRL is achieved (Safarzadeh & Jayervand, 2019). Moreover, the mediating role of metacognitive awareness suggests that interventions aimed at enhancing SRL should focus on developing students' metacognitive skills, particularly in the context of teacher assessment practices (Nikpay et al., 2016).

While the results of this study provide valuable insights, they must be interpreted within the context of certain limitations. First, the reliance on self-report measures for metacognitive awareness and self-regulated learning (SRL) may introduce biases, such as social desirability or recall inaccuracies. Future research could benefit from incorporating more objective measures, such as observational data or performance-based assessments, to enhance the validity of the findings. Second, the cross-sectional design of the study limits the ability to establish causality. Longitudinal studies are needed to track the development of metacognitive awareness and SRL over time and to examine the sustained impact of teacher assessment practices. Third, the sample was restricted to secondary school students in a specific geographic location, which may limit the generalizability of the findings. Future research should aim to include more diverse samples, encompassing different educational levels, cultural contexts, and socioeconomic backgrounds.

Despite these limitations, the study offers several avenues for future research. First, there is a need to explore the specific assessment practices that most effectively promote metacognitive awareness and SRL. For instance,

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investigating how different types of feedback, such as descriptive versus evaluative, influence students' metacognitive development could provide valuable insights. Second, future studies could examine the role of teacher training and professional development in enhancing teachers' ability to implement assessment practices that foster SRL. Third, research could delve into the interplay between metacognitive awareness and other psychological factors, such as motivation and self-efficacy, within the context of SRL. Finally, employing advanced statistical methods, such as multi-level modeling or structural equation modeling with longitudinal data, could offer a more nuanced understanding of the relationships among the variables.

For educational practice, the findings of this study highlight the importance of integrating metacognitive awareness into teacher assessment practices. Teachers should design assessments that not only evaluate students' knowledge but also encourage them to reflect on their learning processes and strategies. Providing specific and constructive feedback can help students develop a deeper understanding of their strengths and areas for improvement, thereby enhancing their metacognitive awareness. Additionally, teachers can model metacognitive strategies, such as goal-setting and self-monitoring, to support students in developing SRL skills. Professional development programs should equip teachers with the necessary knowledge and skills to implement assessment practices that promote metacognitive awareness and SRL, ultimately fostering more effective and self-directed learners.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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