ISSN: 2583-7354

International Journal of Emerging Knowledge Studies

Publisher's Home Page: https://www.ijeks.com/

Fully Open Access

Research Paper

The Role of Self-Regulated Learning Strategies in Shaping Mathematics Outcomes of High and Low Performing Students

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DOI: https://doi.org/10.70333/ijeks-01-12-010

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Article Info: - Received : 13 October 2022 Accepted : 28 November 2022 Published : 30 December 2022

Abstract

This study investigates the role of self-regulated learning (SRL) strategies in determining mathematics attainment among high and low performing secondary school students. Mathematics, a cognitively demanding subject, requires not only procedural and conceptual knowledge but also personal regulation of learning behaviours and motivation. While several studies have acknowledged SRL as a powerful predictor of academic success, limited research has examined its differential influence on students with varying levels of academic achievement in mathematics. A quantitative, research design was adopted, involving 300 secondary school students categorized into high and low achievers based on their previous academic records. A self-developed Self-Regulated Learning Strategies Inventory and mathematics test score were used for data collection. The study examined metacognitive, motivational, behavioural, and cognitive strategy dimensions of SRL and correlated them with mathematics performance. Findings from statistical analysis using independent samples t-test and Pearson correlation indicated a significant positive relationship between SRL strategies and mathematics attainment.

Keywords: *Self-Regulated Learning, Mathematics Attainment, High Achievers, Low Achievers, Metacognition, Motivation.*

1. INTRODUCTION

Mathematics performance among school students often varies widely, influenced by not only cognitive capabilities but also by students' learning behaviours **(Kliziene et al., 2022)**. Self-regulated learning (SRL) has emerged as a pivotal framework for understanding how students control their own learning processes **(Beishuizen, J., & Steffens, K., 2011). Zimmerman (2002)** describes SRL as a proactive process where learners set goals, monitor progress, and reflect on outcomes. In the context of mathematics, SRL is

ISSN: 2583-7354

especially crucial due to the subject's cumulative and hierarchical nature (Gu, P., & Lee, Y, 2019). Despite growing awareness, gaps remain in understanding how SRL differentially impacts students across performance levels.

This study aims to explore the influence of SRL strategies on mathematics attainment, particularly comparing high and low achievers, to uncover patterns that may guide targeted instructional practices.

2. REVIEW OF LITERATURE

Self-regulated learning (SRL) refers to the process by which learners actively plan, monitor, control, and reflect on their learning behaviours and strategies to achieve academic goals. Pintrich (2000) conceptualized SRL as a multidimensional construct involving cognitive, metacognitive, motivational, and behavioural components. These elements play a crucial role in complex subjects like mathematics, where continuous reflection, error analysis, and strategic thinking are necessary for problem-solving and conceptual understanding. The significance of SRL in mathematics education has been well-documented. Boekaerts and Corno (2005) emphasize that students who possess strong self-regulatory skills are more likely to persist in the face of mathematical challenges, adapt their strategies, and seek appropriate resources. Panadero (2017) reviewed various SRL models and concluded that effective self-regulation enhances mathematics learning outcomes by promoting deeper engagement and sustained effort. Metacognitive monitoring such as checking one's progress and adjusting problem-solving strategies was found to be a distinguishing trait among high achievers.

Zimmerman (2002), a leading scholar in SRL, introduced the triadic model that highlights the interaction between personal, behavioural, and environmental factors in learning regulation. His research suggests that high achievers tend to be more self-regulated because they regularly set specific goals, use feedback to adjust performance, and persist through difficulties. In contrast, low achievers often display learned helplessness, lack of motivation, and poor time management skills, all of which undermine their mathematical achievement (Cleary & Zimmerman, 2012). Empirical studies further support the association between SRL and mathematics attainment. Nota, Soresi, and Zimmerman (2004) found that self-regulated learners in high school mathematics classes demonstrated superior academic performance and were more likely to use strategies like elaboration, rehearsal, and organization. In an Indian context, Jaleel, and Premachandran (2016) investigated SRL among secondary school students in Kerala and reported that those with higher levels of self-regulation achieved significantly better results in mathematics. The study also highlighted a gender difference, where girls exhibited more strategic learning behaviour than boys.

Moreover, students' motivational beliefs such as self-efficacy and intrinsic value have been linked to their use of SRL strategies. According to Schunk and Zimmerman (2008), students who believe in their ability to succeed in mathematics are more likely to invest effort in planning and goal setting, which ultimately enhances learning outcomes. A study by Sun and Rueda (2012) also demonstrated that both motivation and SRL mediated students' performance in mathematics, especially when digital tools were integrated into instruction. Interestingly, few studies have examined how SRL strategies vary between high and low achievers within the same learning environment. Kramarski and Michalsky (2009) explored this dynamic in the context of mathematical problem-solving and found that SRL-based instruction significantly benefited low achievers, helping them close the performance gap. The study concluded that explicit teaching of metacognitive strategies such as self-questioning and planning can level the playing field for students with diverse achievement levels. Despite these insights, there remains a scarcity of research comparing SRL profiles of high and low performing students in Indian school settings. Given the influence of cultural, instructional, and socio-economic variables on learning behaviour, more localized studies are needed to understand how SRL can be effectively cultivated across diverse learner populations. The present study seeks to address this gap by examining how self-regulated learning strategies differ among high and low achievers in mathematics at the secondary level.

3. OBJECTIVES OF THE STUDY

- To assess the level of self-regulated learning strategies among high and low performing students in mathematics.
- To compare the use of SRL strategies between high and low achievers.
- To analyse the relationship between SRL strategy use and mathematics attainment.

4. HYPOTHESES

- There is no significant difference in the use of SRL strategies between high and low achievers.
- There is no relationship between SRL strategies and mathematics attainment.

5. METHODOLOGY

5.1. Research Design

The study adopted a quantitative research design to investigate the role of self-regulated learning (SRL) strategies in shaping mathematics outcomes among high and low performing secondary school students. This design was chosen because it allows for systematic comparison of two distinct groups high achievers and low achievers based on their use of SRL strategies and mathematics performance. The approach is appropriate for establishing statistical differences and relationships among the variables of interest using numerical data and inferential analysis.

5.2. Population and Sample

The target population for the study consisted of secondary school students studying in classes IX and X from various government and private schools in Tirunelveli district. A purposive sampling technique was employed to select a sample of 300 students. These students were categorized into two equal groups: 150 high achievers and 150 low achievers. The classification was based on students' academic records in mathematics over the previous two consecutive academic terms. High achievers were those consistently scoring 75% and above in mathematics, while low achievers scored below 50%. Equal representation from both gender groups and school types (government and private) was ensured to avoid sampling bias and promote generalizability within the district context.

5.3. Tools and Instruments Used

(i) Self-Regulated Learning Strategies Inventory (SRLSI)

A self-developed and validated inventory was used to measure students' self-regulated learning strategies. The inventory was designed based on theoretical frameworks by **Zimmerman (2002) and Pintrich (2000)**, encompassing four key dimensions:

- Cognitive strategies (e.g., rehearsal, elaboration)
- Metacognitive strategies (e.g., planning, monitoring, evaluating)
- Motivational regulation (e.g., effort regulation, intrinsic goal orientation)
- Behavioral strategies (e.g., time management, help-seeking)

The final version of the inventory contained 40 items (10 items per component), rated on a 5-point Likert scale ranging from "Strongly Disagree (1)" to "Strongly Agree (5)."

The inventory was subjected to expert validation and a pilot study. The Cronbach's alpha for internal consistency was calculated to be 0.87, indicating high reliability.

(ii) Mathematics Attainment

The high and low achieving students were selected based on students' academic records in mathematics over the previous two consecutive academic terms.

5.4. Procedure for Data Collection

Prior to data collection, permission was obtained from school authorities, and informed consent was secured from students and their parents. The researcher personally administered the tools during regular school hours in a controlled environment. The SRL inventory was administered and the mathematics score of the students were collected.

5.5. Statistical Techniques Used

The data collected was subjected to statistical analysis using SPSS software. The following techniques were used:

- Descriptive Statistics: Mean and standard deviation were calculated
- Independent Samples t-Test: Conducted to compare the mean SRL scores (and subcomponents) between high and low achievers, thereby testing for statistically significant differences.

- Pearson Correlation Coefficient: Employed to determine the strength and direction of the relationship between SRL strategies and mathematics attainment across the total sample.

6. FINDINGS

Table 1: Mean and Standard deviation of Self-Regulated Learning by Gender

Gender	N	Mean	SD
Male	160	74.10	8.95
Female	140	76.20	9.35
Total	300	75.02	9.18

The table 1 shows the average self-regulated learning (SRL) scores of male and female students. From the results, that female students have a slightly higher average SRL score (76.20) compared to male students (74.10). The standard deviation (SD) values 8.95 for males and 9.35 for females. Both groups show a good level of self-regulation, the data hints that female students may be slightly more consistent and engaged in managing their own learning, such as planning, setting goals, staying motivated, and seeking help when needed.

Table 2: Mean and Standard deviation of Mathematics Attainment by Gender

Gender	N	Mean	SD
Male	160	73.84	12.80
Female	140	76.94	11.45
Total	300	75.43	12.30

The table 2 presents the average mathematics attainment scores for male and female students. According to the data, female students scored a higher average (76.94) compared to male students (73.84). The standard deviation (SD) for males is 12.80, and for females, it is 11.45. Both boys and girls show reasonably good performance in mathematics.

Table 3: Mean and Standard deviation of Self-Regulated Learning by locality

School Locality	N	Mean	SD
Urban	180	77.55	8.78
Rural	120	71.84	9.21
Total	300	75.02	9.18

This table 3 shows how students from urban and rural schools differ in their self-regulated learning (SRL) strategies. The results reveal that urban students have a higher average SRL score (77.55) compared to rural students (71.84). The standard deviation values 8.78 for urban and 9.21 for rural students. students from urban schools tend to be more self-regulated learners than those from rural schools. This difference might be influenced by factors like better access to educational resources, technology, teaching methods, or parental support in urban areas.

Table 4: Mean and Standard deviation of Mathematics Attainment by locality

School Locality	N	Mean	SD
Urban	180	78.40	10.90
Rural	120	71.22	12.85
Total	300	75.43	12.30

This table 4 shows the differences in mathematics attainment between students from urban and rural schools. The data reveals that students in urban schools have a higher average score (78.40) compared to those in rural schools (71.22). The standard deviation for rural students is 12.85, which is higher than that of urban students (10.90). This difference could be due to several factors such as availability of qualified teachers, access to learning materials, exposure to technology, or home learning environments.

Table 5: Independent Samples t-Test Comparing SRL Scores Between High and Low Achievers

SRL Component	Group	Mean	SD	t-value	Remark
Cognitive Strategies	High Achievers	20.67	1.94	9.85	S
	Low Achievers	16.81	2.13		
Metacognitive Strategies	High Achievers	20.14	2.05	10.12	S
	Low Achievers	15.92	2.48		
Motivational Regulation	High Achievers	21.67	1.84	8.74	S
	Low Achievers	17.56	2.24		

Behavioural Strategies	High Achievers	20.23	1.91	7.48	S
	Low Achievers	16.24	2.17		
Overall SRL	High Achievers	82.45	6.32	17.23	S
	Low Achievers	67.58	7.14		

The results in Table 5 show a clear difference in self-regulated learning (SRL) strategies between high and low achievers in mathematics. High achievers scored higher in all areas of SRL cognitive, metacognitive, motivational, and behavioural strategies as well as in their overall SRL score. high achievers had an average overall SRL score of 82.45, while low achievers scored 67.58. This pattern was consistent across all components, and the t-test results showed that these differences were statistically significant. Mathematically strong students are better at SRL strategies and Low achievers, on the other hand, frequently struggle with these abilities, which could have an impact on their performance and learning.

Table 6: Relationship between Self-Regulated Learning and Mathematics Attainment

Variable		Self-Regulated Learning	Mathematics Attainment
Self-Regulated Learning	Pearson Correlation	1	0.64
	Sig. (2-tailed)		.000
	N	300	300
Mathematics Attainment	Pearson Correlation	0.64	1
	Sig. (2-tailed)	.000	
	N	300	300

Table 6 shows the relationship between students' self-regulated learning (SRL) and their mathematics attainment using Pearson's correlation coefficient. The correlation value is 0.64, which indicates a strong positive relationship between the two variables. This means that students who are better at regulating their own learning through strategies tend to perform better in mathematics. This finding highlights the importance of encouraging SRL skills in students to help boost their academic success.

7. DISCUSSION

The findings of this study reveal a strong and meaningful relationship between students' use of self-regulated learning (SRL) strategies and their mathematics attainment. Students who performed well in mathematics consistently showed higher use of SRL strategies and effort compared to low achievers **(DiFrancesca et al., 2016)**. This suggests that SRL plays a vital role in academic success, particularly in challenging subjects like mathematics **(Sun et al., 2018)**. These findings are consistent with the work of **Zimmerman (2002)**, who emphasized that self-regulated learners take active control of their learning processes, which leads to better academic performance. Similarly, **Panadero (2017) and Cleary & Zimmerman (2012)** found that high achievers tend to be more metacognitively aware, motivated, and behaviourally engaged in their studies, which enhances their problem-solving skills and persistence in mathematics.

The gender-based findings also align with previous research. In this study, female students showed slightly higher SRL scores and mathematics attainment than male students, which supports the observations of Zimmerman & Martinez , who found that girls are generally more strategic and organized in their learning behaviours **(Zimmerman & Martinez-Pons, 1990)**. While the difference is not vast, it suggests that girls may engage more consistently in learning routines that support academic success. Another important observation is the disparity between urban and rural students. Students from urban schools showed significantly higher SRL scores and mathematics attainment than those from rural schools. This may be due to differences in access to educational resources, teacher quality, and home support systems. **Sun and Rueda (2012)** reported similar findings, where students with better access to structured learning environments and motivation-enhancing tools showed stronger SRL and better performance **(Liu, 2012)**. This suggests a need to strengthen learning support systems and SRL development programs in rural settings to bridge the gap.

Not all studies have found a straightforward relationship between SRL and academic performance. For example, **Dent and Koenka (2016)** in their meta-analysis found that while SRL is generally associated with achievement, the strength of this relationship can vary based on age, subject area, and context. They noted that in some cases, students may report high SRL use but still underperform due to poor implementation or lack of feedback. This could explain some of the variability in scores seen within each group in this study. The strong positive correlation ($r = 0.64$) between overall SRL and mathematics attainment in this study reinforces the idea that improving SRL could be a valuable strategy for boosting mathematics performance, particularly for low achievers. The present study confirms that SRL is a powerful predictor of mathematics success. The differences observed across gender, locality, and achievement levels suggest that targeted interventions especially for low-achieving and rural students could help reduce academic gaps and promote more equitable learning outcomes.

8. CONCLUSION AND IMPLICATIONS

This study set out to examine the influence of self-regulated learning (SRL) strategies on mathematics attainment among high and low performing secondary school students. The findings provide clear evidence that SRL plays a significant role in shaping students' academic outcomes, particularly in the domain of mathematics. High achievers consistently demonstrated greater use of cognitive, metacognitive, motivational, and behavioural SRL strategies compared to their low-achieving peers. A strong positive correlation between overall SRL and mathematics performance was also found, suggesting that students who actively manage their learning tend to perform better. One of the most important conclusions drawn from this research is that SRL is not an innate ability limited to high achievers but a set of skills and habits that can be taught and developed over time. The consistent difference in SRL scores between high and low achievers highlights the need for deliberate efforts to nurture self-regulation among students who are struggling academically. The data also revealed that female students and those from urban schools reported higher SRL and achievement scores, indicating that environmental and socio-cultural factors may influence students' ability to regulate their learning. Given the strong link between SRL and mathematics attainment, it becomes essential for educators to integrate SRL skill development into everyday classroom practices. Teachers should receive training on how to embed SRL techniques such as goal setting, planning, self-monitoring, and reflection into their teaching. Likewise, students should be explicitly taught how to take ownership of their learning process through activities that promote self-questioning, time management, and persistence.

The implications of this study are particularly relevant in the Indian educational context, where students often rely heavily on rote memorization and teacher-directed learning. By fostering self-regulation, we can shift the focus from passive absorption of content to active, independent learning. This is especially important for low-achieving students, who often lack confidence, direction, and effective strategies for improving their performance. Tailored interventions, including study skill workshops, mentoring, and SRL-focused tutorials, could help these students improve their learning outcomes and develop a stronger academic identity. Moreover, the urban-rural divide observed in this study points to a need for equity-based interventions. Students in rural areas may lack access to the same resources, teaching quality, and learning environments as their urban peers, affecting their ability to engage in self-regulated learning. Schools in rural settings could benefit from resource-rich environments, digital learning platforms, and training programs that specifically target SRL enhancement.

In conclusion, this study reaffirms the importance of self-regulated learning strategies in academic achievement and calls for a systematic focus on building these skills among all students. Equipping learners with SRL abilities not only supports better performance in mathematics but

ISSN: 2583-7354

also lays the foundation for lifelong learning, critical thinking, and academic resilience. Future research could expand on these findings by incorporating longitudinal designs and exploring the effectiveness of specific SRL interventions across diverse educational contexts.

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Cite this article as: Dr. A. Pio Albina and A. Anula Hyasinth., (2022). The Role of Self-Regulated Learning Strategies in Shaping Mathematics Outcomes of High and Low Performing Students, International Journal of Emerging Knowledge Studies. 1(12), pp.64-70. https://doi.org/10.70333/ijeks-01-12-010