



Vol. 3 No. 2 (February) (2025)

## Relationship between Self-Regulated Learning, Students' Academic Engagement and Achievement in Mathematics at Secondary Level

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### ABSTRACT

This study examines how self-regulated learning (SRL), academic engagement (AE), and achievement in mathematics are connected at the secondary level. The main objectives of the study were to assess the level of self-regulated learning (SRL), examine students' academic engagement (AE), evaluate their achievement in mathematics, and find the relationship between all the three variables. The research employed quantitative, correlational survey design. Data were collected from 925 Grade-10 students studying in public secondary schools across three selected districts of Punjab: Faisalabad, Lahore, and Rawalpindi. Main instruments were: 1. The Motivated Strategies for Learning Questionnaire (MSLQ), 2. The School Engagement Measure (SEM), 3. Students' mathematics achievement scores (BISE Grade-9 Result). Reliability of the instruments was confirmed through pilot testing. Permission was obtained from school administrations, and ethical guidelines were followed during the process of data collection. The findings of this study revealed that secondary school students displayed moderate to high levels score for self-regulated learning and academic engagement in mathematics. A strong positive relationship was found between them, and both variables were positively related to students' mathematics achievement. These results indicate that the performance in mathematics may be enhanced through developing students' self-regulated learning and academic engagement. The study is useful for the teachers who teach mathematics at secondary level.

**Keywords:** Self-Regulated Learning, Academic Engagement, Achievement, Mathematics, Secondary Level, Survey Research.

### Introduction

Self-regulated learning (SRL), academic engagement, and academic achievement are three constructs that have long been a subject of scholarly interest in the field of educational research. They have been researched separately, but their interrelationships, especially within the field of mathematics education is a worth studying issue to the researchers and policymakers. Mathematics is commonly considered to be a gateway subject to science, technology, and engineering (OECD, 2019). Therefore, it is important to know how learners control their learning, how they perform mathematical tasks, and the ways those behaviours are converted into quantifiable achievement to enhance the performance of individual students as well as the education system nationwide.



## Vol. 3 No. 2 (February) (2025)

Self-regulated learning is the construct in which students take responsibility of their learning activities. It consists of goal setting, tracking progress, time management, resource management and the ability to adjust strategies as needed (Zimmerman, 2002). Students with effective SRL abilities are more likely to be persistent in their approach to tasks, strategy of learning deeper, and are motivated to carry on with learning despite setbacks (Schunk and Zimmerman, 2011). Notably, these traits are not inborn, but they may be taught, modelled and practiced.

The concept of academic engagement closely parallels the SRL and has been defined as a multidimensional construct that includes behavioural, emotional, and cognitive aspects (Fredricks, Blumenfeld, and Paris, 2004). Engagement is demonstrated by the active involvement of students in classes, their interest in learning, and the use of higher-order thinking tools. Engagement is especially vital in mathematics education since the subject may require persistence, abstract thinking, and being able to persevere when things are not going well (Wang and Eccles, 2013). Disengaged students might engage in rote memorization or avoidance, as compared to engaged students who have higher chances of continuing to solve problems and finding some use to mathematical concepts in new situations.

Mathematical success does not only measure the level at which one learns but also a pointer of future academic and career prospects. The outcomes of large-scale examinations such as PISA have consistently shown that mathematical literacy is linked closely to a superior level of education and job opportunities (OECD, 2019). Nevertheless, cognitive ability is not the only factor that determines achievement. Motivation, self-regulation, and engagement roles are conclusive regarding performance and meta-analyses show a strong and consistent effect across cultures and grades (Dent and Koenka, 2016; Schneider and Preckel, 2017).

Interrelationships between SRL, engagement, and achievement are being conceptualized in integrated models more and more. Indicatively, the cyclic model of SRL developed by Zimmerman emphasizes forethought, performance and reflection as processes that in turn are congruent with dimensions of engagement like persistence, emotional involvement and cognitive effort (Zimmerman, 2002). These links are supported by empirical research. Students with planning and monitoring of learning are more likely to have an increased manifestation of engagement, and engagement, in turn, mediates the correlation between SRL and achievement (Martin and Marsh, 2006; Cleary and Kitsantas, 2017). This implies that not just is SRL a predictor of performance, but also a motivating factor behind the engaged learners who are characterized by active participation and investment.

## Literature Review

### Self-Regulated Learning (SRL) and its Sub-domains

Although self-regulated learning (SRL) is typically described as a holistic concept, researchers have suggested that the concept can be examined most effectively through its sub-domains in isolation (Pintrich and De Groot, 1990; Zimmerman, 2002). SRL in this study is operationalized using five sub-domains based on the Motivated Strategies for Learning Questionnaire (MSLQ).

**Self-efficacy:** Self-efficacy is the belief that students have that they can achieve success in academic activities (Bandura, 1997). It does not just happen to be confidence but rather a context based judgment that determines decisions, hard work and perseverance. Usher and Pajares (2009) noted that self-efficacy in Mathematics had been cited as one



## Vol. 3 No. 2 (February) (2025)

of the best predictors of problem-solving performance among middle school students despite prior achievement. Similarly, a meta-analysis by Multon, Brown, and Lent (1991) established a strong positive correlation between self-efficacy and academic achievement in all subjects.

**Intrinsic Value:** Intrinsic value is the interest, significance, and fun students have towards the learning activities (Deci and Ryan, 2000). It is the personal desire to do Mathematics not because of grades but because of its own intrinsic value. When students view Mathematics as significant or challenging, they will be more inclined to put in long-term efforts and use more intensive learning methods (Wigfield and Eccles, 2002). Intrinsic value in SRL studies motivates learners to develop mastery objectives and elaborate plans that result in improved long-term retention and transfer of mathematical knowledge (Pintrich, 2000).

**Test Anxiety:** Test anxiety is the state of worry and emotional distress of evaluative situations. Although a moderate level of anxiety can sometimes lead to a sharper focus, too much anxiety cripples performance by eating up working memory resources and limiting the effective utilization of strategies (Putwain and Symes, 2018). A study conducted by Ashcraft and Krause (2007) revealed that a high degree of Mathematics anxiety has a direct negative effect on performance in problem-solving tasks. Likewise, Owens et al. (2012) established that students who had high levels of anxiety levels reported lower occurrence of SRL strategies like planning and monitoring.

**Cognitive Strategies Used:** Cognitive strategies refer to the way students process, encode and store information. The most common ones are rehearsal (repetition), elaboration (paraphrasing, summarizing), and organization (structuring material) (Weinstein and Mayer, 1986). Cognitive strategy use enables students to encode abstract mathematical concepts into knowledge that could be retrieved and useful. Weinstein and Hume (1998) showed that elaboration and organization strategies enhance conceptual knowledge whereas Wolters and Pintrich (2001) revealed that high performing Mathematics students often used the strategies.

**Self-regulation:** It is defined by the supervision and control of mental, motivational, and behavioral procedures when learning (Zimmerman and Moylan, 2009). It encompasses time management, persistence, self-monitoring and reflection strategies. Pintrich and De Groot (1990) showed that self-regulation explained a large amount of variance in classroom performance in students over and above cognitive ability. Subsequent research has demonstrated that successful self-regulators are flexible in their approach, react positively to failures, and remain motivated in the long run (Cleary and Zimmerman, 2012).

All these dimensions signify the motivational will and strategic skill of learners applied to mathematics tasks (Schunk and DiBenedetto, 2020).

### SRL as Cyclic Process

Self-regulated learning as defined by Zimmerman (2002) is not merely a collection of skills in isolation but is an active process in which learners assume conscious control of their thoughts, feelings, and actions in an effort to realize their academic objectives. It is a cycle of three phases:

*Forethought Phase:* The learners establish goals, break down tasks and choose strategies.



## Vol. 3 No. 2 (February) (2025)

*Performance Phase:* Students execute plans, keep track of their energy and remain motivated

*Self-Reflection Phase:* learners analyze results, consider learning successes or failures and change future learning strategies.

Pintrich (2004) also stressed that these stages can be acquired in four areas namely cognitive, motivational, behavioural and contextual and SRL is a holistic process to learning. SRL is especially important in mathematics education. Mathematics can be long-term, abstract in thinking, and persevering. The existing research proves that students who have developed high self-regulatory strategies are more prepared to meet the cognitive challenges of mathematics, exhibit higher rates of persistence, and achieve better outcomes (Schunk and DiBenedetto, 2020; Panadero, 2017). A more recent study by Jansen et al. (2019) has shown that SRL was a predictive variable of persistence and success in online mathematics courses and Malmberg et al. (2022) indicated that metacognitive monitoring and adaptive strategy use are significant in both individual and collaborative problem-solving situations.

### **Students' Academic Engagement and its Sub-domains**

One of the most important constructs of the educational research has been academic engagement as it defines the level and quality of students' participation in learning (Fredricks, Blumenfeld, and Paris, 2004). Engagement is not merely based on compliance with the routine of the classroom, but it represents a psychological energy expended upon getting knowledge, learning, and utilizing the same (Skinner and Pitzer, 2012). Engagement in mathematics education is a mediator of motivation and achievement in domains where persistence and effort frequently help a person to overcome conceptual obstacles (Kahu and Nelson, 2018).

**Behavioural Engagement:** Behavioral engagement is the open involvement of students in the academic activities. This will involve attending classes on time, doing homework, classroom conversations and following the norms of the institution (Finn and Zimmer, 2012). This is absolutely necessary in mathematics where the skills accumulate in a cumulative way, and the behavioural involvement is essential.

**Emotional Engagement:** Emotional engagement refers to the emotional responses of students to the learning process such as feelings of interest, enjoyment, belonging, and valuing the tasks (Reschly and Christenson, 2012). This dimension is particularly relevant because mathematics can evoke both the other types of emotions, e.g. curiosity and excitement as well as anxiety and frustration.

**Cognitive Engagement:** The cognitive engagement is the intellectual effort; the students put in learning an academic content. It entails the use of deep learning techniques, critical thinking, and self-control (Pintrich and De Groot, 1990). Cognitively engaged students do not just memorize but also, they build meaning.

### **Academic Achievement in Mathematics**

One of the most commonly studied constructs in the educational research is academic achievement due to the fact that this construct determines how successful students are to achieve the desired learning outcomes of their formal education. Conventionally, achievement has been viewed as performance in standardized tests, school grades or course completion (Ames, 1992). Newer approaches, though, acknowledge achievement not in terms of cognitive learning products but rather as including non-cognitive factors like persistence, self-discipline, and carefully regulating both effort and self-discipline



## Vol. 3 No. 2 (February) (2025)

(McClelland et al., 2015). In this respect, academic achievement is to be conceived as a multidimensional construct, which integrates subject-specific content mastery, problem-solving, and reasoning on the one hand, and behavioural expressions (consistent effort, persistence, and adaptive learning strategies) on the other.

In the recent decades, Mathematics achievement has become a highly discussed issue due to its high predictive power of future academic and career achievement in the science, technology, engineering, and mathematics (STEM) areas (OECD, 2019). Mathematics is associated with critical thinking, logical reasoning, and problem-solving, and these are competencies that are critical in succeeding in the present knowledge-based economies. In most countries, however, including Pakistan, mathematics performance at secondary level is still a great concern.

### **Statement of the Problem**

Performance of students in mathematics at secondary level is a serious concern throughout the world. Most of the students find it difficult to perform well in this subject. Several studies show that self-regulated learning and academic engagement are important factors for success in mathematics. Self-regulated learning helps students in planning, monitoring, and improving their learning. Academic engagement shows how actively they take part in lessons. Recent studies also show that self-regulated learning is connected with better academic engagement and achievement in mathematics (Li et al., 2022; Duru & Eya, 2021; Huang & Zhang, 2021). However, most of the studies conducted at limited groups or specific contexts, and little is known about how self-regulated learning and academic engagement work together for secondary school students. The present study will examine the relationships between self-regulated learning, academic engagement, and mathematics achievement at the secondary level to add the literature in this research gap. It is important to understand the relationship between these variables to develop strategies that can improve students' performance in mathematics (Salma & Alsa, 2023; Schunk & DiBenedetto, 2020).

### **Objectives of the Study**

Following research objectives were formulated for this study to:

Measure self-regulated learning and academic engagement of students in mathematics at secondary level

Find students' achievement in mathematics at secondary level

Determine the relationship between self-regulated learning, academic engagement and achievement in mathematics at secondary level

### **Limitations and Delimitations of the Study**

This study is restricted to the secondary school students of Punjab and to mathematics subject only. The research was also constrained by the time factor to include only public schools.

### **Research Design**

The research design was correlational survey design, which explored relationship among self-regulated learning, academic engagement and mathematics achievement of 10<sup>th</sup> grade students in the province of Punjab, Pakistan. Correlational research design was selected due to the possibility of identifying and quantifying statistical relations among the variables without affecting the setting of the study in any way (Fraenkel, Wallen, & Hyun, 2019).

### **Population**



## Vol. 3 No. 2 (February) (2025)

The research population was composed of students at secondary level in the secondary schools of Punjab, Pakistan.

### Sample and Sampling Technique

A total of 925 (539 female 386 male) students at public secondary schools were selected from three districts; Faisalabad, Lahore and Rawalpindi for this study. In the second stage, random sampling was used to select schools within each district, and ten schools were selected from each district to collect data. Finally, within each selected school, simple random sampling was applied to select students from the 10<sup>th</sup> grade who had completed their 9<sup>th</sup>-grade examination. The age range of the students was 14 - 17 years.

**Table 1:** Sample data characteristics

Characteristic	Category	N	%
Gender	Female	539	58.3
Gender	Male	386	41.7
District	Faisalabad	300	32.4
District	Lahore	300	32.4
District	Rawalpindi	325	35.1
Academic Stream	Arts	262	28.3
Academic Stream	Science	663	71.7
Parents' Qualification	Graduate	106	11.5
Parents' Qualification	Intermediate	134	14.5
Parents' Qualification	MPhil	22	2.4
Parents' Qualification	Matric/Under	652	70.5
Parents' Qualification	Matric		
Parents' Qualification	PhD	11	1.2
Parents' Profession	Businessman	206	22.3
Parents' Profession	Govt. Job	121	13.1
Parents' Profession	Labourer	385	41.6
Parents' Profession	Private Job	213	23.0

Table 1 indicates the characteristics of sample data. Table shows that there are 925 students (females = 539) from three districts: Faisalabad ( $N=300$ ), Lahore ( $N=300$ ) and Rawalpindi ( $N=325$ ). The number of science group students is 663 and 262 students belong to arts group. Majority of the parents are matriculate or have education below matric (70.5 %), 14.5 % of parents have intermediate qualification, 11.5 % are graduates, 2.4 % MPhil and 1.2 % have PhD qualification. Similarly, majority of the parents (41.6 %) are labourers, 23 % do private jobs, 22.3 % have their own business and 13.1 % have government jobs.



## Vol. 3 No. 2 (February) (2025)

### **Instrumentation**

Following instruments were used for the collection of data.

Motivated Strategies for Learning Questionnaire (MSLQ)

School Engagement Measure (SEM)

Students' Academic Achievement in Mathematics

### **Motivated Strategies for Learning Questionnaire (MSLQ)**

Self-regulated learning in Mathematics was measured using the Motivated Strategies for Learning Questionnaire (MSLQ) that was developed by Pintrich and De Groot (1990) for junior high school students. The MSLQ comprises 44 items with five sub-domains (self-efficacy, intrinsic value, test-anxiety, cognitive strategy use, self-regulation) in a seven-point Likert-scale of 1 (Not at all true of me) to 7 (Very true of me). The instrument measures motivational beliefs and learning strategies and therefore has a holistic measure of SRL. The reliability and validity of MSLQ have been proved to be effective in a wide range of contexts in different systems of education (Duncan & McKeachie, 2005; Pintrich et al., 1993). It has been translated into many languages to use in several countries for research purposes. In this study, it has been translated into Urdu for the convenience of students. Its Urdu translation was done by language experts and validated by experts in the field of Education.

### **School Engagement Measure (SEM)**

School Engagement Measure (SEM) that was developed by the MacArthur was used to measure academic engagement in Mathematics among students (Fredricks et al., 2005). SEM measures three sub-domains; behavioural, emotional, and cognitive engagement. It consists of 19 items measured on a 5- point Likert scale. To ensure uniformity and convenience of use, the instrument was modified to a 7-point Likert Scale by the researcher to correspond to the MSLQ so that students would be able to follow the same range of responses across the two questionnaires. The SEM has been adequately utilized in studies on engagement where it has demonstrated good internal reliability and construct validity (Fredricks et al., 2005; Veiga et al., 2014). For the convenience of students, SEM was translated into Urdu language by language experts.

### **Students' Academic Achievement in Mathematics**

To measure students' academic achievement in mathematics, their obtained marks of mathematics in the Grade-9 Examination of BISE 2023 were considered as their academic achievement. This information of obtained marks was attained through the instrument, and it was included in the part of demographic information.

### **Administration of Instrument**

The two main instruments, MSLQ and SEM, were used together for the convenience of the students simultaneously in the form of self-report questionnaire. Students were asked to answer all the items themselves by evaluating the items or statements in accordance with their experiences and perceptions. Both the instruments have been translated into Urdu languages and provided to the students in both languages (bilingual) for the convenience of the students. The first language of the students, participated in this study is not English. That is why bilingual questionnaires were used to collect data.

The students responded to 63 statements, provided marks obtained in Mathematics and demographic data about their parents' qualifications and professions. They were given sufficient time of about 30 minutes to respond to all statements. The researcher himself administered the instruments in male schools. In female institutions, the concerned



## Vol. 3 No. 2 (February) (2025)

teachers were requested to administer the instruments with the same directions given to male students. First, the researcher told them the purpose of data collection and information about instruments. After understanding the procedure, the concerned female teachers administered the instruments.

### Validity and Reliability of the Instruments

The two standardized tools used in the study; the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich & De Groot, 1990), and School Engagement Measure (SEM) (Fredricks et al., 2005) have been used frequently in educational psychological research and documented to be used with numerous different cultural contexts. However, since the above measures required contextual and linguistic adjustments for this study, further steps were taken to assure its validity and reliability in the local context.

### Validity Procedures

**Content Validity:** Content validity was identified by a panel of five experts in educational psychology, measurement and Mathematics education. They tested relevance, clarity and the appropriateness culturally, after translation into Urdu. The final version was based on the opinion of these experts thus aligned it to the objectives of the study as well as the cultural context.

**Face Validity:** Face validity was assured using a clear layout, proper font size and even spacing of the questionnaires created in MS Word to help alleviate reading problems. A pilot test conducted among 30 students at the secondary level confirmed that the items were not difficult to understand and minor changes in wording were done to increase clarity.

**Construct Validity:** The long history of previous application of both instruments and the fact that their factor structures are consistent with theoretical explanations (Pintrich and De Groot, 1990; Fredricks et al., 2005) support greatly the fact that the instruments have construct validity.

### Reliability Procedures

Internal consistency Cronbach's alpha was verified through SPSS with the aggregated data in regard to both instruments (63 items). The reliability coefficient of the analysis was 0.916, and it is higher than a commonly accepted value of 0.70, which shows the excellent internal consistency (George & Mallery, 2019). In the previous research, reliability coefficients of MSLQ have been reported as between 0.74 and 0.93 (Pintrich et al., 1993) and reliability coefficient in SEM has been shown between 0.78 and 0.88 (Fredricks et al., 2005).

**Table 2:** Reliability analysis (internal consistency) of MSLQ & SEM

Reliability Statistics	
Cronbach's Alpha	No. of Items
.916	63



## Vol. 3 No. 2 (February) (2025)

### Data Collection

The researcher undertook field work to guarantee the validity and adequacy of data collection. The students were provided with clear instructions so that they may respond easily and accurately. The instrument was designed in both languages; English and Urdu so that the students may read and understand all the items easily. The instrument in bilingual form to ensure the accuracy of responses is necessary in multilingual education (Singh, 2017).

Besides responses of the students for 63 items, mathematics achievement scores of the students were also acquired. The students were asked to self-report their scores of mathematics in G-9 BISE Exam in the questionnaire. It was difficult to some extent because some students had forgotten their obtained marks in mathematics. So, they were provided assistance to access the necessary information by using the website of Board of Intermediate and Secondary Education (BISE) on the spot. This process was relatively tedious but guaranteed successful data on Mathematics achievement and thus aided in the strength of the dataset.

### Data Analysis

The statistical package for social sciences (SPSS-26) was used to analyze the collected data. According to educational research, it is considered one of the most widely used tools to analyze quantitative data (Pallant, 2020). Before the analysis of the data, it was screened to identify missing values and outliers. Data pertaining to missing responses were handled by assigning the mean score of the specified item. It is the common approach to deal with missing data on the recommendations of surveying studies (Tabachnick & Fidell, 2019).

Frequency, percentage, mean, and standard deviation were calculated on each item. The composite score of the sub-domains of self-regulated learning (SRL) and academic engagement (AE) was also calculated. This gave a detailed description of the responses of the students and helped to derive the trends of the findings (Creswell & Creswell, 2018).

In the case of inferential statistics, the product-moment correlation coefficient by Pearson was used to analyze the bivariate correlations between self-regulated learning, academic engagement, and the achievement in mathematics. It was suitable to find the strength and direction of linear relationships (Field, 2018). It identified the extent of each predictor contributing to students' Mathematics achievement, while controlling for the effect of the other variable (Tabachnick & Fidell, 2019). Mean and standard deviation were used to find the level of self-regulated learning and Academic Engagement whereas for achievement in Mathematics their obtained marks in Grade-9 BISE Exam were considered.



Vol. 3 No. 2 (February) (2025)

Results and Discussion

Table 3: Descriptive statistics

	N Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	SD Statistic	Skewness Statistic	SE	Kurtosis Statistic	SE
Marks Obtained	925	3.0	75.0	36.674	16.6140	.365	.080	-.567	.161
BE	925	1.00	7.00	5.5194	.96232	-.295	.080	-.295	.161
EE	925	1.00	7.00	5.5551	.91943	-.975	.080	1.569	.161
CE	925	1.75	7.00	5.3291	1.02487	-.802	.080	.588	.161
AE	925	1.72	7.00	5.4679	.74418	-.838	.080	1.465	.161
SE	925	1.67	7.00	5.5185	1.02035	-1.012	.080	.952	.161
IV	925	1.00	7.00	5.8261	.92906	-1.390	.080	2.659	.161
TA	925	1.00	7.00	5.1187	1.33481	-.714	.080	.096	.161
CSU	925	1.69	7.00	5.4337	.78720	-.916	.080	1.125	.161
SR	925	1.67	7.00	4.9662	.79223	-.019	.080	.790	.161
SRL	925	2.44	6.73	5.3727	.67165	-1.010	.080	1.274	.161
Valid N (listwise)	925								

Table 3 displays the descriptive statistics of the study variables. The variable Marks Obtained ranged from 3 to 75, with an overall mean of 36.67 (SD = 16.61), indicating moderate achievement levels with considerable variability in performance. Parents' qualification (coded 1-5) had a mean of 1.493 (SD = .87), suggesting that most parents' education was clustered around lower categories (Matriculation or below). Parents' profession (coded 1-4) showed a mean of 2.932 (SD = 1.08), reflecting greater representation of families engaged in labour and private-sector employment.

For the constructs of academic engagement, the mean scores were relatively high across dimensions: behavioral engagement (BE = 5.52, SD = .96), emotional engagement (EE = 5.56, SD = .92), and cognitive engagement (CE = 5.33, SD = 1.02). The overall academic engagement composite (AE) recorded a mean of 5.47 (SD = .74) on a seven-point scale, indicating strong engagement of students in mathematics learning.

Regarding self-regulated learning (SRL) strategies, the descriptive results also showed moderately high means: self-efficacy (SE = 5.52, SD = 1.02), intrinsic value (IV = 5.83, SD = .93), test anxiety (TA = 5.12, SD = 1.33), cognitive strategy use (CSU = 5.43, SD = .79), and self-regulation (SR = 4.97, SD = .79). The overall SRL composite mean was 5.37 (SD = .67), suggesting that participants reported a generally high level of self-regulated learning strategies in mathematics.

With respect to normality, skewness and kurtosis values for the main study variables (BE, EE, CE, AE, SE, IV, TA, CSU, SR, and SRL) were within acceptable ranges of  $\pm 2$  (George & Mallery, 2010; Kline, 2011), indicating that the data were approximately normally distributed and suitable for subsequent parametric analyses such as correlation and regression.



Vol. 3 No. 2 (February) (2025)

**Table 4:** Correlations between sub-domains of SRL, AE and mathematics achievement

	BE	EE	CE	SE	IV	TA	CSU	SR	SMEAN(MarksObtained)
BE	1								
EE	.443**	1							
CE	.241**	.479**	1						
SE	.207**	.389**	.616**	1					
IV	.367**	.529**	.704**	.713**	1				
TA	-.130**	.078*	.178**	.071*	.166**	1			
CSU	.276**	.427**	.607**	.584**	.687**	.170**	1		
SR	.418**	.402**	.455**	.445**	.558**	-.085**	.583**	1	
SMEAN(MarksObtained)	.107**	.094**	.169**	.251**	.173**	-.112**	.173**	.219**	1

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

Table 4 shows the Pearson product-moment correlation, Pearson tested the correlations of the sub-domains of academic engagement (behavioral engagement, emotional engagement, cognitive engagement), self-regulated learning (self-efficacy, intrinsic value, test anxiety, cognitive strategy use, self-Regulation) and mathematics achievement.

**Academic Engagement and Mathematics Achievement:** Findings showed that behavioural engagement was positively related with mathematics achievement,  $r(923) = .11, p = .001$ . Likewise, emotional engagement had a low but meaningful correlation with achievement,  $r(923) = +.09, p = .004$ . There was a stronger relationship in cognitive engagement with  $r(923) = .17, p < .001$ . Such findings indicate that higher behavioural, emotional, and cognitive engagement is associated with the better performance in mathematics.

**Self-regulated Learning and Mathematics Achievement:** Self-efficacy, the sub-domain of self-regulated learning that was the most positively correlated with achievement in mathematics,  $r(923) = .25, p < .001$ . Achievement was also positively correlated with intrinsic value,  $r(923) = .17, p < .001$ , and cognitive strategy use,  $r(923) = .17, p < .001$ . Self-Regulation was also positively correlated with achievement,  $r(923) = .22, p < .001$ . Conversely, Test anxiety showed that achievement had a significant negative correlation,  $r(923) = -.11, p = .001$ , and the higher the anxiety, the lower the performance in mathematics.

**Relationships between Academic Engagement and Self-regulated Learning:** The sub-domains of academic engagement and self-regulated learning had significant positive correlation with each other. Self-efficacy and Intrinsic value were significantly related to cognitive engagement,  $r(923) = .62, p < .001$ , and  $r(923) = .70, p < .001$ , respectively. There was a positive correlation between emotional engagement and intrinsic value,  $r(923) = .53, p < .001$ , and cognitive strategy use,  $r(923) = .43, p < .001$ . Behavioral engagement was positively related to self-regulation,  $r(923) = .42, p < .001$  and intrinsic value,  $r(923) = .37, p < .001$ . Moreover, self-efficacy correlated positively with all three areas of engagement at a range of  $r(923) = .21, r(923) = .62$  with a significance level of less than .001.

The findings affirm the fact that academic engagement and self-regulated learning have a significant correlation with mathematics achievement. Cognitive engagement was the most significant achievement-related predictor among other engagement sub-domains, whereas, among self-regulated learning, Self-efficacy and self-regulation had



## Vol. 3 No. 2 (February) (2025)

the most positive correlations. Conversely, test anxiety had negative relations with achievement. The fact that academic engagement and self-regulated learning are strongly correlated also suggests that these two concepts rely on one another to influence mathematics performance in students.

### Conclusion

The current study confirms the importance of self-regulated learning (SRL) and academic engagement (AE) in determining the academic performance of students in mathematics at secondary level. Both constructs were identified to have a positive relationship with the achievement of mathematics. SRL was found as a relatively stronger predictor. This shows that when the students plan, monitor and regulate their learning, their likelihood of succeeding in mathematics becomes higher.

In the SRL dimensions, self-efficacy and self-regulation were the strongest contributors to the achievement, and it is possible to conclude that students with strong self-belief and ability to hold themselves accountable in learning produce better outcomes. Conversely, the test anxiety was found to play a negative role hence the importance of implementing interventions aimed at assisting students to cope with emotional pressure when taking Mathematics tests. Though the effect of intrinsic value was not direct, the existence of this value is indicative of the motivational beliefs that can indirectly affect achievement. The use of cognitive strategies made a significant but weak impact, which emphasizes the need to instruct the students in the use of the learning strategies that are effective.

Behavioural and cognitive engagement were found to be important predictors of academic achievement in terms of academic engagement (AE). The result supports the notion that the engagement of students and their eagerness to put a mental effort into learning activities are more closely related to academic performance than emotional satisfaction on its own.

SRL and AE jointly contributed to an insignificant part of the variance in Mathematics achievement which agrees with the earlier study carried out in different international settings. This underscores the fact that SRL and AE are significant, but the attainment also depends on contextual factors in the teaching practice, school environment and the design of the school curriculum.

### Recommendations

On the basis of the findings of this study the following recommendations can be suggested:

- Curriculum developers must incorporate activities that enhance the five sub-domains of SRL and three sub-domains of engagement discussed in this study.
- SRL and AE frameworks should be prioritized in teacher education programs.
- The schools should provide cognitive and behaviorally supportive environment.
- The parents should be informed about the significance of SRL and AE through workshops and seminars.
- The students with low achievement in mathematics should be provided with intervention of SRL and AE.
- Formative assessment should be prioritized to minimize test anxiety of the students.



## Vol. 3 No. 2 (February) (2025)

- Longitudinal studies should be conducted in future to observe the impacts of SRL and AE in various subjects and grades.

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