Original Research Article

Exploring Students' Mathematics Performance Through Self-Regulated Learning

ABSTRACT

This study aimed to explore students' mathematics performance through self-regulated learning among first-year college students at a state college in the southern Philippines. A total of 333 students were selected using stratified random sampling, and data were gathered through surveys and academic records. Results indicated that students had a high level of self-regulated learning and achieved a 'very good' level of mathematics performance. Correlation analysis revealed a significant positive correlation between self-regulated learning and mathematics performance in blended learning. Furthermore, regression analysis identifiedgeneral self-regulation, goal-setting, resource-seeking, environment management, and time managementindicators of self-regulated learningas significant predictors of mathematics performance. Recommendations were made to enhance academic and extracurricular activities by integrating self-regulation strategies through self-reflective workshops, peer mentoring programs, and interactive learning sessions.

Keywords: self-regulated learning, college mathematics performance, blended learning

1. INTRODUCTION

Theeducational approaches, particularly in mathematics instruction, ~~has~~ havechanged a lot. We now need a deeper understanding of the factors influencing students' learning. Blended learning, which mixes traditional and online methods, has become a fundamental aspect of this new educational paradigm, providing a flexible approach that caters to the diverse needs of learners across the Philippines [1]. The challenge now lies in identifying and integrating non-cognitive factors that significantly affect learning outcomes. Recent studies have highlighted the importance of non-cognitive factors, such as students' attitudes and beliefs, in shaping their academic performance [2,3,4,5]. These factors, often overlooked, play animportant role in the development of effective mathematics learning interventions. Furthermore, students' preferences in the mathematics classroom have been shown to influence their engagement and success, suggesting a need for tailored educational experiences [6].

Self-regulated learning (SRL) emerges as a key component of student success in mathematics[7,8]. Self-regulated learners are aware of their educational strengths and weaknesses [9]. Zimmerman and Schunk [10] describe Self-Regulated Learning (SRL) as a method by which learners manage their motivation, ~~behavior~~behaviour, and emotions to achieve learning goals. It is crucial for student independence and academic development, especially with the growth of knowledge and technology [11].Ekuri and Offiah[12] suggested that self-regulatory skills should be instilled in students to encourage the application of study skills, build self-efficacy, and enhance academic motivation in mathematics. Proper use of digital learning devices in online learning can affect academic achievement [13]. Therefore, self-regulated learning is proposed as a strategy to enhance students' digital learning environments and academic performance [14].Samo[15]and Galizty&Sutami [14]found that increasing SRL improves students' mathematical abilities among students.

Despite the correlations, there remains a gap in research specifically in addressing the impact of SRL on mathematics performance within a blended learning setting. This study seeks to address this gap by examining the predictive indicators of SRL on mathematics performance among students in a state college in Southern Philippines. This research is emphasizing its potential to enhance mathematics education through targeted learning interventions, guided by a comprehensive understanding of both cognitive and non-cognitive factors.

This study is grounded in self-regulation theory (SRT) [16], which involves managing one's thoughts, ~~behaviors~~behaviours, and feelings to achieve goals. This suggests that students who effectively self-regulate, set and monitor goals, and maintain motivation are likely to improve their math performance. This framework highlights the importance of fostering self-regulation skills to enhance academic outcomes in mathematics.

2. OBJECTIVES

This study examined the impact of self-regulated learning on the mathematics performance of first-year college students at a state college in Southern Philippines during the first semester of the 2022-2023 school year. Specifically, it aimed to:

1. Determine the level of respondents' self-regulated learning in terms of:
   1.1 General self-regulation;
   1.2 Goal-setting;
   1.3 Resource-seeking;
   1.4 Environmental ~~management~~Management; and
   1.5 Time management.
2. Assess the mathematics performance of the respondents.
3. Identify the significant relationship between students' self-regulated learning and their mathematics performance.
4. Determine a regression model that best ~~fit~~ fitsself-regulated learning and mathematics performance.

3. MATERIALS AND METHODS

Research Design

A descriptive-correlational research design was used in this study to describe the variables and the natural relationships between them. This design is common in quantitative research as it involves gathering data from larger groups. The primary aim was to describe the level of self-regulated learning among college students. Additionally, the researchers sought to determine the significant relationship between self-regulated learning and mathematics performance during the first semester of the 2022-2023 school year. It was also aimed to identify which indicators of self-regulated learning significantly influence mathematics grades. Data were collected using surveys and academic records to measure students' self-regulated learning levels and mathematics performance, respectively.

Research Instrument

The research instrument used in this study was an adopted questionnaire from Bylieva et al. [17]. It measures various aspects of self-regulated learning, including general self-regulation, goal-setting, resource-seeking, environment management, and time management, each with its ~~own~~ acceptable reliability coefficients of 0.861, 0.673, 0.743,

0.809, and 0.839, respectively. The questionnaire consists of twenty-one statements, with responses ranging from strongly agree to strongly disagree.

Students' mathematics performance was assessed based on their final grade in the “Mathematics in the Modern World” course during the first semester of the 2022-2023 school year. Grades were obtained from the respective Institute Dean’s offices.

Respondents of the Study

The respondents of this study were first-year college students enrolled during the first semester of the 2022-2023 school year. They were proportionally distributed across the four institutes through stratified random sampling, and all were participating in blended learning. The randomly selected students completed the adopted survey questionnaire. The distribution of respondents is detailed in Table 1 below.

Table 1. Distribution of Respondents

INSTITUTE	POPULATION (N)	SAMPLE SIZE (n)	PERCENTAGE (%)
1	523	88	26.43
2	660	111	33.33
3	219	37	11.11
4	574	97	29.13
Total	**1,976**	**333**	**100.00**

Data Gathering

In gathering data for this study, the following steps served as guide for the researchers:

1. The researchers obtained permission to conduct the study by presenting a formal letter to the Vice President for Academic Affairs (VPAA) and the Deans of each institute, requesting approval to connect randomly selected first-year college students. Additionally, approval was sought and acquired from the registrar’s office to collect the "Mathematics in the Modern World" final grades of the selected respondents.
2. An adopted questionnaire was used as the data-gathering instrument. A general orientation on the scope and privacy of the study was provided before the respondents completed the questionnaire. Additionally, informed consent was obtained to collect the respondents' grades. Respondents were also allowed to withdraw from the study if they felt uncomfortable. The researchers administered the questionnaires to the respondents, monitoring the process.
3. After the respondents completed the questionnaires, all collected data were treated with utmost respect and confidentiality. The data were tallied, collated, and tabulated for processing and analysis. Tables were created to illustrate the data. The results were summarized and analyzed using appropriate statistical tools with the aid of statistical software.

4. RESULTS AND DISCUSSION

Level of Self-Regulated Learning of College Students

Self-Regulated Learning (General)

In Table 2, the mean score for general self-regulated learning is 4.03, indicating that students possess these skills to a great extent. This suggests that students have a high level of proficiency in using comprehensive learning strategies within blended learning environments. This finding is consistent with the study by Broadbent and Poon [18], which highlights that self-regulated learning strategies are crucial for academic success in blended learning contexts. Additionally, the research by Barnard-Brak, Paton, and Lan [19] supports the notion that students who effectively self-regulate their learning tend to perform better academically in online and blended learning environments.González [20] further asserts that effective self-regulation requires students to employ diverse strategies for planning, monitoring, and evaluating their learning activities, as well as managing their motivation and emotions. The effectiveness of students' self-regulated learning processes can vary based on their academic environment and personal goal orientations.

Self-Regulated Learning (Goals)

The mean score for self-regulated learning in goals is 4.08, indicating that students possess these skills to a great extent. This result suggests that students demonstrate significant effort and commitment to learning in a blended learning environment, aligning with Hashem's [21] finding that university students exhibit high levels of self-regulation in goal-setting. Students set goals by adjusting their learning strategies and methods even during distractions. This finding is consistent with Magsino [22] and Wang, Yang, and Li [23], who noted that setting short-term goals and organizing plans towards specific goals are effective strategies for achieving long-term aspirations.

Self-Regulated Learning (Resource-Seeking)

Self-regulated learning in resource-seeking has a mean score of 4.00, indicating that students greatly seek information through various means, such as asking others for help in the new normal. This aligns with Setyaningrum[24], who found that resource-seeking significantly rises in a blended learning environment in mathematics classes. Students with higher self-regulation skills participate in interactions to plan their learning activities, carry out self-assessments, and increase their self-confidence in problem-solving. They commonly seek help from others when necessary. What sets self-regulated learners apart is their goal of becoming more independent [25,26,22].

Self-Regulated Learning (Environment-Related)

Self-regulated learning in environment-related aspects has a mean score of 4.19, indicating that students are greatly aware of their learning settings, including physical spaces and the use of gadgets and internet connectivity in blended learning. This result relates to [22], who found that students generally exhibited a moderately high level of self-regulation in terms of environmental structuring, preferring environments conducive to their learning. Students are extremely mindful of their environment and find it important in blended learning. Akçayoğluand Dağgöl[26] found that students avoid distractions and prefer comfortable study places. However, students may face obstacles due to conflicts between family responsibilities and academic tasks during the pandemic [27,28].

Self-Regulated Learning (Time-Related)

Self-regulated learning in time-related aspects, as shown in Table 2 with a mean score of 3.99, indicates that students possess a strong sense of time consciousness in blended learning contexts. This reflects their ability to effectively allocate time for learning activities, supported by Akçayoğluand Dağgöl[26] findings on students' proficient time

management in online learning environments. This result aligns with [29,30] emphasis on time management as anessential self-regulation process for achieving academic goals through controlled scheduling and duration of essential activities.

Self-Regulated Learning (Overall)

The grand mean of 4.06 suggests that college students possess all indicators of self-regulated learning (SRL) to a great extent. This finding underscores the importance of their ability to plan goals and strategies, manage ~~behaviors~~behaviours, and evaluate self-improvement, especially in the current educational environment.This result resonates with the findings of Wolters and Brady[30] which ~~highlights~~ highlightthe pivotal role of time management in SRL among post-secondary students. Effective time management allows students to strategically plan and monitor their academic tasks, facilitating goal achievement and self-assessment. The study's emphasis on the interconnectedness of time management and SRL processes aligns with the high grand mean observed in this study, suggesting that students' proficiency in time management contributes significantly to their overall SRL abilities.Moreover, Wandler and Imbriale[31]discussed strategies to enhance SRL across diverse learning environments, including blended learning contexts. The article underscores that fostering SRL skills, such as goal setting and self-monitoring, leads to positive academic outcomes. The support provided by instructors in developing these skills is crucial, particularly in environments where students navigate between online and in-person learning components. This perspective reinforces the high grand mean of SRL found in this study, emphasizing the effectiveness of structured support in enhancing students' self-regulatory capacities.

Table 2: The Respondents' Level of Self-Regulated Learning

INDICATORS	MEAN	STD. DEVIATION	DESCRIPTION
General self-regulation	4.0300	0.82	High
Goal-setting	4.0763	0.85	High
Resource-seeking	4.0015	0.99	High
Environment management	4.1934	0.97	High
Time-management	3.9909	0.92	High
Self-Regulated Learning (Overall)	**4.0583**	**0.72**	**High**

Level of Mathematics Performance of College Students

Table 3 presents the mathematics performance of first-year college students at SPAMAST for the school year 2022-2023. A significant portion of respondents, comprising 55.56% of the total sample, exhibited a very good level of mathematics performance, indicating strong foundational knowledge and skills development. Additionally, 23.72% of the sample demonstrated a good level of mathematics proficiency, suggesting they possess fundamental skills but may require occasional guidance. Another 17.12% of respondents achieved a superior level, surpassing core requirements in both knowledge and skills. Conversely, 3.60% of the sample displayed a fair level of mathematics performance, indicating basic understanding but needing substantial assistance from teachers and peers. The average mathematics grade for the respondents in the school year 2022-2023 was 1.70, categorized as very good, with a standard deviation of 0.31. This suggests that, overall, students have developed solid knowledge and skills and can apply their understanding effectively across various tasks. While most respondents demonstrated a strong grasp of mathematics, a minority encountered challenges requiring additional support.

This outcome aligns with findings by Gabales et al. [32] andŽnidaršič et al. [33], which indicated that despite the challenges posed by the COVID-19 pandemic, college students' mathematics performance generally remained, with only minor or no negative effects of distance learning. A recent study at a college in southern Philippines among first-year college students also reported a very good level of performance in their Mathematics subject [34], reinforcing the strong academic standards observed in various disciplines despite ongoing educational disruptions.

Table 3: The Respondents' Level of Mathematics Performance

RANGE OF SCORES	DESCRIPTION LEVEL	FREQUENCY (f)	PERCENTAGE (%)
1.49-1.00	Superior	57	17.12
1.99-1.50	Very Good	185	55.56
2.49-2.00	Good	79	23.72
2.50-3.00	Fair	12	3.60

n=333; Mean= 1.70; SD= 0.31

Relationship Between the Self-Regulated Learning and Students' Mathematics Performance

Table 4 presents the relationship between the level of self-regulated learning and the mathematics performance of first-year college students. The obtained r-value for the indicator "General self-regulation" is 0.488, indicating a low correlation with mathematics performance. However, the p-value of 0.00, which is less than the 0.05 level of significance, indicates a significant relationship between the "General self-regulation" indicator and mathematics performance. This finding slightly ~~differ~~differs~~with~~ fromMagsino's[22] claim of a moderately high correlation between learning responsibility and student performance, albeit in the context of high school students, whereas this study focuses on college students.Students lacking adequate self-regulatory skills often encounter challenges in mathematics performance [35]. The study also aligns with previous research indicating that self-regulated adolescents are keenly aware of their educational strengths and weaknesses, set educational goals, and employ multiple strategies to achieve them [30].

The "Goal-setting" indicator has an ~~r-value~~R-value of 0.533, indicating a moderate correlation with math performance, and a p-value of 0.00, showing a significant relationship. This supports Wang et al.'s [36]claims that ~~goal-setting~~goal-setting and self-regulation are consistently associated with higher mathematics performance. It also aligns with Tee, Leong, and Rahim's [38] study, which found that self-regulation processes like goal-setting significantly influence math reasoning and achievement. Additionally, Gafoor and Kurukkan[8] highlight that having mastery goal orientation, an important part of self-regulated learning~~,~~ is linked to better achievement and positive attitudes in math education.

The "Resource-Seeking" indicator obtained an r-value of 0.466 suggests a low correlation with mathematics performance, yet the p-value of less than 0.05 indicates a significant relationship. This stresses the importance of effective resource management in student learning outcomes. Zheng and Zhang [39] emphasize that help-seeking ~~behaviors~~ behavioursare positively associated with academic achievement, including in blended classroom settings. Similarly, Lobczowski et al. [40] and Osborne [41] found that students who actively seek help from teachers and peers tend to perform better academically. These findings align with the study results, highlighting that students' ability to manage resources and seek assistance plays an important role in their math performance.

The "Environment-Related" indicator shows an r-value of 0.507, indicating a moderate correlation to mathematics performance, and a p-value of less than 0.05, implying

that the relationship exhibited is significant. This result matches findings by Magsino[22] and Ejubović&Puška[42], who found that how students set up their learning environment is important for their academic success. Magsino [22] observed that students who reduce distractions tend to do better in their studies. Ejubović&Puška[42] also noted that having a good learning space helps students focus and perform better. These studies show that managing the learning environment is key to improving math performance.

The indicator, "Time Related," has an ~~r-value~~R-value of 0.542, indicating a moderate correlation with mathematics performance, and a p-value of less than 0.05, showing this relationship is significant. This finding aligns with the study by Ahmad, Batool, and Choudhry [43], which confirmed that students' learning is strongly influenced by their time management skills, showing a strong positive relationship between time management and academic achievement. Additionally, Pelikan et al. [44] and Atmojo et al. [45] found that self-regulated learning related to time management contributes significantly to students' success in both traditional and online learning environments. This study supports these findings, highlighting the importance of effective time management in improving mathematics performance.

Consequently, the r-value of the overall self-regulated learning is 0.606, indicating a moderate correlation. This suggests a significant relationship between self-regulated learning and mathematics performance, as the p-value is less than the 0.05 level of significance. This means that a high level of self-regulated learning improves students' mathematics performance. These findings align with those of Çetin [46], who found that as university students' levels of self-regulated learning increased, their GPAs also significantly increased. Additionally, Lawrenceand Saileela[46] observed a positive relationship between self-regulation and achievement in mathematics among higher secondary students. This study supports these previous findings, highlighting the importance of self-regulated learning in enhancing academic performance.

Table 4. The Relationship between the self-regulated learning and students' mathematics performance in blended learning.

INDICATORS	r-VALUE	DESCRIPTION	p-VALUE
General self-regulation	0.488	Low correlation	<0.001
Goal-setting	0.533	Moderate correlation	<0.001
Resource-seeking	0.466	Low correlation	<0.001
Environment management	0.507	Moderate correlation	<0.001
Time-management	0.542	Moderate correlation	<0.001
Self-Regulated Learning (Overall)	0.623	Moderate correlation	<0.001

Regression Model that Best ~~fit~~ Fit Self-Regulated Learning and Mathematics Performance

Table 5 presents the summary of the stepwise multiple regression analysis, revealing that all indicators of self-regulated learning—General, Goal, Resource-Seeking Related, Environment Related, and Time-Related—significantly influence students' mathematics performance. The regression coefficients for these indicators are 0.043, 0.127, 0.113, 0.113, and 0.23, respectively, with each p-value being less than 0.05, indicating significant contributions to mathematics performance. The constant in the regression model is 1.916, and the model is:

$$y = 1.916 + 0.043x_1 + 0.127x_2 + 0.113x_3 + 0.113x_4 + 0.235x_5$$

general self-regulation, goal-setting, resource-seeking, environment management, and time management

where,

$x_1 = General\ self - regulation$
$x_2 = Goal - setting$
$x_3 = Resource - seeking$
$x_4 = Environment\ management$
$x_5 = Time\ management$
$y = Mathematics\ performance$

Further, the r^2 ~~value~~ value of 0.825 indicates that 82.50% of the variance in mathematics performance is explained by the regression model. Hence, this affirms the existence of a significant regression model that fits the relationship between Self-Regulated Learning (SRL) and Mathematics performance among college students.

This finding aligns with the study by Tee, Leong, and Rahim [38], which claimed that self-regulation processes, including goal setting, significantly influence student mathematical reasoning and academic achievement. Their research highlights the importance of ~~behavioral~~ behavioural and cognitive regulation processes in enhancing students' mathematical reasoning abilities and overall academic performance. The emphasis on goal setting and time management in their study corroborates the significant contributions of these SRL indicators to mathematics performance, as evidenced by the regression analysis. Moreover, Gafoor and Kurukkan[8] emphasize that mastery goal orientation, a key component of SRL, is positively associated with enhanced achievement and desirable affective outcomes in mathematics education. Their study underscores the interrelationship between self-efficacy and self-regulated learning, suggesting that students who set mastery-oriented goals are more likely to engage in effective self-regulation strategies, leading to improved academic outcomes. These findings further support the significant contributions of SRL indicators to students' mathematics performance, as evidenced by the regression analysis results.Therefore, self-regulated learning is a valuable skill to develop among students to better prepare them for blended learning environments. This approach is particularly effective in the face of disruptions and uncertainties in the delivery of education, such as those experienced during the COVID-19 pandemic where most of the campuses ~~where~~ were closed and governments imposed public health measures like wearing face masks, ~~practicing~~ practising proper sanitation, and maintaining social distancing [47], highlighting the need for adaptable and resilient learning strategies.

Table 5. Summary of Stepwise Multiple Regression Analysis

Predictor	Unstandardized Coefficients	p-value	Interpretation
(Constant)	1.916	0.000	Significant
General self-regulation	0.043	0.034	Significant
Goal-setting	0.127	0.000	Significant
Resource-seeking	0.113	0.000	Significant
Environment management	0.113	0.000	Significant
Time management	0.235	0.000	Significant

r^2 = 0.825

5. CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Based on the findings and statistical results of the study, the following conclusions were drawn:

1. With the five indicators of self-regulated learning considered in this study, it was shown that first-year college studentsduring the school year 2022-2023 exhibited a high level of self-regulated learning in mathematics. This indicates that in learning mathematics, students are independent regulators of their motivation and actions. Notably, the students maintained this high level of self-regulated learning despite the disruptions caused by COVID-19, showcasing their resilience and adaptability.

2. The students' grade point average in mathematics displayed a very good level of performance, demonstrating that students have developed fundamental knowledge and skills in the subject. Remarkably, this high level of mathematics performance was achieved despite the challenges posed by the COVID-19 pandemic, highlighting the effectiveness of their self-regulated learning strategies.

3. There is a significant relationship between students' self-regulated learning and their mathematics performance in a blended learning environment. Therefore, enhancing students' level of self-regulated learning can potentially improve their performance in mathematics.

4. The regression analysis revealed that all indicators of self-regulated learning - General, Goal, ~~Resource-seeking Related~~Resource-seeking-related, ~~Environment Related~~Environment-related, and Time-related, significantly influence students' mathematics performance. The regression coefficients for these indicators underscore the importance of self-regulated learning in achieving high mathematics performance, even amidst educational disruptions.

Recommendation

1. The college students display a high level of self-regulated learning. It is recommended to continue to foster these skills among the students and their peers by designing meaningful classroom and school activities that boost self-regulated learning in mathematics. Additionally, increasing students' awareness about the positive effects of self-regulation on mathematics performance in blended learning is important.

2. Although the respondents display a very good level of mathematics performance in blended learning, many students still struggle with the subject. Therefore, it is recommended to develop and implement intervention programs that address the specific learning needs of these students, particularly during ~~the~~ challenging times.

3. Given the significant correlation between students' self-regulated learning and their mathematics performance, it is recommended to strengthen self-regulation skills by incorporating self-reflective class activities, acknowledging and ~~modeling~~ modellingself-regulatory behaviors, and encouraging goal-setting among students.

4. Given that all indicators of self-regulated learning significantly influence mathematics performance, it is recommended to enhance classroom, school, and extracurricular activities by integrating self-regulation strategies. Activities such as workshops, peer mentoring programs, and interactive learning sessions can help students develop these skills in various contexts, ultimately improving their overall academic performance.

5. Further research on the interrelation between self-regulated learning and mathematics performance would be valuable. It is also recommended to include other non-cognitive variables in future research to provide a more comprehensive understanding of the factors affecting mathematics performance. Variables such as creativity, resiliency, and ~~bouyancy~~buoyancycan play significant roles in academic success. Exploring these factors in conjunction with self-regulated learning can offer deeper insights into student performance.

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