Self-Regulated Learning Strategies, Academic Motivation, Perception of Technology and Mathematics Performance of the Senior High School STEM Students

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Abstract: The objective of the study was to identify potential indicators of mathematics performance among students at three senior high schools in the province of Pangasinan. It took into consideration self-regulated learning methodologies, technological perception, and academic motivations. Inferential and descriptive statistics were used to obtain the values necessary for drawing logical conclusions. The research was conducted in three STEM-focused mega schools in the province of Pangasinan. The population of the study consisted of 124 11th graders enrolled during the first semester and continuing through the second semester of the 2020-2021 school year. The most common way for students to self-regulate their learning is to consider time and search for an appropriate learning environment. When students set aside time and cultivate a conducive learning environment, they perceive themselves as more productive. In addition, students felt comfortable learning with their mobile devices in and out of the classroom. Academic motivation (7), self-regulated learning strategies (9) and perception of technology were utilized to predict students' performance in mathematics using hierarchical multiple regression. As identified, identified regulation, motivation, rehearsal, time and study environment, and introjection regulation and rehearsal significantly predict students' mathematical performance. The derived model has a predictive accuracy of approximately 72.3% and was determined to be a good model. It is recommended that additional research be conducted on these factors contributing to the academic performance of students and that effective teaching strategies be developed to maximize the effects of these variables.

Keywords: Self-Regulation, Academic Motivation, Mathematics Performance, Technology in Education, STEM, Perceptions

1. Introduction

1.1 Background of the Study

Education has always been regarded as essential to a person's advancement in life. When a child begins school, parents and teachers exert pressure on him or her to achieve academic success. Students and many education stakeholders have continued to be interested in the motivations for working hard in school, how to work hard, and the factors that predict academic achievement. Educational scholars, psychologists, and guidance and counseling specialists have conducted research in these areas, with inconclusive results, Padernal [10].

Self-regulated learning is a cyclical process in which a student creates a task, monitors their progress, and then assesses the outcomes. The cycle is then repeated as the learner adjusts and prepares for the subsequent challenge through reflection. Rather than being a one-size-fits-all approach, the method should be tailored to each student's specific learning objectives.

According to Ningrum [9], academic achievement is one indicator of student learning success. Academic achievement is enhanced by students' ability to self-regulate their learning, and there appears to be a correlation between student self-control and academic achievement.

According to Steinmayr [11], achievement motivation is not a single construct but rather encompasses multiple constructs, including ability self-concepts, task values, goals, and achievement motives. The few existing studies that investigated diverse motivational constructs as predictors of school students' academic achievement beyond students' cognitive abilities and prior achievement demonstrated that the majority of motivational constructs predicted academic achievement beyond intelligence, and that students' ability self-concepts and task values are more predictive of their achievement than goals and achievement motives.

In addition, technology bridges the divide between quarantine and education. In the second quarter of 2020, we will be able to recall how our education sector conducted online classes. Numerous LGUs distributed mobile devices to students, teachers received training to maximize digital learning, and learning programs were added to ChildHope Philippines' television channels [3]. Digital technology is currently a necessity for everyone.

1.2 Statement of the Problem

Both the individual learner and society as a whole can lose out on a variety of rewarding life opportunities if they perform poorly on national tests. The student may miss out on the opportunity for higher education, while society as a whole may lack the competent human capital necessary to meet the needs for wealth creation. Therefore, it is necessary to investigate the factors associated with high or low academic achievement.

Given the background of the study, it is evident that self-regulated learning has been identified as a significant predictor of students' academic success. However, there are few studies in the Philippines that examine the relationship between student self-regulation and mathematics achievement, especially during pandemics when students are physically unable to attend classes.

It sought to answer the following questions in particular:

1. What is the level of self-regulated learning strategies of the respondents?
2. Is there a statistically significant difference in mathematics performance, self-regulated learning strategies, and academic performance in Mathematics based on students School?
3. How well do the constructs of Self-Regulated Learning Strategies, academic motivation, and perception of technology predict students' mathematical achievement?

1.3 Hypotheses

1. There i a statistically significant difference in performance in mathematics, self-regulated learning strategies, and academic performance in Mathematics.
2. None of the variables, self-regulated learning strategies, perception of technology nor academic motivation predict the mathematics performance of the students.

2. Design and Methodology

Quantitative research methodology was used in the study to determine the self-regulated learning strategies of the respondents and the model that predicts their academic performance.

The research was carried out in three mega schools in the Pangasinan province. The study's population consisted of STEM students enrolled in the school year 2020-2021. The data set included 124 grade 11 students enrolled in basic calculus and statistics and probability.

To facilitate data collection possible, permission was forwarded to the school's principal for approval. Additionally, for students under the age of 18, parental approval was obtained prior to data collection.

2.1 The Instrument

The MSLQ, which was developed by Pintrich et al. (1993) and modified by Apostol [2], will be utilized. The Modified MSLQ is a self-report Likert-type questionnaire comprised of 50 items from two distinct domains, motivational beliefs and learning strategy use. In addition, the Academic Motivation Scale (High School Version) developed by Vallerand, Pelletier, Blais, Briere, Senecal, and Vallieres was used to evaluate the academic motivation of the participants.

During pilot testing, the cronbach's alpha for all 50 items measuring self-regulated learning strategies was acceptable (=0.920). By removing item number 43, "When subject work is difficult, I give up or only study the easy parts," alpha could be increased to 0.923; however, this is a very small improvement to an already reliable scale, and all 50 items were included to ensure the validity of the measures used in the study.

2.2 Testing Assumptions

Prior to execution, assumptions underlying the various statistical tests employed were evaluated. To determine the normality of the data set, the Shapiro-Wilk test was performed. The normal distribution of the variables is confirmed by a p-value greater than 0.05. In addition, the fundamental assumptions underlying hierarchical linear regression are comparable to those underlying other types of regression studies. As demonstrated by the Durbin–Watson test for residual independence, this includes the fact that multicollinearity does not exist or exists at extremely low levels. Additionally, researchers should examine plots of standard residuals for assumptions such as homoscedasticity, linearity, error independence, and absence of outliers.

3. Result and Discussion

3.1 Self-Regulated Learning Strategies of the Students

School	Domain	Mean	Standard Deviation
School A	Rehearsal	4.85	1.06
	Elaboration	4.92	0.97
	Organization	4.64	1.13
	Critical Thinking	4.84	0.83
	Meta-Cognitive SRL	4.79	0.77
	Time and Environment	5.12	0.70
	Effort Regulation	4.49	0.77
	Peer Learning	4.16	1.16
	Help Seeking	4.72	0.92
School B	Rehearsal	5.14	1.22
	Elaboration	4.87	1.12
	Organization	5.15	1.21
	Critical Thinking	4.90	1.06
	Meta-Cognitive SRL	4.93	0.91
	Time and Environment	5.20	0.86
	Effort Regulation	4.55	1.07
	Peer Learning	4.62	1.32
	Help Seeking	5.01	1.02
School C	Rehearsal	4.32	0.92
	Elaboration	4.35	0.85
	Organization	4.27	0.93
	Critical Thinking	4.22	0.80
	Meta-Cognitive SRL	3.97	0.58
	Time and Environment	4.16	0.66
	Effort Regulation	4.07	1.11
	Peer Learning	4.20	1.09
	Help Seeking	3.93	1.15

Table 1. Self-Regulated Learning Strategies of the Students

Table 1 displays statistics on the three schools' self-regulated learning practices. It demonstrates that students at schools A and B's prevalent technique is to arrange time and look for a desirable learning environment. Students at school C, on the other hand, strategize learning by summarizing, taking notes, paraphrasing, and connecting facts.

3.2 Academic Motivation of the Students

School	Domain	Mean	Standard Deviation
School A	IM-To know	3.94	0.97
	IM-Toward accomplishment	3.89	0.92
	IM-To experience stimulation	3.92	1.04
	EM-Identified	3.73	1.05
	EM-Introjected	4.19	1.04
	EM-External Regulation	3.83	1.03
	Motivation	3.93	0.96
School B	IM-To know	4.06	1.14
	IM-Toward	4.00	0.98

	accomplishment		
	IM-To experience stimulation	4.38	0.96
	EM-Identified	4.16	1.10
	EM-Introjected	3.86	0.99
	EM-External Regulation	3.95	1.05
	Motivation	4.00	0.93
School C	IM-To know	3.91	1.02
	IM-Toward accomplishment	3.98	0.99
	IM-To experience stimulation	4.01	1.12
	EM-Identified	3.95	1.12
	EM-Introjected	3.98	0.78
	EM-External Regulation	4.08	1.14
	Motivation	4.07	1.04

Table 2. Academic Motivation of the Students

The table depicts the academic motivation of students from each of the three schools. The students' most motivating classifications are identifiable regulation, introjected regulation, and experiential stimulation. This means that students are motivated because they understand that their efforts will result in positive outcomes in the long run, that there is a strong desire to accomplish things because failure to do this will result in failures or guilt, and that they enjoy participating in an activity for the experience of fun, excitement, and positive sensations.

The guilt manipulation substantially enhanced post-test guilt sentiments, which were related with greater post-test body anxiety, but only for individuals in the guilt condition, Hurst [8].

3.3 Perception of Technology of Students

School	Mean	Standard Deviation
School A	3.88	0.56
School B	3.61	0.54
School C	3.03	0.61

Table 3. Perception of Technology of Students

Table 3 depicts the students' perceptions on technology. Students in the three schools felt at ease learning with their mobile applications both inside and outside of the classroom.

Ho_1: There is a statistically significant difference in performance in mathematics, self-regulated learning strategies, and academic performance in Mathematics.

There was a statistical difference in Basic Calculus performance of students if classified based on schools, $F(4,320)= 10.435$, $p<0.05$, wilk's $\lambda = 0.782$, and partial $\eta^2 = 0.116$.

	F	Value	Sig.	Partial η^2
Wilk's λ	10.435	.782	0.000	0.116

Students' performance in Basic Calculus if classified based on their present school attended has significant difference, $F(2,161)=21.673$, $p<0.05$, and partial $\eta^2=.212$. However, students in the three schools has no significant difference on performance in Statistics and Probability.

The post-hoc tukey's HSD test demonstrated that the means of performance for Basic Calculus were significantly different amongst Schools A, B, and C.

Basic Calculus	Schools	Mean Difference	Sig.
	A vs B	-6.05**	0.000
	B vs C	2.88**	0.019
	C vs A	3.18**	0.001

***significant at the 0.05*

Table 5 revealed that, based on the follow-up examinations, there are disparities in the performance of schools in Basic Calculus. Students in school C do much better in Basic Calculus than students in school A. Furthermore, the data shows that School B was much higher than Schools A and B.

Self-Regulated Learning Strategies	Schools	Mean Difference	Sig.
	A vs B	-.167	0.429
	B vs C	.759**	0.000
	C vs A	-.593**	0.000

***significant at the 0.05*

The table compared the three schools' self-regulated learning strategies.

Students' Self-regulated Learning Strategies differ significantly depending on the school they now attend, $F(2,161)=17.257$, $p<0.05$, and partial $\eta^2=.177$.

Students in School C had much greater levels of Self-Regulated Learning Strategy than students in School B. Furthermore, students at School A show much greater levels of self-regulated learning technique than students at Schools B and C.

Running several analyses of variance and post-hoc tests on student academic motivation indicates that there is no significant difference between the students in the three schools.

The significance of no difference between the students' achievement in mathematics may be attributed to student attitude (student factor) and teaching quality (teacher factor). Teachers should know their students'' ability, interest and attitude towards the subjects, Andaya [1].

Ho_2: None of the variables, self-regulated learning strategies, perception of technology nor academic motivation predict the mathematics performance of the students

Multiple linear regression was executed to predict students' performance in mathematics from different constructs of academic motivation (7), self-regulated learning strategies (9), and perception of technology.

Model	R	R Square	Std Error	F	Sig
-	.437	.191	.103	2.166	.008

Only Internal Motivations Identified Regulation and Introjected Regulation. These variables statistically significantly predicted mathematics performance, $F(16, 147) = 2.166$, $p < .0005$, $R^2 = .191$.

Introjected regulation is driven by an internalized, pressuring voice. Guilt, worry, or shame are the sources of motivation for a conduct. Introjected regulation motivates a person to engage in an activity not because he wants to, but because he fears not doing so due to a sense of responsibility. On the other hand, if a person has personally connected with the significance of a behavior and embraced it as her own regulation because it helps her achieve a goal, she is driven by identified regulation.

Individuals are said to become more self-determined, as seen by enhanced internal control and persistent behaviors, when they feel a course of action would meet the three psychological demands of autonomy, relatedness, and competence. Based on this observation, one may conclude that the presence of basic psychological requirements will result in self-determined kinds of motivation such as intrinsic motivation and recognized regulation. Because of their internal character, these self-determined kinds of motivation will result in beneficial consequences. Furthermore, non-self-determined kinds of motivation, such as motivation, external and introjected rules, may be more likely to result in undesirable results, especially when the external reason is no longer present or appreciated, Deci [4]. Furthermore, a hierarchal regression was performed, in which all of the independent variables are entered into the equation initially and then discarded one at a time if they do not contribute to the regression equation. Variables can be kept or removed based on their statistical significance.

A backward stepwise multiple linear regression was utilized to uncover potential predictors of mathematics performance among the constructs of academic motivation (7), self-regulated learning strategies (9), and technology perception. Variables were selected based on p-values at each phase, and a p-value threshold of 0.1 was used to establish a limit on the total number of variables included in the final model.

$$\textit{Mathematics Performance} = 85.14 + 0.868(\textit{Identified Regulation}) + 0.668(\textit{Motivation}) + 0.891(\textit{Rehearsal}).$$

The identified regulation, motivation, and rehearsal have a significantly predict the mathematics performance. The adjusted R^2 or the coefficient of determination is the proportion of variance in the dependent variable (academic performance) which can be predicted from the independent variables (identified regulation, motivation, and rehearsal) is 72.3%. Considering that this is an overall measure of the strength of association, and does not reflect the extent to which any particular independent variable is associated with the dependent variable.

Model	R	R Square	Std Error	F	Sig
-	.850	.723	3.69	5.61	.000

4. Conclusion

Based on the study's findings, the following conclusions were drawn. To begin, the most common self-regulated learning of students is to consider time and seek out a suitable learning environment. Students tend to view themselves as more productive if they set aside time and have a favorable atmosphere for studying. Furthermore, students' factors responsible for academic motivation is identified regulation, introjected regulation, and experience stimulation. This means that students are motivated because they know that their efforts will lead to positive outcomes in the long run, that there is a strong desire to accomplish things because failure to do this will result in defeats, and that they enjoy having participated in an activity for the experience of fun, excitement, and positive sensations. Finally, identified regulation, motivation, and rehearsal predict significantly the mathematics performance of the students.

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Author Profile

Gerald C. Apostol earned his B.S. in Mathematics from the Pangasinan State University - Main Campus in 2014 and an M.S. at Central Luzon State University in Mathematics Education in 2019. He is currently pursuing a doctorate in philosophy at Saint Mary's University. From his bachelor's degree to his doctorate, he was a scholar of the Department of Science and Technology - Science Education Institute. He taught courses in elementary and advanced mathematics, research, and professional education at Pangasinan State University, Far Eastern University, and Emilio Aguinaldo College. He is also a researcher and data expert with a history of outstanding accomplishments in a variety of fields, demonstrating originality and a commitment to achieving results. Focused on achieving short- and long-term goals that benefit the general public.