Students' Self-Regulated Learning Strategies, Self-Efficacy, and Mathematics Performance in a Mobile Technology-Integrated Classroom of Selected Grade 8 Learners

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Abstract: This quasi-experimental research design's objective was to determine the students' self-regulated learning strategies (SRLs), self-efficacy (motivation), and mathematics performance (MP) in the mobile technology-integrated face-to-face classroom and predict potential indicators of MP among (simple randomized) 82 selected Grade 8 learners of San Jose Community High School, before and after the instruction. The values required for analyses were obtained using descriptive and inferential statistics. The questionnaires were valid and found reliable (excellent), and assumptions for parametric tests are met. Both the traditional classroom and the technology-integrated classroom (intervention) resulted in statistically significant difference (improvement) between the pre-test & post-test, SRLs, and self-efficacy means. However, comparing the two groups & variables in groups, the intervention was more effective and found to have enhanced the SRLs, self-efficacy, and MP of learners. Rehearsal and extrinsic goal orientation were the most utilized SRLs and self-efficacy subscales of the MSLQ, respectively. Out of nine subscales of SRLs, only the rehearsal and metacognitive self-regulation subscales served as predictors of learners' MP with a predictive accuracy of approximately 68.5% (good model). Thereof, learners were motivated (increased self-efficacy) in learning mathematics by engaging in an activity/task for the motives like grades, performance, comparing one's performance to that of others, evaluation by others, and rewards. And with the proper planning, monitoring, assessing, understanding, and rehearsing a skill over and over in order to gain proficiency, this affected the students' mathematics performance.

Keywords: extrinsic goal orientation, face-to-face learning, mathematics performance, metacognitive self-regulation, motivated learning strategies, motivation in learning, rehearsal learning strategy, self-efficacy, self-regulated learning strategies, technology-integrated education

1. Introduction

1.1: Rationale of the Study

A person's development in life has traditionally been viewed as being dependent on their level of education. Parents and teachers put pressure on a student to succeed academically as soon as they start school. The reasons behind putting forth a lot of effort in school, the methods for doing so, and the variables that influence academic success continue to pique the interest of students and numerous education stakeholders. It was well known that young Filipinos had a consequential attachment to their smartphones for a variety of reasons, including communication, entertainment, and productivity.

While there were many benefits to using a smartphone, the unfortunate truth was that youngest Filipinos used theirs for amusement purposes, particularly playing online games and interacting on social media. While it is all right to use a smartphone for entertainment purposes, doing so for a large portion of each day might have negative effects on the students' health and quality of life. In light of the post-epidemic and societal issues, young Filipinos should put their smartphones to good use by using them for educational purposes and other worthwhile endeavors, since this is their duty as students and as the future needs them.

According to empirical evidence this year (2022), young Filipinos are relatively high in their utilization of mobile technologies and for entertainment purposes such as social media and online games, Dixon et al., [1][5][7][13]. The benefit of spending an inordinate amount of time using mobile devices is that, according to Apostol [3], the students already had a concrete understanding of what and how the smartphones work due to the findings on student perceptions of mobile applications that they didn't change significantly even before the actual intervention.

Related studies discussed that the self-regulated learning strategies (Nemati et al., [10]) and self-efficacy (Flores et al., [6][11][14]) or student motivation have a real impact on performance on mathematics exams and courses or subjects, but some studies have yielded inconclusive results. Akisono [2] recommended that ICT should be utilized to teach mathematics in secondary schools. Even the constructivist learning theory suggests using technology in education, Kurt [8] & Roblyer [12].

1.2: Objectives of the Study

This quasi-experimental research design's objective was to determine self-regulated learning strategies, self-efficacy, and mathematics performance in the mobile technology-integrated F2F classroom and predict potential indicators of mathematics performance among 82 selected Grade 8 learners of San Jose Community High School, before and after the instruction.

The dependent variables in the study were the students' self-regulated learning strategies, self-efficacy, and mathematics performance affected by the subscales of the motivated strategies for learning questionnaire (MSLQ) of Pintrich, et al. (1991) and the pre-test & post-test means of the control group (traditional lecture-style instruction) and experimental group (mobile technology-integrated instruction / intervention), before and after the instruction. The study was only focused on the stated objectives. Outside factors of the study were not included.

Specifically, the following questions are aims of this study:

1. What is the students' mathematics performance on pre-test and post-test scores?
2. What is the students' self-regulated learning strategy before and after instruction?
3. What is the self-efficacy of the students before and after instruction?
4. Is there a statistically significant difference between the experimental group and the control group in terms of pre-test and post-test scores?
5. Is there a statistically significant difference in the self-regulated learning strategies of the experimental group before and after the instruction?
6. Does the integration of mobile technologies to support traditional lecture-style instruction affect the self-efficacy of the students in the experimental group?
7. Which of the learning strategy scales can be used to predict how well the students in the experimental and control groups would do on a math test?

1.3: Hypotheses

1. There is no statistically significant difference between the experimental group and control group in terms of pre-test and post-test scores;
2. There is no significant difference in changes in the self-regulated learning strategies of the experimental group before and after instruction;
3. The integration of mobile technologies to support traditional lecture-style instruction has a negative effect on the self-efficacy of the students in the experimental group; and
4. Learning strategy scales does not predict the mathematics achievement test scores of the students in the experimental and control group.

2. Methodology

Quasi-experimental research methodology was used in the study to determine the self-regulated learning strategies (MSLQ of Pintrich et, al., 1991), self-efficacy (motivation), and mathematics performance (pre-test & post-test) in the mobile technology-integrated F2F classroom and predict potential indicators of mathematics performance among (simple randomized) 82 selected Grade 8 learners of San Jose Community High School, before and after the instruction. The request for authorization was sent to the school's principal for approval (approved) in order to make data gathering possible. Additionally, parental consent was requested and accepted before data collection for children under the age of 18.

2.1: The Instrument

The instruments used in this study were the following:

Pre-test and Post-test Instruments. These instruments (valid and found reliable, $a = .941$) were used for determining the mathematics performance of students and developed by the acting teacher-researcher and aligned with the DepEd mathematics curriculum guide. There were total of 25 questions.

The Motivated Strategies for Learning Questionnaire (MSLQ). This instrument (valid and found reliable, $a = .947$) of Pintrich et al. (1991) was used to determine the students' self-regulated learning strategies and self-efficacy before and after the instruction. MSLQ was a self-report Likert-type questionnaire that consists of 81 items from two separate domains: learning technique utilization and motivational views.

2.2: Testing Assumptions

The statistical tests used were subjected to evaluations of assumptions before executing the tests. The Shapiro-Wilk test was used to evaluate if the data set was normal. A p-value larger than 0.05 indicates that the variables have a normal distribution. The box plot was used to determine if the data have no significant outliers. Additionally, the assumptions of multiple linear regression were observed. This includes the fact that multicollinearity does not exist or only occurs at very low levels (tested using variance inflation factor values), had a linear relationship between the outcome variable and the independent variables (tested using scatter plots), and residuals must be normally distributed (multivariate normality, tested using Q-Q plot). Researchers should also check plots of standard residuals for the presence of outliers and assumptions like homoskedasticity, linearity, and error independence. All the assumptions for statistical tests were met in this study.

3. Results and Discussions

3.1 Tables

Table 1: *Students' Pre-test & Post-test Means of the Control and Experimental Groups*

Group	Tests	Mean	SD	Mean Gain	Interpretations
Control	Pre-test	7.14	2.27	10.4	Improved Test Scores
	Post-test	17.53	2.04		
Experimental	Pre-test	6.49	2.63	13.59	Improved Test Scores
	Post-test	20.08	2.25		
Control – Experimental (Mean Difference)	Pre-test	.65		-3.19	Improved Test Scores
	Post-test	-2.55			

Table 1 displays the students' pre-test & post-test means of the control and experimental groups. The results revealed that there was an improvement of scores between the pre-test and post-test of both control and experimental groups. Nevertheless, comparing the mean gain of control and experimental groups, there is also an improvement of test scores of students, before & after the instruction. However, does the mean difference or mean gain of control and experimental groups are statistically significant?

Table 2: *Dependent Sample T-test of Students' Pre-test & Post-test of the Control and Experimental Groups*

Group	Test Scores	Mean Difference	SD	t	P-value	INTP(a)
CTL(b)	Pre-test – Post-test Scores	-10.395	2.527	-26.97	.000	Statistically Significant Difference
EXPT(c)	Pre-test – Post-test Scores	-13.590	2.087	-40.67	.000	Statistically Significant Difference

a. INTP(a) = Interpretations
b. CTL(b) = Control Group
c. EXPT(c) = Experimental Group

Table 2 displays the dependent sample t-test of students' pre-test & post-test of the control and experimental groups. The paired sample t-test shows that there was a statistically significant difference between the test scores means of both the control and experimental groups ($p(.000) < .05$). The results in table 2 were statistically tested. Thereof, mobile technology-integrated instruction enhances the mathematics performance of the students.

Table 3: *Descriptive Statistics for Each Subscale of Students' Self-Regulated Learning Strategies of the Control and Experimental Groups (Before and After the Instruction)*

SUBSCALES	CONTROL GROUP				MEAN GAIN	EXPERIMENTAL GROUP				MEAN GAIN
	BEFORE		AFTER			BEFORE		AFTER		
	MEAN	SD	MEAN	SD		MEAN	SD	MEAN	SD	
Rehearsal	4.68	1.27	4.94	1.23	0.26	4.01	1.18	4.93	1.09	0.92
Elaboration	4.32	1.35	4.56	1.36	0.24	3.83	1.21	4.75	1.1	0.92
Organization	4.72	1.09	4.63	1.14	-0.09	4.08	1.12	4.84	1.02	0.76
Critical Thinking	4.18	1.33	4.39	1.33	0.21	3.76	1.24	4.71	1.12	0.95
Metacognitive Self-Regulation	4.42	1.29	4.55	1.27	0.13	3.89	1.19	4.77	1.06	0.88
Time and Study Environment	4.55	1.35	4.63	1.34	0.08	4	1.19	4.78	1.07	0.78
Effort Regulation	4.36	1.33	4.46	1.24	0.1	3.83	1.2	4.72	1.09	0.89
Peer Learning	4.35	1.35	4.44	1.36	0.09	3.85	1.31	4.71	1.16	0.86
Help-seeking	4.42	1.42	4.43	1.38	0.01	3.91	1.3	4.72	1.14	0.81
Grand Mean	4.44	1.31	4.56	1.29	0.12	3.91	1.22	4.77	1.09	0.86

Legend

MEAN	***REFLECTION***
1.00 – 1.83	*Very untrue of me*
1.84 – 2.67	*Untrue of me*
2.68 – 3.50	*Somewhat untrue of me*
3.51 – 4.33	*Somewhat true of me*
4.34 – 5.17	*True of me*
5.18 – 6.00	*Very True of me*

Table 3 shows the descriptive statistics of each subscale of students' self-regulated learning strategies of control group and experimental group (both groups had improvements on subscales of self-regulated learning strategies), before and after the instruction. There was an increase of mean in control group, and there was a large increase of mean in experimental group compared to control group. The highest mean of the subscale of self-regulated learning strategies was the rehearsal learning strategy in both the groups with a mean of 4.94 and 4.93 respectively (True of me). However, does the mean gain or mean difference between the before and after instruction of two groups, are statistically significant?

Table 4: *Dependent Sample T-test of Students' Self-Regulated Learning Strategies of the Control and Experimental Groups (Before and After the Instruction)*

Group	SRLs Scale	Mean	Std. Deviation	t	P-Value	Interpretations
Control Group	Before – After	-.114	.112	-3.055	.016	Statistically Significant Difference
Experimental Group	Before – After	-.863	.0665	- 38.935	.000	Statistically Significant Difference

Table 4 shows the dependent sample t-test of students' self-regulated learning strategies scales of control and experimental groups, before and after the instruction. The paired samples or dependent samples t-test shows that there was a statistically significant difference between the learning strategies scales of MSLQ means of both the control and experimental group, before and after the instruction ($p(.016) < .05$ & $p(.000) < .05$, respectively). The results in table 3 were statistically tested. Thereof, mobile technology-integrated instruction enhances the self-regulated learning strategies of the students and most of them regulated their learning by practicing their gained information in this math class repeatedly to learn mathematics.

Table 5: *Descriptive Statistics for Each Subscale of Students' Self-Self-Efficacy of the Control and Experimental Groups (Before and After the Instruction)*

SUBSCALES	CONTROL GROUP				MEAN GAIN	EXPERIMENTAL GROUP				MEAN GAIN
	BEFORE		AFTER			BEFORE		AFTER		
	MEAN	SD	MEAN	SD		MEAN	SD	MEAN	SD	
Intrinsic Goal Orientation	4.38	1.43	4.72	1.2	0.34	3.85	1.17	4.87	1.06	1.02
Extrinsic Goal Orientation	4.66	1.45	5.11	1.25	0.45	4.08	1.31	4.95	1.12	0.87
Task Value	4.39	1.47	4.85	1.23	0.46	3.84	1.21	4.88	1.09	1.04
Control Beliefs	4.38	1.46	4.44	1.46	0.06	3.91	1.24	4.67	1.17	0.76
Self-efficacy for Learning & Performance	4.32	1.47	4.34	1.51	0.02	3.82	1.25	4.63	1.1	0.81
Test Anxiety	3.68	1.37	3.39	1.38	-0.29	4.41	1.18	3.7	1.09	-0.71
Grand Mean	4.3	1.44	4.48	1.34	0.17	3.99	1.23	4.62	1.11	0.63

Legend

MEAN	***REFLECTION***
1.00 – 1.83	*Very untrue of me*
1.84 – 2.67	*Untrue of me*
2.68 – 3.50	*Somewhat untrue of me*
3.51 – 4.33	*Somewhat true of me*
4.34 – 5.17	*True of me*
5.18 – 6.00	*Very True of me*

Table 5 shows the descriptive statistics of each subscale of students' self-efficacy of control group and experimental group (both groups had improvements on subscales of self-efficacy), before and after the instruction. There was an increase of mean in control group, and there was a large increase of mean in experimental group compared to control group, except the test anxiety subscale, there was a decrease of math anxiety of the students in control and experimental (much decreased compared to control group) groups. The highest mean of the subscale of self-efficacy was the extrinsic goal orientation subscale in both the groups with a mean of 5.11 and 4.95 respectively (True of me). However, does the mean gain or mean difference between the before and after instruction of two groups, are statistically significant?

Table 6: *Dependent Sample T-test of Students' Self-Efficacy of the Control and Experimental Groups (Before and After the Instruction)*

Group	Motivation Scales	Mean Difference	Std. Deviation	t	P-Value	Interpretations
Control Group	Before - After	-.17	.271	-3.806	.001	Statistically Significant Difference
Experimental Group	Before - After	-.63	.634	-5.608	.000	Statistically Significant Difference

Table 6 shows the dependent sample t-test of students' self-self-efficacy scales of control and experimental groups, before and after the instruction. The paired samples or dependent samples t-test shows that there was a statistically significant difference between the self-efficacy means of both the control and experimental group, before and after the instruction ($p(.001) < .05$ & $p(.000) < .05$, respectively). The results in table 5 were statistically tested. Thereof, mobile technology-integrated classroom enhances the self-efficacy or motivation of the students in learning this mathematics class and most of them increases their self-efficacy or motivation by engaging in an activity or task for the motives like grades, performance, comparing one's performance to that of others, evaluation by others, and rewards.

H_{01}: There was no statistically significant difference between the experimental group and control group in terms of pre-test and post-test scores

Table 7: *Independent Sample T-test of Students' Pre-test and Post-test of the Control and Experimental Groups*

Test Scores		Levene's Test for Equality of Variances F	Levene's Test for Equality of Variances P-Value	t	Mean Difference	P-Value	Interpretations
Pre-test Scores	Equal variances assumed	2.287	.134	1.203	.652	.232	Statistically No Significant Difference
Post-test Scores	Equal variances assumed	.347	.557	-5.364	-2.542	.000	Statistically Significant Difference

Table 7 shows the independent sample t-test of students' pre-test & post-test scores in control and experimental groups. Based on the Levene's test for equality of variances, p-value (.134) of pre-test scores & p-value (.557) of post-test scores are greater than the significance level, this implies to, do not reject the null hypothesis, therefore there is no statistically significant differences within the variances, both test scores are assumed equal variances. The result in the pre-test scores was to, do not reject the null hypothesis, t = 1.20, p(0.232) > 0.05, there was no statistically significant difference between the two groups with respect to the pre-test scores of students. This implies that students in both the control and experimental groups had the same knowledge before the instruction.

The result in the students' post-test scores was to reject the hypothesis, t = -5.36, p(.000) < 0.05, there was a significant difference between the two groups in terms of post-test. In other words, the intervention had a significant effect (improvement) on the post-test mean scores of the students. Thereof, mobile technology-integrated instruction enhances the mathematics performance of the students.

H_{02}: There is no significant difference in changes in the self-regulated learning strategies of the experimental group before and after instruction

Table 8: *Descriptive Statistics for Dependent Sample T-test for Each Subscale of Students' Self-Regulated Learning Strategies of the Experimental Group (Before and After the Instruction)*

SRL STRATEGIES SCALE	MEAN DIFFRENCES	SD	T-COMPUTED	P-VALUE (2-tailed)	INTERPRETATIONS
Rehearsal	-0.92	.128	-14.339	.001	Statistically Significant Difference
Elaboration	-0.93	.113	-20.035	.000	Statistically Significant Difference
Organization	-0.76	.082	-18.52	.000	Statistically Significant Difference
Critical Thinking	-0.95	.12	-17.758	.000	Statistically Significant Difference
Metacognitive Self-regulation	-0.88	.155	-19.618	.000	Statistically Significant Difference
Time & Study Environment	-0.78	.137	-16.078	.000	Statistically Significant Difference
Effort Regulation	-0.89	.135	-13.146	.001	Statistically Significant Difference
Peer Learning	-0.86	.211	-7.039	.020	Statistically Significant Difference
Help-Seeking	-0.81	.136	-11.950	.010	Statistically Significant Difference

Table 8 displays the descriptive statistics (better picture) for dependent sample t-test for each subscale of students' self-regulated learning strategies of the experimental group, before and after the instruction. The paired samples or dependent samples t-test of all subscale of self-regulated learning strategies in MSLQ shows that there was a statistically significant difference in changes in the self-regulated learning strategies of the experimental group before and after instruction, because the null hypothesis is rejected, p-values < 0.05. Noticed that this was also the findings in table 4, same as in the mean gain of table 3.

H_{03}: The integration of mobile technologies to support traditional lecture-style instruction has a negative effect on the self-efficacy of the students in the experimental group

Table 9: *Descriptive Statistics for Dependent Sample T-test for Each Subscale of Students' Self-Efficacy of the Experimental Group (Before and After the Instruction)*

MOTIVATION (SELF-EFFICACY) SCALE	MEAN DIFFRENCES	SD	T-COMPUTED	P-VALUE (2-tailed)	INTERPRETATIONS
Intrinsic Goal Orientation	-1.02	.142	-14.216	.001	Statistically Significant Difference
Extrinsic Goal Orientation	-0.87	.12	-14.5	.001	Statistically Significant Difference
Task Value	-1.04	.08	-31.774	.000	Statistically Significant Difference
Control Beliefs	-0.76	.045	-32.996	.000	Statistically Significant Difference
Self-efficacy for Learning & Performance	-0.81	.102	-22.272	.000	Statistically Significant Difference
Test Anxiety	0.71	.532	2.866	.046	Statistically Significant Difference

Table 9 shows the descriptive statistics (better picture) for dependent sample t-test for each subscale of students' self-regulated learning strategies of the experimental group, before and after the instruction. The paired samples or dependent samples t-test of all subscale of self-efficacy in MSLQ shows that the integration of mobile technologies to support traditional lecture-style instruction had a positive effect on the self-efficacy of the students in the experimental group, because the null hypothesis is rejected, p-values < 0.05. Noticed that this was also the findings in table 6, same as in the mean gain of table 5.

H_{04}: Learning strategy scales does not predict the mathematics achievement test scores of the students in the experimental and control group

Table 10: *Multiple Linear Regression of Self-Regulated Learning Strategies in Mathematics Performance of Students in the Control and Experimental Groups After the Instruction*

Table 10 would show the multiple regression and the needed statistical test to predict the self-regulated learning strategies (independent variables) in mathematics performance (dependent variable, post-test), of students in the control and experimental group after the instruction.

Table 10.1: *Probability of Predicting the Dependent Variable (Post-test) in the Multiple Linear Regression Model*

Model	R	R Square	F	P-Value	Interpretation
1	.828(a)	.685	17.425	.000(a)	Good Fit

a. Predictors: (Constant), Help-seeking, Metacognitive Self-regulation, Rehearsal, Effort Regulation, Time & Study, Organization, Elaboration, Peer Learning, Critical Thinking
b. Dependent Variable: Post Test

Table 10.1 shows the probability of predicting the dependent variable (post-test) in the multiple linear regression model. The predictors which were the self-regulated learning strategies of participants (Help-seeking, Metacognitive Self-regulation, Rehearsal, Effort Regulation, Time & Study, Organization, Elaboration, Peer Learning, and Critical Thinking) of the regression model (Good fit), statistically significant predicts the dependent variable (69%) efficiently.

Table 10.2: *Multiple Linear Regression*

Model		B	P-Value	Interpretations
1	(Constant)	13.815	.000	Predictor
	Rehearsal	1.001	.002	Predictor
	Elaboration	-.184	.634	Not Predictor
	Organization	.645	.149	Not Predictor
	Critical Thinking	.516	.266	Not Predictor
	Metacognitive Self-regulation	.765	.041	Predictor
	Time & Study	-.476	.374	Not Predictor
	Effort Regulation	-.209	.659	Not Predictor
	Peer Learning	.148	.728	Not Predictor
	Help-seeking	.493	.347	Not Predictor

Result revealed that in self-regulated learning strategies scales of MLSQ, the rehearsal and metacognitive self-regulation were the predictors of mathematics performance of students in the control and experimental group after the instruction, as shown in the table 10.2. This indicated that students' awareness, understanding, control of cognition, and reciting or identifying the elements on a list of to-be-learned items could predict mathematics performance. The students who practiced self-regulated learning strategies in rehearsal, they practice saying material to themselves and read their class notes & the course readings over and over, memorize keywords to remind them of important concepts in the class, and make lists of important terms for their course then memorize the lists. The students who practiced self-regulated learning strategies in cognitive practiced the self-regulatory activities which are planning, monitoring, and regulating.

One of the metacognition skills was rehearsal (Malamed, [8]), thinking about thinking was a common definition of metacognition and it enables learners to successfully execute a job by planning, monitoring, assessing, and understanding (Difference Between Cognition and Metacognition, [4]), and repeatedly rehearsing a skill (any skills) in order to gain proficiency, Malamed [8]. It did make sense that the predictors were rehearsal and metacognitive self-regulation subscales of MLSQ.

4. Conclusions

Based on the results and findings, the following conclusion were derived. Both the traditional classroom and technology-integrated classroom (intervention) resulted in statistically significant improvement (difference) between the pre-test & post-test, self-regulated learning strategies, and self-efficacy means. However, comparing the two groups & variables in groups, the intervention was more effective and found to have enhanced the self-regulated learning strategies, self-efficacy, and mathematics performance of learners. Rehearsal and extrinsic goal orientation were the most utilized self-regulated learning strategies and self-efficacy subscales of the MSLQ, respectively. Out of nine subscales of self-regulated learning strategies, only the rehearsal and metacognitive self-regulation learning strategies served as predictors of the learners' mathematics performance with a predictive accuracy of approximately 68.5% (good model). Thereof, learners were motivated (increases self-efficacy) in learning mathematics by engaging in an activity/task for the motives like grades, performance, comparing one's performance to that of others, evaluation by others, and rewards. And with proper of planning, monitoring, assessing, understanding, and rehearsing a skill over and over in order to gain proficiency affects the students' mathematics performance.

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