MOBILE APPLICATION FOR LEARNING MATHEMATICS: ITS EFFECTS ON STUDENTS' SELF-CONCEPT, SELF-EFFICACY AND CONCEPTUAL UNDERSTANDING

De Asis, Joven & Ucang, Jenyliza T.
Science Education Department, Central Mindanao University, University Town, Musuan, Bukidnon, 8710 Philippines.
Correspondence Tel.: +639178531872, *Email: jenylizaucang@gmail.com

ABSTRACT: *This study investigated the effects of mobile application for learning Mathematics (MALMath) in Grade 8 students at San Jose High School of Sinayawan Inc., Valencia City, Bukidnon. Specifically, it aimed to determine the level of students' self-concept in terms of self-image, self-esteem, and ideal self; identify the level of students' self-efficacy in terms of mastery experiences, vicarious experiences, social persuasion, and emotional and physiological states; and describe the level of students' conceptual understanding in pretest and post-test when exposed to MALMath. Also, it aimed to find out if there is a significant difference in students' self-concept, self-efficacy, and conceptual understanding in pretest and post-test when exposed to MALMath. Quantitative research involving a one-shot pretest-post-test research design was employed in this study. A teacher-made conceptual understanding test and an adapted self-concept and self-efficacy test scale were used as the instruments. Descriptive statistics were used to describe the levels of students' self-concept, self-efficacy, and conceptual understanding. Also, a parametric paired t-test was used to test the significant difference in the gathered data. Research results revealed a moderate level of self-concept and self-efficacy after their exposure to MALMath. While, the results showed a lack of conceptual understanding of students after their exposure to MALMath. Further results indicated no significant difference in students' self-concept, while significant differences in students' self-efficacy and conceptual understanding were shown after their exposure to MALMath.*

Keywords: conceptual understanding, Mobile Application for Learning Math, self-concept, self-efficacy

1. INTRODUCTION

According to Trends in International Mathematics and Science Study by the International Association for the Evaluation of Educational Achievement, the Philippines ranks last among the participating countries where only 1% of Filipino students met the high benchmark in Mathematics, which means that "students apply conceptual understanding to solve problems" [1]. This implies that only very few Filipino students can solve math problems with conceptual understanding. At the national level, the result of the National Achievement Test 2019 revealed that students obtained low proficiency levels in Mathematics [2]. This implies a necessity for educators in Mathematics to cultivate in-depth conceptual understanding among Filipino students. Even before the pandemic, students already felt indifferent and seemed to struggle in Mathematics, especially those who are not logical-mathematical intelligent. In addition, students had only moderate self-concept in Mathematics during face-to-face classes [3]. Similarly, students had also moderate self-efficacy in Mathematics during face-to-face classes [4]. These existing problems add to the new challenge of learning independently due to the implementation of modular distance learning that caused students to struggle in education.

In the implementation of modular distance learning during the pandemic, students were culture-shocked by the learning system at home without direct teaching and supervision from teachers. The study found that students struggle with mere self-learning modules [5]. Consequently, struggling students are least likely to learn and benefit from modular distance learning [6]. In fact, students were found to have a low conceptual understanding of Mathematics during the pandemic [7]. In addition, motivation, which includes students' self-concept and self-efficacy, is one of the identified challenges encountered by students in self-learning modules [8]. Hence, teachers should re-evaluate the modules, and they must make sure that all the lessons or activities are appropriate to the needs of the learners [5].

Various investigations have been conducted to determine factors associated with students learning such as teachers' skills and competencies [9, 10, 11, 12], teachers' awareness, perceptions and challenges [13, 14, 15], contemporary pedagogies [16, 17, 18, 19, 20, 21] and others [22, 23, 24, 25, 26], however, little has been done on exploring the use of technology especially applications in teaching mathematics.

Despite the challenges encountered, teachers can do something helpful and beneficial for students like creating comprehensive self-learning modules to increase students' motivation and conceptual understanding in Mathematics [27]. In addition, teachers could integrate technology and technological gadgets to enhance learning, especially during these exceptional times [28]. In 2014, Microblink created Photomath. It is one of the most popular math mobile applications students use to solve mathematical problems with step-by-step solutions and explanations [29]. Moreover, the teaching and learning process assisted by Photomath can improve the student's conceptual understanding [7], and the integration of it into the mathematics curriculum can increase students' motivation [30].

In the previous study about students' experiences in using math mobile applications during modular distance learning, it was found that students were using various mobile applications to help them understand their mathematics lessons, and one of those is Photomath [31]. During the school year 2020-2021, grade 8 students at San Jose High School of Sinayawan Inc. got only an overall general weighted average of 81.28% in Mathematics. Based on the interview with their mathematics teacher, students had very low motivation, which included their self-concept and self-efficacy, which affected their beliefs within themselves and their abilities to solve mathematics problems in Mathematics. In addition, students were having a difficult time dealing with problem-solving questions as reflected in their module which requires an in-depth conceptual understanding skill in Mathematics. This implies a need for teachers to improve

students' self-concept, self-efficacy, and conceptual understanding of Mathematics with feasible learning strategies such as technology integration during this modular distance learning. Hence, this study on a mobile application for learning Mathematics (MALMath): its effects on students' self-concept, self-efficacy, and conceptual understanding needs to be conducted because of the emerging challenges faced by many students in learning Mathematics during modular distance learning [8].

2. MATERIALS AND METHODS

This study assessed the effects of MALMath on students' self-concept, self-efficacy, and conceptual understanding in Mathematics in the 8th grade of San Jose High School of Sinayawan Inc. composed of 40 students. This quantitative research study used a one-shot pre-experimental pretest-post-test research design. A homogenous group was exposed to MALMath as a learning intervention of the study. A pretest and post-test were also conducted to measure the significant differences in students' self-concept, self-efficacy, and conceptual understanding in Mathematics exposed to MALMath.

A Mathematics self-concept rating scale was adapted [32] and modified [3] to measure the rating of students' perception of their skills, abilities, enjoyment, and interest in Mathematics in terms of the three sub-components namely: self-image (learned), self-esteem (organized), and ideal-self (dynamic). The questionnaire is a 5-point rating scale, and it was administered to the 42 grade 9 students of SJHSSI for pilot testing. The test obtained a Cronbach Alpha of 0.833, which indicated a reliable instrument.

The mean of each item as well as the overall mean score was interpreted using the scale presented below:

Rating	Scale	Descriptive rating	Interpretation
5	4.51 – 5.00	Strongly Agree	Very high
4	3.51 – 4.50	Agree	High
3	2.51 – 3.50	Uncertain	Moderate
2	1.51 – 2.50	Disagree	Low
1	1.00 – 1.50	Strongly Disagree	Very low

A Mathematics self-efficacy rating scale was adapted from the study [33] to measure the rating of students on their abilities to solve math problems in terms of the four sub-components, namely: mastery experiences, vicarious experiences, social persuasion, and emotional and physiological states. The questionnaire is a 5-point rating scale, and it was administered to the 42 grade 9 students of SJHSSI for pilot testing. The test obtained a Cronbach Alpha of 0.871, which indicated a reliable instrument.

The mean of each item as well as the overall mean score was interpreted using the scale presented below:

Rating	Scale	Descriptive rating	Interpretation
5	4.51 – 5.00	Strongly Agree	Very high
4	3.51 – 4.50	Agree	High
3	2.51 – 3.50	Uncertain	Moderate
2	1.51 – 2.50	Disagree	Low
1	1.00 – 1.50	Strongly Disagree	Very low

To measure students' conceptual understanding, the researcher conducted a 5-item conceptual understanding test about polynomials' lessons. It was administered to the 42 grade 9 students of SJHSSI for pilot testing. The test obtained a Cronbach Alpha of 0.850, which indicated a reliable instrument. Also, a conceptual understanding rubric was adapted from the Oregon Department of Education to rate students' conceptual understanding of Mathematics.

The overall mean score from the conceptual understanding test was interpreted using the scale presented below.

Rating	Scale	Descriptive rating	Interpretation
5	4.51 – 5.00	Strongly Agree	Very high
4	3.51 – 4.50	Agree	High
3	2.51 – 3.50	Uncertain	Moderate
2	1.51 – 2.50	Disagree	Low
1	1.00 – 1.50	Strongly Disagree	Very low

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The overall mean score from the conceptual understanding test was interpreted using the scale presented below.

Rating	Scale	Interpretation
5	5.00	Full Conceptual Understanding
3	3 – 4.99	Partial Conceptual Understanding
1	1 – 2.99	Lack of Conceptual Understanding

The researcher observed proper ethical consideration in the research development planning. Before conducting the study, the researcher asked permission from the school principal to conduct a study among the grade 8 students of SJHSSI, endorsed by the research adviser. During the conduct of the study, the researcher informed the participants about the research study, and they would be given a freedom of participation with a letter of consent addressed to the students approved by the school principal and research adviser. The researcher ensured the confidentially of all data gathered and used them for research purposes only.

The implementation of the study in the school was divided into three (3) phases:

Phase 1: The researcher carried out the self-concept, self-efficacy, and conceptual understanding printed pretest through the participants' parents/guardians who came to school during the distribution.

Phase 2: The pretest questionnaires were collected after two weeks. On the same day, the MALMath printed modules together with the self-concept, self-efficacy, and conceptual understanding printed post-test were distributed to their parents/guardians in the school. Also, students were given two (2) weeks to study and answer it.

Phase 3: After two (2) weeks, the modules and post-test questionnaires were collected. However, not all were retrieved during the day of the collection since some modules and questionnaires were submitted late. Eventually, the researcher came up with a final 40 participants.

The researcher analyzed all the data gathered in the study through statistical software. To determine students' self-concept, self-efficacy, and conceptual understanding, the

collected data were analyzed using descriptive statistics such as mean, frequency, and percentage. To determine the significant differences in the students' self-concept, self-efficacy, and conceptual understanding between the pretest and post-test, a parametric paired t-test was utilized.

3. RESULTS AND DISCUSSIONS

This section presents how the findings were analyzed and interpreted in order to test the hypotheses. Tables and other figures are also included to make data analysis easier. The presentation is in the same order as the objectives of the study.

Table 1 presents the level of students' self-concept toward mathematics in terms of their self-image. The table shows the pretest and post-test of students after their exposure to MALMath. The level of self-concept was shown through the mean score followed by a qualitative interpretation.

Table 1: Students' self-concept in terms of self-image before and after their exposure to MALMath.

Self-concept towards Mathematics	Pretest		Post-test	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
Self-image (Learned)				
1. I have never felt incapable of learning Math	3.28	Moderate	3.18	Moderate
2. I am capable of making a good grade in Mathematics.	3.28	Moderate	3.18	Moderate
3. In my Mathematics class, I understand even the most challenging work.	2.85	Moderate	2.75	Moderate
4. I learn Mathematics quickly	2.53	Moderate	3.00	Moderate
5. I am good at Mathematics.	2.33	Low	2.78	Moderate
Overall Mean Interpretation	2.85	Moderate	2.98	Moderate

As shown in Table 1, three (3) items with the highest means before intervention are "I have never felt incapable of learning Math" (3.28), "I am capable of making a good grade in Mathematics" (3.28), and "In my Mathematics class, I understand even the most challenging work" (2.85). On the other hand, the three items with the highest means after intervention are "I have never felt incapable of learning Math" (3.18), "I am capable of making a good grade in Mathematics" (3.18), and "I learn Mathematics quickly" (3.00).

Moreover, Table 1 also shows two (2) items with the lowest mean in the pretest, these are: "I learn Mathematics quickly" (2.53) and "I am good at Mathematics" (2.33). On the other hand, the two (2) items with the lowest mean in the post-test are: "I am good at Mathematics" (2.78) and "In my Mathematics class, I understand even the most challenging work" (2.75).

The overall self-concept pretest and post-test mean scores of students in terms of self-image are 2.85 and 2.98, respectively. This implies a moderate self-concept of students in Mathematics in terms of self-image. Despite the fact that their self-image levels are the same moderate, it is noteworthy to mention that students had a relatively higher self-image after their exposure to MALMath. This implies that students had a better self-image of how they perceived their performance in mathematics.

The result of the study revealed that students had a moderate level of self-concept in terms of their self-image in pretest and post-test after their exposure to MALMath. The reason for this could be their belief that they are not always capable of learning Mathematics during modular distance learning, especially since they believed that Mathematics is a very challenging subject. In addition, the belief that they are not always capable of making good grades in Mathematics could be the reason for their moderate level of self-image after their exposure to MALMath. The result conforms to the study [3], where students had a moderate level of self-concept in terms of self-image. Based on the findings, students had a partial feeling that they are capable of learning Math, capable of making a good grade, and understanding even the most challenging work in their Mathematics class. Consequently, the findings contradict the study [34], where students have a strong belief that they have the ability to learn mathematics. They also have high hopes and positive thoughts that no matter how difficult the process of dealing with mathematics is, they will be able to learn it at the right time.

Table 2 presents the level of students' self-concept toward mathematics in terms of their self-esteem. The table shows the pretest and post-test of students after their exposure to MALMath. The level of self-concept was shown through the mean score followed by a qualitative interpretation.

Table 2: Students' self-concept in terms of self-esteem before and after their exposure to MALMath.

Self-concept towards Mathematics	Pretest		Post-test	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
Self-esteem (Organized)				
6. I usually do well in Mathematics.	3.13	Moderate	3.18	Moderate
7. I get good marks in Mathematics	3.05	Moderate	3.08	Moderate
8. Mathematics is more enthusiastically for me than for a significant number of my schoolmates	3.00	Moderate	3.15	Moderate
9. I have dependably accepted that Mathematics is a standout amongst my best subjects.	2.70	Moderate	2.90	Moderate
10. Mathematics is an easy subject to pass	2.50	Low	2.60	Moderate
Overall Mean Interpretation	2.88	Moderate	2.98	Moderate

As shown in Table 2, three (3) items with the highest means before intervention are, "I usually do well in Mathematics" (3.13), "I get good marks in Mathematics" (3.05), and "Mathematics is more enthusiastically for me than for a significant number of my schoolmates" (3.00). On the other hand, the three items with the highest means after intervention are, "I usually do well in Mathematics" (3.18), "Mathematics is more enthusiastically for me than for a significant number of my schoolmates" (3.15), and "I get good marks in Mathematics" (3.08).

Moreover, Table 2 also shows two (2) items with the lowest mean in pretest, these are: "I have dependably accepted that Mathematics is a standout amongst my best subjects." (2.70) and "Mathematics is an easy subject to pass" (2.50). Similarly, the two (2) items with the lowest mean in the post-test are, "I have dependably accepted that Mathematics is a standout amongst my best subjects." (2.90) and "Mathematics is an easy subject to pass" (2.60).

The overall self-concept pretest and post-test mean scores of students in terms of self-esteem are 2.88 and 2.98, respectively. This implies a moderate self-concept of students in Mathematics in terms of self-esteem before and after the intervention. Although they are of the same moderate, it is noteworthy to mention that students had relatively higher self-esteem in the post-test. This implies that students had improved self-esteem on how they perceived themselves in terms of their abilities and limitations in Mathematics after their exposure to MALMath.

The result of the study revealed that students had a moderate level of self-concept in terms of their self-esteem in the pretest and post-test after their exposure to MALMath. Students' moderate level of self-esteem could be based on their experiences that they don't usually do well in solving mathematics problems and that they don't usually get good grades. In addition, their belief that Mathematics is not an easy subject to pass could also be a factor in not having an increased level of self-esteem after their exposure to MALMath. The result conforms to the study [3], where the level of self-concept of the respondents is moderate in terms of self-esteem. Based on the findings, students had a moderate feeling that they usually do well and get good marks in Mathematics. In comparison to others, they were reasonably enthusiastic about mathematics, and to some extent, they accepted that mathematics was one of their best subjects; however, they do not believe that mathematics is an easy subject to pass. This suggests that it is a challenging subject. Similar findings [35] were obtained that the secondary students had a medium level of self-esteem in Mathematics.

Consequently, the findings contradict the study [34] where students were found highly enthusiastic about participating in mathematics activities. Moreover, no matter how many students believed that mathematics was difficult, they knew that if they gave it a try, they could do it. Also, there were students who diligently kept moving forward and later recognized the value of their perseverance in learning mathematics.

Table 3: Students' self-concept in terms of ideal-self before and after their exposure to MALMath.

Self-concept towards Mathematics	Pretest		Post-test	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
Ideal-self (Dynamic)				
11. Mathematics is essential in the future.	4.15	High	3.95	High
12. I can do practically all the work in Mathematics class if I do not give up.	3.65	High	3.75	High
13. Mathematics improves my learning and retention capacities.	3.55	High	3.58	High
14. Mathematics improves my understanding of other subjects.	3.28	Moderate	3.80	High
15. I feel delighted when answering Mathematics questions	3.10	Moderate	3.13	Moderate
Overall Mean Interpretation	3.55	High	3.64	High

Table 3 presents the level of students' self-concept toward mathematics in terms of their ideal self. The table shows the pretest and post-test of students after their exposure to MALMath. The level of self-concept was shown through the mean score followed by a qualitative interpretation.

As shown in Table 3, three items with the highest means before intervention are, "Mathematics is essential in the future" (4.15), "I can do practically all the work in Mathematics class if I do not give up" (3.65), and "Mathematics improves my learning and retention capacities" (3.55). On the other hand, the three items with the highest means after the intervention is, "Mathematics is essential in the future" (3.95), "Mathematics improves my understanding of other subjects" (3.80), and I can do practically all the work in Mathematics class if I do not give up (3.75).

Moreover, Table 3 also shows two (2) items with the lowest mean in the pretest, these are: "Mathematics improves my understanding of other subjects" (3.28) and "I feel delighted when answering Mathematics questions" (3.10). On the other hand, the two (2) items with the lowest mean in the post-test are, "Mathematics improves my learning and retention capacities" (3.58) and "I feel delighted when answering Mathematics questions" (3.13).

The overall self-concept pretest and post-test mean scores of students in terms of ideal-self are 3.55 and 3.64, respectively. This implies a high self-concept of students in Mathematics in terms of the ideal self. Despite the fact that their ideal-self are the same moderate, it is noteworthy to mention that students had relatively higher ideal-self after their exposure to MALMath. This implies that students had an increased ideal self on how they visualize themselves learning Mathematics in the future and how they perceived Mathematics as a whole. Despite this, there was no significant change in their level of the ideal self.

The result of the study revealed that students had a high level of self-concept in terms of their ideal self in the pretest and post-test after their exposure to MALMath. The high level of ideal self of students could be based on their belief that Mathematics is essential for life and that they can practically do all the work in Mathematics if they just persevere. A similar study [34] revealed that students were found to be optimistic about their ability to complete mathematical tasks and to recognize the importance and role of mathematics in their future lives. Consequently, the findings contradict the study [3] where respondents' self-concept is moderate based on their ideal self. The contradiction of results could be due to their belief that mathematics will be moderately essential in the future. This indicates that they moderately regard the subject as important in their lives because it might be reasonably useful in the future. They also reasonably believed they could apply what they had learned in mathematics to their daily lives. In addition, to a certain extent, they believed that if they were persistent enough in completing their tasks, they could finish all of the math work.

Table 4 presents the summary of the students' self-concept in terms of their self-image, self-esteem, and ideal self before and after their exposure to MALMath. The level of self-concept was shown through the mean score followed by a qualitative interpretation.

As shown in Table 4, during the pretest, the source of self-concept with the highest mean is ideal-self (3.55), while the lowest is self-image (2.85).

Table 4: Summary of the students' self-concept before and after their exposure to MALMath.

Self-concept towards Mathematics	Pretest		Post-test	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
Self-image (Learned)	2.85	Moderate	2.98	Moderate
Self-esteem (Organized)	2.88	Moderate	2.98	Moderate
Ideal-self (Dynamic)	3.55	High	3.64	High
Overall Mean Interpretation	3.09	Moderate	3.20	Moderate

In the post-test, the source of self-concept with the highest mean is still ideal-self (3.64), while the lowest is self-image (2.98) tied to self-esteem (2.98).

Table 4 shows that the total self-concept means of students in pretest and post-test are 3.09 and 3.20, respectively, indicating a moderate self-concept. Students' moderate level of self-concept could be primarily based on their idea-self. This implies that students reasonably believe in the essence of Mathematics in their lives and its application in the future. Although their level of self-concept did not improve from moderate, it is noteworthy to mention that students had relatively higher self-efficacy after their exposure to MALMath. This implies that MALMath had reasonably impacted students' perceptions in terms of their current capabilities, confidence, and future vision toward learning Mathematics.

Students build their moderate self-concept mainly from their ideal self before and after their exposure to MALMath. They are convinced that mathematics will be important in the future. If they did not give up, they could complete almost all of the work in Mathematics class. A similar study [3] revealed that students' self-concept toward Mathematics is moderate. The respondents' self-concept needs to be strengthened in the study since students with a strong self-concept have a better likelihood of completing their activities than those with a low self-concept. In particular, the sources of self-concept from self-image and self-esteem need to be strengthened more to achieve a higher self-concept of students towards Mathematics since students were found to be relatively low in these sources of self-concept. Consequently, a different study [36] showed that students had a positive mathematics self-concept during the pandemic. This implies that they firmly believed in themselves in terms of their capabilities in dealing with mathematics problems during a pandemic.

Table 5 presents students' self-efficacy toward mathematics in terms of mastery experiences. The table shows the pretest and post-test of students after their exposure to MALMath. The level of self-concept was shown through the mean score followed by a qualitative interpretation.

As shown in Table 5, three (3) items with the highest means before intervention are, "I do well on math module" (3.05), "I have always been successful with math" (2.90), and "I do well on even the most difficult math problems" (2.85). Conversely, the three items with the highest means before intervention are, "I do well on math module" (3.33), "I got good scores in math" (3.08), and "I make excellent grades on math tests" (3.05).

Table 5: Students' self-efficacy in mastery experiences before and after their exposure to MALMath.

Self-efficacy towards Mathematics	Pretest		Post-test	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
Mastery Experiences				
1. I do well on math module	3.05	Moderate	3.33	Moderate
2. I have always been successful with math.	2.90	Moderate	2.68	Moderate
3. I do well on even the most difficult math problems	2.85	Moderate	2.93	Moderate
4. I make excellent grades on math tests.	2.80	Moderate	3.03	Moderate
5. I got good scores in math	2.78	Moderate	3.08	Moderate
6. Even when I study very hard, I do poorly in math*	2.63	Moderate	2.73	Moderate
Overall Mean Interpretation	2.83	Moderate	2.96	Moderate

*Negative indicators (scoring is reversed)

Moreover, Table 5 also shows the three (3) items with the lowest mean in the pretest, these are: "I make excellent grades on math tests" (2.80), "I got good scores in math" (2.78), and "Even when I study very hard, I do poorly in math" (2.63). On the other hand, the lowest three mean in the post-test are "I do well on even the most difficult math problems" (2.93), "Even when I study very hard, I do poorly in math" (2.73), and "I have always been successful with math" (2.68).

In terms of mastery experiences, the overall self-efficacy pretest and post-test mean scores of students are 2.83 and 2.96, respectively. This implies a moderate self-efficacy of students in Mathematics. However, even though students had the same moderate level of mastery experiences in pretest and post-test, it is noteworthy to mention its increase in the post-test. This implies that students had a better personal experience of the success of learning Mathematics after their exposure to MALMath.

The result of the study revealed that students had a moderate level of self-efficacy in terms of their mastery experiences in pretest and post-test after their exposure to MALMath. The moderate level of mastery experiences could be based on their experiences that they had quite good performances and had been successful in some exams in Mathematics but failed to do so in some of the others. The result conforms to the study [4], where students had a moderate level of self-efficacy in terms of mastery experiences before and after their exposure to the Gradual Release of Responsibility Instructional Model (GRRIM). Students believed to a certain extent that they could make excellent grades on math tests, be successful with math, and do well on math assignments even the most difficult ones. However, they also believed to a certain extent that they got good grades on their last report card and even though they study hard, they still do poorly in math. Also, this study conforms to the study [37], where students revealed a mid-level of mastery experiences during the new normal in education.

In terms of vicarious experiences, Table 6 shows the level of students' self-efficacy in mathematics. The table shows the pretest and post-test results of students when exposed to MALMath. The mean score was used to demonstrate the

level of self-concept, which was then interpreted qualitatively.

Table 6: Students' self-efficacy in terms of vicarious experiences before and after their exposure to MALMath.

Self-efficacy towards Mathematics	Pretest		Post-test	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
Vicarious Experiences				
7. Seeing kids do better than me in math pushes me to do better.	3.85	High	3.60	High
8. Seeing adults do well in math pushes me to do better.	3.53	High	3.68	High
9. I imagine myself working through challenging math problems successfully.	3.45	Moderate	3.70	High
10. When I see how another student solves a math problem, I can see myself solving the problem in the same way.	3.43	Moderate	3.70	High
11. When I see how an adult solves a problem, I can picture myself solving the problem in the same way.	3.30	Moderate	3.75	High
12. I compete with myself in math.	3.28	Moderate	3.60	High
Overall Mean Interpretation	3.47	Moderate	3.67	High

As shown in Table 6, the three (3) items with the highest means before intervention are, "Seeing kids do better than me in math pushes me to do better" (3.85), "Seeing adults do well in math pushes me to do better" (3.53), and "I imagine myself working through challenging math problems successfully" (3.45). Consequently, the items with the highest three (3) mean scores after intervention are, "When I see how an adult solves a problem, I can picture myself solving the problem in the same way" (3.75), "I imagine myself working through challenging math problems successfully" (3.70), and "When I see how another student solves a math problem, I can see myself solving the problem in the same way" (3.70).

Moreover, Table 6 also shows the three (3) items with the lowest mean in the pretest, these are, "When I see how another student solves a math problem, I can see myself solving the problem in the same way" (3.43), "When I see how an adult solves a problem, I can picture myself solving the problem in the same way" (3.30), and "I compete with myself in math" (2.28).

In terms of vicarious experiences, the overall self-efficacy pretest and post-test mean scores of students are 3.47 and 3.67, respectively. This implies students' moderate and high self-efficacy in Mathematics in the pretest and post-test, respectively. Hence, it is noteworthy to mention the level of increase in students' vicarious experiences from moderate to high after their exposure to MALMath. This implies that students are definitely impacted by the success they observed from others which resulted in them having even better vicarious experiences.

The result of the study revealed that students had a moderate and high level of vicarious experiences in pretest and post-test, respectively. The moderate level of self-efficacy in the pretest could be based on their experiences that seeing other students and adults do well in math pushed them to do better. The high level of self-efficacy in the post-test, on the other hand, could be based on their experience of seeing how adults and other students solve a problem and seeing themselves solving the problem in the same way. The result conforms to the study of [4], where students had a moderate level of vicarious experiences before their exposure to GRRIM. However, the finding contradicts when students still have a moderate level of vicarious experiences after their exposure to MALMath. Students only believed to a certain extent that seeing other students and adults succeed in school motivates them to do better and pushed them to become successful in solving difficult math problems. Furthermore, this finding conforms to the study [37], in which students revealed a mid-level of vicarious experiences during the new normal in education.

In terms of social persuasion, Table 7 shows the level of students' self-efficacy in mathematics. The table depicts the pretest and post-test results of students when exposed to MALMath. The mean score was used to demonstrate the level of self-concept, which was then interpreted qualitatively.

Table 7: Students' self-efficacy in terms of social persuasion before and after their exposure to MALMath.

Self-efficacy towards Mathematics	Pretest		Post-test	
	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
Social Persuasion				
13. Adults in my family have told me what a good math student	2.83	Moderate	3.15	Moderate
14. My classmates like to work with me in math because they think I'm good at it.	2.75	Moderate	2.90	Moderate
15. People have told me that I have a talent for math.	2.68	Moderate	2.88	Moderate
16. I have been praised for my math ability.	2.68	Moderate	3.23	Moderate
17. My math teachers have told me that I am good at learning math.	2.65	Moderate	3.13	Moderate
18. Other students have told me that I'm good at learning math.	2.58	Moderate	2.83	Moderate
Overall Mean Interpretation	2.69	Moderate	3.02	Moderate

As shown in Table 7, three (3) items with the highest means before intervention are, "Adults in my family have told me what a good math student" (2.83), "My classmates like to work with me in math because they think I'm good at it" (2.75), and "People have told me that I have a talent for math" (2.68) tied with "I have been praised for my math ability" (2.68). Consequently, the items with the highest three (3) mean scores after intervention are, "I have been praised for my math ability" (3.23), "Adults in my family have told me what a good math student" (3.15), and "My math teachers have told me that I am good at learning math" (3.13).

Moreover, as shown in Table 7, the two (2) items with the lowest mean in the pretest are, "My math teachers have told me that I am good at learning math" (2.65) and "Other students have told me that I'm good at learning math" (2.58). On the other hand, the three (3) items with the lowest mean in the post-test are, "Other students have told me that I'm good at learning math" (3.02), "My classmates like to work with me in math because they think I'm good at it" (2.90), and "People have told me that I have a talent for math" (2.88).

In terms of social persuasion, the overall self-efficacy pretest and post-test mean scores of students are 2.69 and 3.02, respectively. This implies a moderate level of social persuasion in Mathematics. Although the level of social persuasion received by students did not change from

moderate, it is noteworthy to mention the improvement of social persuasion gained by the students in the post-test. This implies that words of encouragement can boost students' morale in learning Mathematics.

The result of the study revealed that students had a moderate level of self-efficacy in terms of their social persuasion in their pretest and post-test after their exposure to MALMath. The moderate level of social persuasion received by students could be based on the social support coming from their family members and teachers. This implies that students do not get more than enough courage and confidence from those they admire in order to be motivated to learn Mathematics. The result of this study conforms to the study [4], where, in terms of social Persuasion, students had a moderate level of self-efficacy in the pretest and post-test after their exposure to GRRIM. This implies that they did not receive much social persuasion from their math teacher, classmates, schoolmates, adults, and other people in terms of their abilities in Mathematics. Likewise, this finding is parallel to the study [37], in which students revealed a mid-level of social persuasion during the new normal in education.

In terms of emotional and physiological states, Table 8 shows the level of students' self-efficacy in mathematics. The table depicts the pretest and post-test results of students when exposed to MALMath. The mean score was used to demonstrate the level of self-concept which was then interpreted qualitatively.

Table 8: Students' self-efficacy in terms of emotional and physiological states before and after their exposure to MALMath.

	Pretest		Post-test	
Self-efficacy towards Mathematics	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
Emotional and Physiological States				
19. I get depressed when I think about learning math. *	2.95	Moderate	2.98	Moderate
20. My mind goes blank, and I am unable to think clearly when doing math work. *	2.80	Moderate	3.03	Moderate
21. I start to feel stressed out as soon as I begin my math work. *	2.75	Moderate	2.85	Moderate
22. Just being in math class makes me feel stressed and nervous. *	2.68	Moderate	3.03	Moderate
23. Doing math work takes all of my energy. *	2.60	Moderate	2.65	Moderate
24. My whole body becomes tense when I have to do math*	2.55	Moderate	2.93	Moderate
Overall Mean Interpretation	2.72	Moderate	2.91	Moderate

*Negative indicators (scoring is reversed)

As shown in Table 8, three (3) items with the highest means before intervention are, "I get depressed when I think about learning math" (2.95), "My mind goes blank, and I am unable to think clearly when doing math work" (2.80), and, "I start to feel stressed out as soon as I begin my math work" (2.75). Consequently, the items with the highest three (3) mean scores after the intervention is, "My mind goes blank, and I am unable to think clearly when doing math work" (3.03), "Just being in math class makes me feel stressed and nervous" (3.03), and "I get depressed when I think about learning math" (2.98).

Moreover, as shown in Table 8, the three (3) items with the lowest mean in the pretest are, "Just being in math class makes me feel stressed and nervous" (2.68), "Doing math work takes all of my energy" (2.60), and "My whole body becomes tense when I have to do math" (2.55). Consequently, the items with the lowest three (3) mean scores after intervention are, "My whole body becomes tense when I have to do math" (2.91), "I start to feel stressed out as soon as I begin my math work" (2.85), and "Doing math work takes all of my energy" (2.65).

In terms of emotional and physiological states, the overall self-efficacy pretest and post-test mean scores of students are 2.72 and 2.91, respectively. This implies a moderate self-efficacy of students in Mathematics. Even though the level of emotional and physiological states did not change from moderate, it is worthy to mention that it increased after their exposure to MALMath. This implies that mobile application reduces the emotional stress of students caused by the difficulty of learning Mathematics during modular distance learning.

The result of the study revealed that students had a moderate level of self-efficacy in terms of their emotional and physiological states before and after their exposure to MALMath. This could be explained by their experiences of becoming depressed whenever they think about studying Mathematics. Hence, their minds go blank, making it difficult for them to think clearly. The result conforms to the study [4] where students had a moderate level of self-efficacy in terms of emotional and physiological states before and after their exposure to GRRIM. This implies that they reasonably felt nervous, stressed, and tensed once they began their math work. Similarly, this shares the same finding [37], in which students revealed a mid-level of emotional and physiological states during the new normal in education.

Table 9 summarizes students' self-efficacy in terms of mastery experiences, vicarious experiences, social persuasion, and emotional and physiological states before and after their exposure to MALMath. The level of self-efficacy was shown through the mean score followed by a qualitative interpretation.

Table 9: Summary of the students' self-efficacy before and after their exposure to MALMath.

	Pretest		Post-test	
Self-efficacy towards Mathematics	Mean	Qualitative Interpretation	Mean	Qualitative Interpretation
Mastery Experiences	2.83	Moderate	2.96	Moderate
Vicarious Experiences	3.47	Moderate	3.67	High
Social Persuasion	2.69	Moderate	3.02	Moderate
Emotional and Physiological States	2.72	Moderate	2.91	Moderate
Overall Mean Interpretation	2.93	Moderate	3.14	Moderate

As shown in Table 9, during the pretest, the source of self-efficacy with the highest mean is vicarious experiences (3.47), while the lowest is social persuasion (2.69). In the post-test, the source of self-concept with the highest mean is still vicarious experiences (3.647), while the lowest is emotional and physiological states (2.91).

Table 9 shows that the total means self-efficacy of students before and after their exposure to MALMath are 2.93 and 3.14, respectively, indicating moderate self-efficacy. Although their self-efficacy levels are the same moderate, it

is worth emphasizing that students had relatively higher self-efficacy after their exposure to MALMath. This implies that students are positively influenced by their performance outcomes, social role models, encouragements, and disposition towards Mathematics after their exposure to MALMath.

Since students have a relatively higher self-efficacy in terms of vicarious experiences, it implies that students build their self-efficacy mainly from their vicarious experiences before and after their exposure to MALMath. They firmly believed that seeing kids and adults do well pushed them to do better. They believed that they could imagine themselves working through challenging math problems successfully when they see how another student and adult solves a problem. Also, they strongly believed that they competed within themselves when learning math.

The result of the study revealed that students had a moderate level of self-efficacy before and after their exposure to MALMath. The moderate level of self-efficacy could be based on their vicarious experiences. Students are reasonably influenced by what they have observed from their peers and family members in terms of working and completing their tasks in Mathematics. The findings conform to the study [4], where students' self-efficacy toward Mathematics is moderate. The respondents' main source of self-efficacy in Mathematics was their vicarious experiences when exposed to GRIMM. They compare their math performance to others to evaluate how well they are doing. They also enjoy comparing their performance to their classmates and adults, when assessing their own mathematical abilities. Similarly, this finding conforms to the study [37], where students in the new normal education only exhibit a mid-level self-efficacy in Mathematics. However, this finding contradicts the research results [38] that students had positive self-efficacy beliefs in Mathematics before and after their exposure to RATE.

Table 10 presents the mathematics conceptual understanding of students in the pretest and post-test after exposure to MALMath. Students' conceptual understandings were shown through frequency, percentages, and overall mean score, followed by qualitative interpretation.

Table 10: Conceptual understanding of students before and after the intervention.

Range	Pretest		Post-test		Qualitative Interpretation
	f	%	*f*	%	
5.00	1	2.5	2	5.0	Full Conceptual Understanding
3.00 - 4.99	4	10.0	9	22.5	Partial Conceptual Understanding
1.00 - 2.99	35	87.5	29	72.5	Lack Conceptual Understanding
	$\bar{x}$ = 1.59		$\bar{x}$ = 2.40		Lack Conceptual Understanding

As shown in the Table, in terms of pretest, 1 student or 2.5% of the students had full conceptual understanding, 4 students or 10% had partial conceptual understanding, and 35 students or 87.5% of the students lacked conceptual understanding. On the other hand, in terms of post-test, 2 students or 5% of the students had full conceptual understanding, 9 students or 22.5% of the students had partial conceptual understanding, and 29 students or 72.5% of the students had a low conceptual understanding.

Moreover, the overall mean score of the students in the pretest is 1.59, which indicates a lack of conceptual understanding. Meanwhile, in the post-test, students got an overall mean score of 2.40, which also shows a lack of conceptual understanding. However, it is worth mentioning that students had relatively higher conceptual understanding after the intervention. This implies that after their exposure to MALMath, they improve their scores.

Based on the pretest and post-test, only a few students had a full conceptual understanding of Mathematics with 1 and 2 students, respectively. Similarly, only a few students had a partial conceptual understanding of Mathematics with 4 and 9 students. On the other hand, the majority of the population lacked conceptual understanding, with 35 and 29 students, respectively. However, it is noteworthy to mention the decrease in the number of students with a lack of conceptual understanding after the intervention. This implies that some of the students were able to improve after their exposure to MALMath.

The study revealed that students have a lack of conceptual understanding before and after their exposure to MALMath. The lack of conceptual understanding could be based on their difficulty learning Mathematics during modular distance learning. However, minor improvements were still shown in their scores. Hence, the minor improvement could be caused by the answers and some explanations provided by the math mobile application. The findings of this study conform to the study [7] when they found a very low conceptual understanding in the pretest before Photo math assisted them on System of Linear Equations in Two Variables (SELTV). However, they discovered that students' conceptual understanding improved in their post-test, but the improvement was still in the low category.

Figure 3 presents the sample work of students with lack of conceptual understanding. As shown, the student was not able to answer the problem completely. Based on the solution, the student missed some parts of it. Hence, it could be easily concluded that the student just copied the solution in the mobile application without properly understanding the problem.

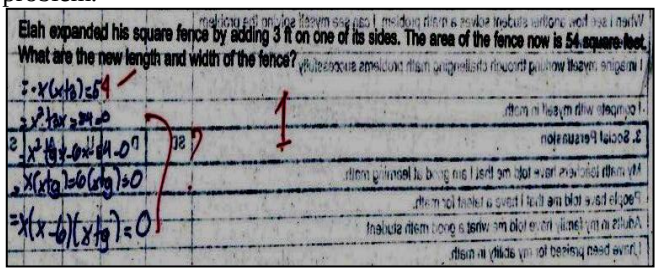

Figure 3. Students' sample work lacks conceptual understanding.

Figure 4 presents the sample work of students with partial conceptual understanding. As shown, the student could get the values of x correctly. However, the student was not able to address the problem being asked. Hence, it could be easily concluded that the student is just merely solving the values of x and not properly understanding what is being asked by the problem.

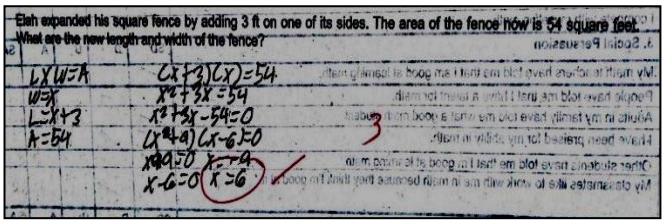

Figure 4. Student's sample work with partial conceptual understanding.

Figure 5 shows an example of a student's work that demonstrates full conceptual knowledge. As shown, the student provided solutions in a step-by-step manner. The student started by writing the formula and equation of the problem. The student then derived the values of x. Lastly, the student ended by answering the problem and giving a conclusion.

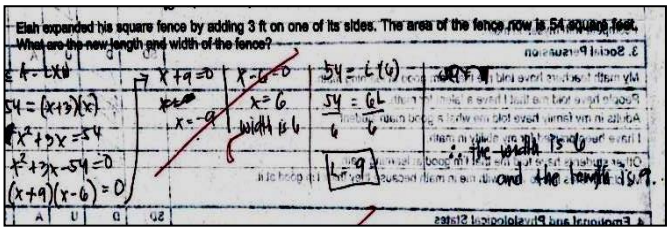

Figure 5. Student's sample work with full conceptual understanding.

Table 11 presents the test of significant difference on students' self-concept before and after their exposure to MALMath. The data results revealed the pretest mean scores, self-image (M = 2.85, SD = 0.57); self-esteem (M = 2.88, SD = 0.67) and ideal-self (M = 3.55, SD = 0.72). While in the post-test mean scores, self-image (M = 2.98, SD = 0.68); self-esteem (M = 2.98, SD = 0.70) and ideal-self (M = 3.64, SD = 0.68).

Table 11: Test of significant difference in students' self-concept before and after their exposure to MALMath.

Self-concept towards Mathematics		Mean	Std. Dev.	t-value	P-value
Self-image	Pretest	2.85	0.57	-1.226	0.228^{ns}
	Post-test	2.98	0.68		
Self-esteem	Pretest	2.88	0.67	-1.090	0.282^{ns}
	Post-test	2.98	0.70		
Ideal-self	Pretest	3.55	0.72	-.915	0.366^{ns}
	Post-test	3.64	0.68		
Overall Self-concept	Pretest	3.09	0.58	-1.358	0.182^{ns}
	Post-test	3.20	0.59		

Legend: ns = not significant

The result of the test indicated an overall pretest mean score of 3.09 (SD = 0.58) and an overall post-test mean score of 3.20 (SD = 0.59), t = -1.358, p = 0.182. Hence, we do not reject the null hypothesis. Therefore, there is no significant difference in students' self-concept before and after exposure to MALMath. This result is consistent among student' self-image, self-esteem, and ideal self where there is no significant difference with the values of t = -1.226, p = 0.228; t = -1.090, p = 0.282 and t = -0.915, p = 0.366, respectively.

The study found that there is no significant difference in students' self-concept before and after their exposure to MALMath. Similarly, all the self-concept indicators were found not significant after their exposure to MALMath. The insignificant result could be based on the stagnant level of their self-image, self-esteem, and ideal self as they assess their real capabilities, confidence, and personal vision towards learning Mathematics after exposure to MALMath. This implies that students' self-concept needs to be improved because it affects their performance in Mathematics. The result conforms to the finding [39], wherein there was no significant difference in students' self-concept between the pretest and post-test in the control group. However, the result contradicts after students' exposure to peer tutoring in the experimental group wherein there was a significant difference in students' self-concept between the pretest and post-test. This result also contradicts the findings [40], which found that students had a better mathematics self-concept when exposed to Jigsaw learning strategy than taught using traditional teaching methods.

Table 12 presents the test of significant difference on students' self-efficacy before and after their exposure to MALMath. The data results revealed that the pretest mean scores, mastery experiences (M = 2.83, SD = 0.58); vicarious experiences (M = 3.47, SD 0.80); social persuasion (M = 2.69, SD = 0.76) and emotional and physiological states (M = 2.72, SD = 0.86). On the other hand, these are the post-test mean scores, mastery experiences (M = 2.96, SD = 0.68); vicarious experiences (M = 3.67, SD 0.67); social persuasion (M = 3.02, SD = 0.75) and emotional and physiological states (M = 2.91, SD = 0.85).

Table: 12 Test of significant difference in students' self-efficacy before and after their exposure to MALMath.

Self-efficacy towards Mathematics		Mean	Std. Dev.	t-value	P-value
Mastery Experiences	Pretest	2.83	0.58	-1.282	0.207^{ns}
	Post-test	2.96	0.68		
Vicarious Experiences	Pretest	3.47	0.80	-1.488	0.145^{ns}
	Post-test	3.67	0.67		
Social Persuasion	Pretest	2.69	0.76	-2.576	0.014^{*}
	Post-test	3.02	0.75		
Emotional and Physiological States	Pretest	2.72	0.86	-1.635	0.110^{ns}
	Post-test	2.91	0.85		
Overall Self-efficacy	Pretest	2.93	0.45	-2.576	0.014^{*}
	Post-test	3.14	0.53		

Legend: *significant at 0.05
ns not significant at 0.05

The result of the test indicated the overall pretest mean score of 2.93 (SD = 0.45) and the overall post-test mean score of 3.14 (SD = 0.53) with a t-value of -2.576 (p = 0.014). Hence, we reject the null hypothesis. This means that there is a significant difference in students' self-efficacy before and after exposing them to MALMath. However, among the four indicators, only social persuasion obtained a pretest mean score of 2.69 (SD = 0.76) and a post-test mean score of 3.02 (SD = 0.75) with a t-value of -2.417 (p = 0.014), which is less than the significant threshold of 0.05.

The study found that there is a significant difference in students' self-efficacy before and after their exposure to MALMath. Also, the study revealed that among the four indicators of self-efficacy, only social persuasion was found to be significant after their exposure to MALMath. Hence, the significant improvement in students' self-efficacy was mainly attributed to the social persuasion coming from their family members, teachers, classmates, friends, and all the people

who believed in them to do well in Mathematics. This implies that receiving verbal encouragement from others enables students to overcome self-doubt and instead motivates them to do their best in learning Mathematics. The findings of this study conform to the study [41], where the self-efficacy level of students exposed to DA is significantly higher than those exposed to non-DA. Consequently, the result contradicts the findings [4] which revealed that there is no significant difference in the self-efficacy of students exposed to GRRIM compared to those exposed to non-GRRIM.

Table 13 presents the significant difference in student's conceptual understanding before and after exposing them to MALMath. The data results revealed the pretest mean score (M = 1.59, SD = 1.06) and post-test mean score (M = 2.40, SD = 1.25)

Table 13: Test of significant difference in students' conceptual understanding of Mathematics before and after Intervention.

Conceptual Understanding of Mathematics	Mean	Std. Deviation	t-value	P-value
Pretest	1.59	1.06	-4.423	0.000*
Post-test	2.40	1.25		

Legend: *significant at 0.05

The result of the test indicated an overall pretest mean score of 1.59 (SD = 1.06) and an overall post-test mean score of 2.40 (SD = 1.25) with a t-value of -4.423 (p = 0.000). Hence, we reject the null hypothesis. This means that there is a significant difference in the conceptual understanding of students before and after exposing them to MALMath

The study revealed that MALMAth was found to be significantly helpful in increasing students' conceptual understanding in Mathematics. The significant result could be based on their experiences where they found it helpful in terms of providing explanations and answers. Although students' conceptual understanding is still considered lacking after their exposure to MALMath, the minor improvement implies sufficient empirical evidence that it helps them foster a better conceptual understanding in Mathematics. The findings of this study conform to the study [7] which found that the teaching and learning process assisted by Photomath on System of Linear Equations in Two Variables (SELTV) materials can improve the students' conceptual understanding. However, the improvement is still considered in the low category. Similarly, the result corresponds to the study [42] which found significant improvement in students' conceptual understanding when exposed to Microsoft Mathematics. The pretest and post-test mean scores of students with their conceptual understanding of Mathematics are fair and satisfactory, respectively. Hence, this little change implies a significant improvement in their conceptual understanding of Mathematics when exposed to Microsoft Mathematics.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of the study, the following conclusions are drawn:

The level of students' self-concept in Mathematics before and after their exposure to MALMath is moderate. Specifically, in terms of self-image and self-esteem, students have a moderate self-concept before and after their exposure to MALMath. On the other hand, in terms of ideal self, students have a high self-concept before and after exposure to MALMath.

The level of students' self-efficacy in Mathematics before and after their exposure to MALMath is moderate. Specifically, in terms of mastery experiences, social persuasion, and emotional and physiological states, students had moderate self-efficacy before and after exposure to MALMath. However, in terms of vicarious experiences, students had moderate and high self-efficacy before and after their exposure to MALMath, respectively.

Students lack conceptual understanding in Mathematics before and after their exposure to MALMath.

There is no significant difference in students' self-concept in Mathematics before and after their exposure to MALMath. Similarly, the three indicators of self-concept, namely: self-image, self-esteem, and ideal self, were found to have no significant difference before and after their exposure to MALMath.

There is a significant difference in students' self-efficacy in Mathematics before and after their exposure to MALMath. However, three self-efficacy indicators, namely: mastery experiences, vicarious experiences, and emotional and physiological states, were shown to have no significant difference before and after their exposure to MALMath except for social persuasion.

There is a significant difference in student's conceptual understanding of Mathematics before and after exposure to MALMath.

Based on the findings and conclusions, the following recommendations are given:

Teachers and administrators are highly recommended to simplify Mathematics that can be easily understood by the students to boost their self-concept to be successful in learning Mathematics, especially since their self-image and self-esteem were only moderate after their exposure to MALMath. Also, they are strongly encouraged to avoid assigning complicated tasks, provide constructive feedback, and give compliments on students' work to promote success in Mathematics, most especially that their self-efficacy in terms of mastery experiences, social persuasion, and emotional and psychological states were found to be moderate after their exposure to MALMath. They are highly suggested to not just give students simple mathematical equations to solve. Hence, the learning competencies about problem-solving should not be skipped in providing lessons to foster in-depth conceptual understanding of students in Mathematics. Moreover, they are highly encouraged to further develop the integration of math mobile applications into the curriculum to positively improve students' self-concept in Mathematics even though students' self-concept after exposure to MALMath was not found to be significant since it is viewed as a critical aspect of their success in Mathematics. Consequently, they are strongly advised to continue to develop math mobile applications to boost students' self-efficacy in Mathematics which is frequently seen as a critical learning outcome that influences the learning process since it was found to be significantly helpful after their exposure to MALMath. And finally, they are highly endorsed to apply various mobile applications such as Desmos and Geogebra to different topics in Algebra to

enhance students' conceptual understanding of Mathematics since it is a vital aspect of problem-solving. Although the result was found to be significant after their exposure to MALMath, their conceptual understanding of Mathematics was still found to be in the lacking category. To understand the reasons behind students' lack of conceptual understanding after their exposure to MALMath, it is advised to conduct a quantitative study for a longer period of implementation. In addition, a quasi-experimental study is also highly recommended to test the significant difference in students' conceptual understanding exposed to MALMath and Non-MALMath specifically after the pandemic when face-to-face classes are back.

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