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Improving the Computational Skills in Integers, Fractions, and Decimals Through Technology-Enhanced Mathematics Instruction (TEMI)

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Abstract Advances in instructional technologies for teaching mathematics are seen as an effective method of learning. Several studies have shown that technology-enhanced mathematics instruction (TEMI) is effective in enhancing the transfer of learning to mathematics students. This study investigates the effect of TEMI on the computational skills in integers, fractions, and decimals of the Grade 7 students at Dologon National High School, focusing on the level of the students' computational skills and the effectiveness of TEMI in their learning, as well as the learning experiences of the students who experienced the TEMI intervention.The study employed a quasi-experimental pretest-posttest design that compared the scores of the control group and the experimental group before and after the TEMI intervention. Simple random sampling was used in selecting the two groups of respondents. The study further used descriptive statistics such as means, frequencies, and standard deviation in analyzing the computational skills scores of the students and the Likert scale questionnaire that solicited learning experiences from the TEMI group. It utilized the independent t-test in comparing the mean scores between the experimental and control groups, while a 0.05 level of significance was used to test the significance of the difference between the two independent means.Results show that the level of computational skills of the experimental and control groups before exposure to TEMI showed no significant difference; however, when TEMI was applied to the experimental group, there was a highly significant difference in the posttest scores of the two groups. Moreover, the findings from the learning experiences of the students in the TEMI group showed that they had pleasant learning experiences, and TEMI motivated the students to enjoy the learning. These findings prove that, indeed, TEMI as an intervention was very effective in enhancing the computational skills of the Grade 7 students at Dologon National High School.

Keywords: *Experimental, Controlled, TEMI, Integers, Fractions, and Decimals*

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1. Introduction

The results of some evaluations of Filipino students' mathematics learning are very discouraging. In 1999, an international test was conducted in 38 countries to assess grade 8 students' mathematical achievement. Trends in International Mathematics and Science Studies (TIMSS) reported that the Philippines ranked third from the bottom of the participating countries. The Philippines got an average score of 345. After four years, in 2003, there was a slight increase in the scores that the Grade 8 students got in TIMSS [1]. The Philippines got an average score of 378, but the ranking of the country dipped 1 rank since it was ranked second from the bottom. Since then, the Grade 8 students of the Philippines have not participated in the TIMSS test as the Department of Education struggles to improve the mathematics achievement of the Filipino students. Instead, the Department of Education gauges the achievement of Filipino students by administering the National Achievement Test (NAT) every year. However, according to Junio-Sabio et al. [2]. Consolidated Test Result Learning Outcomes in Mathematics from 2013 to 2018, the MPS clearly differs by grade or level. From 81.94 in SY 2013–2014 to 78.59 in SY 2017–2018, the MPS has steadily fallen. It shows students' math performance over the course of five school years, with a downward trend regardless of school year. Their overall performance is deteriorating as the year continues.

Now that the students are gradually adjusting to the "old normal," which is face-to-face classes in the school year 2022-2023, the researcher has a lot of questions on his mind. Did the students learn their lessons during the pandemic? What are the ways to help the students improve their performance, particularly in mathematics?

The teacher's role is important in designing manipulatives and assisting students in using them successfully. Researchers have discovered that, as valuable as manipulatives are, teachers confront challenges in bridging the gap between manipulative knowledge and math symbolization and abstraction [3]. There has been a rise in interest in incorporating technology into the teaching and learning of mathematics. Students with good attitudes and confidence in their abilities to do mathematics, develop mathematical knowledge, and visualize abstract mathematical concepts have benefited from the use of technology in mathematics education.

TEMI stands for technology-enhanced mathematics instruction. There is already precedent for this study using the concept of TEMI. This was done by Carlos Marrero in his dissertation, "Implementing Technology-Enhanced Mathematical Instruction in an Algebra I Course to Increase Students' Academic Achievement in Mathematics." According to Marrero [4], in general, the satisfaction and motivation levels among the students in the treatment group about their learning experience using TEMI approaches were significantly high. Moreover, in every statement asking students about their perception of the use of technology in mathematics, students showed a positive attitude toward the TEMI experience. The numbers represented most of the respondents. Conclusively, 84% of the participants expressed their desire to continue the learning of algebra by using technology in class. In another TEMI study conducted by Young [5], results indicate that technology function and study quality are major contributors to effect size variation. Computation enhancement technologies, in particular, are most effective in students' mathematical learning processes. Teachers are also mandated by DepEd Order No. 42, s. 2017, issued on August 11, 2017, on the national adoption and implementation of the Philippine Professional Standards for Teachers (PPST), which stipulates that under domain 4 (curriculum and planning), the highest stage in the career stages of a teacher is called a "distinguished teacher" [6]. A distinguished teacher models exemplary skills and leads colleagues in the development and evaluation of teaching and learning resources, including ICT, for use within and beyond the school. ICT stands for Information and Communications Technology. Using TEMI is an example of a distinguished teacher who is well-versed in information and communications technology.

The results of the recent action research by Paglinawan (2018) conducted in Dologon National High School showed that the level of grammatical competence of Grade 10 students before exposure to TELI was at a fairly competent level and increased significantly after exposure, thus giving proof that TELI can help improve the grammatical competence of the students. The use of TELI can be applied to any subject. In this research, the focus will be on using technology-enhanced learning instruction in the mathematics area. A slight change in the acronym from TELI to TEMI is emphasized to indicate that this research focuses on mathematics subject. Based on the DNHS school records, the mean percentage score (MPS) of the Grade 10 students in the Mathematics subject at Dologon National High School in the years 2014, 2015, and 2020 was 34.17, 61.57, and 47.10, respectively. These MPS are very low compared to the national acceptable average MPS, which is 75. Before the pandemic hit in 2019, based on the records obtained from the fellow Grade 7 mathematics teachers as well as the researcher's own records as a mathematics teacher in Grade 7, the particular skill for which the students had very low scores in the exam was rational numbers, particularly their computational skill in integers, fractions and decimals, which are all topics in the first quarter. This motivated the researcher to find ways to improve the performance of the seventh grade students in their first quarter topics.

The researcher chose the teaching of computational skills in mathematics as the main focus of his research because computational skills in integers, decimals, and fractions are windows that open for the world of algebra, which are very necessary in finding the unknown variables. Without knowing the concepts of negative numbers, decimals, and fractions, students cannot go to a higher level of learning more complicated mathematical concepts. Chew et al. [8] stated that students must be well-versed in the idea of both positive and negative numbers in order to be prepared to learn a deeper concept of teaching algebra.

Proposed Innovation

Google Classroom is one of the most popular online platforms that the researcher utilized as his intervention in delivering the online activities of learning to the experimental group of Grade 7 students at Dologon National High School. Google Classroom is a web-based e-learning platform that Google provides, according to Martinez-Monés et al. [9]. This service was created to assist teachers in creating and distributing projects to students without the use of paper. This service requires that users have a Google account. Furthermore, Google Classroom is only available to schools that have Google Apps for Education installed. Google Classroom is used to facilitate virtual interactions between a professor or teacher and a student or students [10]. The researcher put real-life problem-solving activities in Google Classroom, which the students in the experimental group answered in their respective homes or during their vacant times. All of the activities were related to their computational skills in integers, fractions, and decimals. One of the very important innovations that teachers can make is to integrate the use of tools and technology that further the visualization, modeling, and sense-making of mathematics. For these to be implemented effectively, consider professional learning focused on how to promote reasoning and sense-making with tools and technology while learning content. Also, provide opportunities on how to use technology to give students feedback and maintain communication with families [11]. The teaching of mathematics through the use of the internet is one of the effective innovations that is very applicable at this time. The setting would be similar to that of classroom teaching, where the teacher and the students are the main components of the learning that takes place. However, TEMI was further enhanced in this teaching by using virtual manipulatives. Virtual manipulatives are digital representations of concrete manipulatives for use on computers, mobile devices, or interactive whiteboards (e.g., virtual base-10 blocks, virtual fraction cubes, and virtual algebra tiles) [12]. The researcher applied the teaching strategies learned when he attended the Pedagogical Retooling in Mathematics, Languages, and Science (PRIMALS) seminar, which was held from October 22 to 24, 2019 in Cagayan de Oro City. In that particular seminar, new strategies were taught to the participants, and the researcher was one of the recipients of the teaching, particularly on how to effectively teach computational skills in integers, decimals, and fractions to the seventh grade students. The teaching strategy involved the use of manipulatives. The manipulatives that were used in teaching the computational skills in integers were two sets of packets of tiles. These tiles were uniform in size. One packet of tiles represented the positive integers, while the other packet of tiles represented the negative integers. The packet of tiles was used to concretize positive and negative integers and would be used in expounding the concepts of adding, subtracting, multiplying, and dividing integers, decimals, and fractions. However, since the teaching was conducted using technology, the researcher used virtual tiles with the aid of a Microsoft PowerPoint presentation.

YouTube was another important online platform that the researcher integrated in his TEMI classes. The researcher selected several related topics that were thoroughly discussed on YouTube and put those topics in the Google Classrooms for the students to watch during their free time or in their respective homes.

Another innovation that the researcher incorporated into his teaching was the use of online resources, which had never been done at Dologon National High School in teaching mathematics before this research was conducted. When the researcher was still a secondary teacher in Thailand, one of the online resources that he integrated into his lessons was Kahoot.com.

Kahoot is a set of questions on a certain topic. They are asked in real-time to an unlimited number of "players," creating a social, engaging, and game-like learning environment. They are created by teachers, students, businesspeople, and social users [13]. According to Chotimah et al. [13], based on the data analysis and research findings, it can be determined that the usage of Kahoot as a media in teaching reading for English Department students at STKIP PGRI Jombang in the academic year 2017-2018 had a substantial impact. The teachers can create multiple-choice questions involving the subject they are teaching. The questions are flashed on the screens of the mobile phones of the students. When a student selects the answer from the choices and his or her answer is correct, his or her name will be flashed on the common display for the whole class to see. This would continue until all the questions are exhausted and the student who gets the highest score is declared the winner by Kahoot.com.

The teaching of the computational skills in integers, fractions, and decimals for the experimental group was done for 1 hour every day until all the topics were covered. The division of a one-hour lesson was as follows: 5–10 minutes for a review of the previous lessons or drills; 20–30 minutes for the lesson proper using the virtual manipulatives; and 20–25 minutes for the interactive games using Kahoot.com. The intervention happened in a span of three weeks, with one week each for each computational skill for integers, fractions, and decimals.

The researcher employed a pretest-posttest design for the experimental and control groups. Before the start of the intervention, a dry run was conducted with a different group of students to test the reliability of the questionnaire with the use of the Cronbach Alpha as a statistical tool. A revision was not necessary since all the items passed the required standard of more than 0.70.

Action Research Questions

This research determined the computational skills of the Grade 7 students in Dologon National High School, Maramag, Bukidnon.

Specifically, this research sought out the answers to the following questions:

1. What are the levels of the pretest and posttest scores of the non-TEMI and TEMI groups before and after the study in
   1.1. integers,
   1.2. fractions, and
   1.3. decimals?
2. Is there a significant difference between the scores of the non-TEMI and TEMI groups before and after the study?
3. What are the TEMI experiences of the students?

Statement of Hypothesis

Based on the stated research questions, the following hypotheses were constructed to help address the research problems:

- H0: There is no significant difference in the posttest score or mean between the controlled group and the experimental group.
- H1: There is a significant difference in the posttest score or mean between the controlled group and the experimental group.

2. Methodology

This part deals with the research design, participants, and other sources of data and information. This also explains the data gathering method that was employed in this research study. Lastly, the data analysis plan is discussed in this part.

Research Design and Data Gathering Methods

The research design that was employed in this study was a quasi-experimental design. In determining the control and experimental groups, the researcher employed fishbowl sampling for the control and experimental groups. Through the fishbowl method, the researcher chose one of the six sections in grade 7 to serve as the controlled group. The controlled group would not be exposed to any type of learning modality except through the traditional classroom setup. On the other hand, the researcher used the fishbowl method to randomly select another section to be the experimental group. The researcher provided the students with internet access so that they could use their cellphones as gadgets during the online game using the Kahoot.com platform.

Participants and other sources of information

The students who were exposed to TEMI in this research study were the experimental group of Grade 7 students at Dologon National High School. The two groups, controlled and experimental, were the two sections of the 7th grade level at Dologon National High School. The total population of the two sections was 90 students. Table 1 illustrates the number of respondents.

There were 45 students who gave their consent and participated in the TEMI study as the experimental group. On the other hand, there were 45 students who also belonged to the controlled group. Both groups completed the pretest, while 42 students from the experimental group completed the posttest and 43 students from the controlled group completed the posttest. Table 1 represents the number of students for each group.

Table 1.Respondents to the Study

Grade 7 Class	Number of Students
Control Group	45
Experimental Group	45
TOTAL	90

Data Collection Methods

A letter was sent to the principal of another school, asking for permission to perform the pilot testing. The result of the pilot testing indicated a Cronbach alpha of 0.91 and an overall reliability index of 0.91, which meant that the instrument used was ready for the proper conduct of the study. After the pilot testing, the researcher sought, permission from the school principal of Dologon National High School. A letter of consent was also sent to the seventh-grade students who were part of the experimental group to conduct the experiment. With the principal's approval, the researcher implemented his study in the experimental group for the entire duration of the topics, namely integers, fractions, and decimals, which were covered based on the Minimum Essential Learning Competencies (MELC).

Before the start of the TEMI innovation for the experimental group, the researcher gave the pretest to both the experimental and control groups. There were 45 students from the experimental group, and there were also 45 students from the control group who answered the 40-item test. After the implementation of TEMI in the experimental group and the traditional teaching method in the control group, the researcher gave the same posttest to both groups. There were 3 students who were not able to answer the posttest from the experimental group, and there were also 2 students who were not able to answer the posttest from the control group. Also, after the posttest, a survey questionnaire was given to all the respondents from the experimental group, which solicited a Likert scale rating of 1 to 5 about their TEMI experiences.

Validity and Reliability of the Instrument

The academic instrument that was used in this research study solicited answers about the students' knowledge about integers, fractions, and decimals. These 40 academic questions were taken from the books and manuals of the country's expert authors. Three experts were asked to validate the academic questionnaire. They held at least a Master's degree, particularly in teaching mathematics. The non-academic questionnaire was adapted from Johnson [14]. The Cronbach's alpha formula was used to test the reliability of the study, which was done after the pilot testing. Based on the reliability test conducted using Cronbach's alpha, all items were reliable, and there was no revision done by the researcher.

Scoring Procedure

The scores in the math subject were calculated after the posttest in both the control and experimental groups. There were two scoring procedures from the researcher-made questionnaire, of which the first determined the pretest and posttest scoring for each skill, and the second determined the learning experiences of the students during the use of TEMI. The results indicated their level of performance in mathematics during the duration of the intervention. The researcher conducted separate scoring procedures for each skill (fractions, decimals, and integers), as well as another scoring procedure for the Likert scale questionnaire that sought the experiences of the students in the TEMI group, to determine the level of skill of the experimental and control groups. Table 2, Table 3, Table 4 represent the scoring procedure for integers, fractions, and decimals, while Table 5 represents the scoring procedure for the overall score of the respondents. Table 6 represents the scoring procedure for learning experiences of the TEMI group.

Table 2. Scoring Procedure for Integers (13 Items)

Score	Description	Qualitative Interpretation
12-13	Outstanding	Mastered the Skill To a very great extent
10-11	Very Satisfactory	Mastered the Skill To a great extent
7-9	Satisfactory	Mastered the Skill To a moderate extent
4-6	Fairly Satisfactory	Mastered the Skill To some extent
1-3	Did Not Meet the Expectations	Did Not Master the Skill

Table 3. Scoring Procedure for Fractions (14 Items)

Score	Description	Qualitative Interpretation
13-14	Outstanding	Mastered the Skill To a very great extent
10-12	Very Satisfactory	Mastered the Skill To a great extent
7-9	Satisfactory	Mastered the Skill To a moderate extent
4-6	Fairly Satisfactory	Mastered the Skill To some extent
1-3	Did Not Meet the Expectations	Did Not Master the Skill

Table 4. Scoring Procedure for Decimals (13 Items)

Score	Description	Qualitative Interpretation
12-13	Outstanding	Mastered the Skill To a very great extent
10-11	Very Satisfactory	Mastered the Skill To a great extent
7-9	Satisfactory	Mastered the Skill To a moderate extent
4-6	Fairly Satisfactory	Mastered the Skill To some extent
1-3	Did Not Meet the Expectations	Did Not Master the Skill

Table 5. Overall Pretest and Posttest Scoring Procedure (Integers, Fractions, and Decimals)

Score	Description	Qualitative Interpretation
33-40	Outstanding	Mastered all the Skills To a very great extent
25-32	Very Satisfactory	Mastered all the Skills To a great extent
17-24	Satisfactory	Mastered all the Skills To a moderate extent
9 - 16	Fairly Satisfactory	Mastered all the Skills To some extent
1- 8	Did Not Meet the Expectations	Did Not Master all the Skills

Table 6. Scoring Procedure for the Learning Experiences of the Temi Group

Scale	Range	Description	Interpretation
5	4.21 - 5.00	Always	To a very great extent
4	3.41- 4.20	Frequently	To a great extent
3	2.61- 3.40	Sometimes	To a moderate extent
2	1.81- 2.60	Rarely	To some extent
1	1.0 - 1.80	Never	None at all

Statistical Treatment

The researcher used the T-test of independent means to compare the means of the controlled group and the experimental group. Frequency and mean were used to look at the results of the math pre-test and post-test for problem 1. To find whether there was a significant difference between the means of the scores of the control and experimental groups, a 0.05 level of significance was used for problem 2.

For problem number 3, the Likert-scale survey questionnaire was answered by the respondents in the experimental group, and simple statistical tools such as mean, frequency, and percentage were used to analyze the results.

3. Results and Discussions

The level of the pretest and posttest scores of the non-TEMI and TEMI groups before and after the study in their computational skills in integers,

Table 7 shows the mean score of the respondents in the control and experimental groups before and after the usage of TEMI in math class, particularly in their computational skills in integers. The experimental group's pretest results revealed 33 respondents whose results "did not meet expectations," indicating that the majority of the respondents did not master the skill or had no prior knowledge of how to add, subtract, multiply, or divide integers. 11 respondents had a score of "fairly satisfactory," which implies that they had mastered the computational skill of integers to a very small extent, while only 1 respondent had a satisfactory score, which means that he or she had mastered the computational skill of integers to a moderate extent. None of the respondents in the experimental group had shown a very satisfactory or outstanding score in this particular computational skill.

The same could be said of the scores of the students in the control group. The majority of students in the control group had demonstrated no mastery of the computational skill in integers, as 34 students were classified as "did not meet expectations," implying that they had no prior knowledge of the computational skill in integers. Of the 45 students in the control group, 11 had scores in the range of 4 to 6 out of the total 13 items, which could be interpreted as a very small mastery of the computational skill in integer.

Three respondents in the experimental group transferred to another school before the completion of the TEMI treatment. Only 42 respondents had completed the TEMI treatment.

When TEMI was applied to the experimental group, there was a significant improvement in the posttest scores of the students. The result of the posttest showed that there were no respondents who remained in the "did not meet expectations" category, which means that all of the respondents at least mastered the computational skill of working with integers to some extent. 4 respondents had shown a mastery of the computational skill in integers to some extent, while the majority of the respondents had a satisfactory score, as shown by the 24 respondents who exhibited mastery of the computational skill in integers to a moderate extent. There were 10 respondents who had shown mastery of the computational skills in integers to a great extent, while 2 respondents in the experimental group had shown mastery to a very great extent by obtaining a score of 12 to 13 out of the total of 14 items in the computational skill in integers.

Table 7. The Level of the Computational Skills in Integers of the Two Groups

		Experimental Group		Control Group	
Scores	**Description**	*Pretest Freq*	*Posttest Freq*	*Pretest Freq*	*Posttest Freq*
12 -13	Outstanding	0	4	0	0
10 -11	Very Satisfactory	0	10	0	2
7 - 9	Satisfactory	1	24	0	23
4 - 6	Fairly Satisfactory	11	4	11	18
0 - 3	Did Not Meet the Expectations	33	0	34	0
		N =45	N=42	N = 45	N = 43
Mean Score		**2.87**	**8.74**	**2.80**	**3.93**

Score	*Description*	*Qualitative Interpretation*
12-13	*Outstanding*	*Mastered the Skill To a very great extent*
10-11	*Very Satisfactory*	*Mastered the Skill To a great extent*
7-9	*Satisfactory*	*Mastered the Skill To a moderate extent*
4-6	*Fairly Satisfactory*	*Mastered the Skill To some extent*
1-3	*Did Not Meet the Expectations*	*Did Not Master the Skill*

**Freq = Frequency, N = Number of respondents*

On the other hand, the students in the control group who had not received the TEMI treatment showed very little progress in their mastery of the computational skills in integers. There were 43 students out of the original 45 who were able to complete their study in computational skills with integers. The two students were not able to take the posttest.

Although the 34 students did not remain in the "did not meet expectations" category, they showed little progress by having 18 students progressed to a "fairly satisfactory" category, which means that they had only mastered the computational skills in integers to some extent, while 23 students had scores ranging from 7 to 9, which had a satisfactory category. These 23 students had moderately mastered the computational skills in integers. Only two students in the control group had exhibited very satisfactory scores, which means that they had mastered computational skills in integers to a great extent. In the posttest, no one in the controlled group scored exceptionally well.

The results show that the function of the technology and the quality of the study are important factors in the size of the impact. This is in line with the results of this research, which show that TEMI is a useful tool for teaching students how to work with integers. According to Young [5], TEMI improves the learning rate, meaning that students either learn the same amount of content in less time than conventionally taught students or learn more material in the same amount of time. In addition, Marrero [4] reports that students in the treatment group reported considerably higher levels of satisfaction and motivation with their learning experience utilizing TEMI techniques, indicating that they had successfully acquired the necessary computational abilities in integers. TEMI has been shown to improve students' ability to retain information. Students in beginning statistics courses respond well to the use of applets, both because they like the opportunity to play with them and because they are better equipped to explain issues relevant to statistical power [5].

The level of the pretest and posttest scores of the non-TEMI and TEMI groups before and after the study in their computational skills in Fractions

Table 8 depicts the mean scores from both the experimental and control groups before and after TEMI was used in math class to enhance students' computational skills in fractions. The experimental group's pretest results showed 23 individuals who "did not meet the expectations," meaning that most participants lacked mastery of the skill or any previous knowledge in addition, subtraction, multiplying, or dividing fractions. Twenty-two received a fairly satisfactory score, indicating very little expertise in the computational skills of fractions. In this area of computational skills in fractions, in the control group, 28 students "did not meet expectations," which means that they lacked the computational skills in fractions, while 17 students had mastered the computational skills in fractions to some extent.

In the pretest, students’ scores in the control group were comparable to those in the experimental group, suggesting that they had no prior experience with computational skills in fractions. On a total of 14 items, none from the controlled or experimental group scored more than 6 points, which means that the students clearly lacked the basic computational skills and knowledge of fractions.

Three TEMI treatment group respondents were not able to continue since they transferred to another school before the completion of the TEMI study. Only 42 out of the 45 respondents had completed the TEMI treatment in the experimental group, while there were also 43 out of the 45 students who completed the posttest in the control group.

After TEMI was introduced, students in the experimental group performed much better on posttests. The posttest findings showed that no respondents were still in the "did not meet expectations" category, suggesting that everyone who completed the TEMI treatment had at least a passable understanding of the required fractional computational skills. The 19 respondents who showed moderate computational proficiency in fractions received a satisfactory score, demonstrating the majority of respondents. Ten respondents scored with a very satisfactory description, which means that they have mastered their computational skills in fractions to a great extent, whereas one respondent in the experimental group scored well with an outstanding description, which means that she or he has mastered the computational skill in fractions to a very great extent.

Table 8. The Level of the Computational Skills in Fractions of the Two Groups

Scores	Description	Experimental Group		Control Group	
		Pretest Freq	*Posttest Freq*	*Pretest Freq*	*Posttest Freq*
13-14	Outstanding	0	1	0	0
10 -12	Very Satisfactory	0	10	0	0
7 – 9	Satisfactory	0	19	0	0
4 – 6	Fairly Satisfactory	22	12	17	29
0 – 3	Did Not Meet the Expectations	23	0	28	14
		N =45	N=42	N = 45	N = 43
Mean Score		3.53	8.10	3.18	4.23

Score	*Description*	*Qualitative Interpretation*
13-14	*Outstanding*	*Mastered the Skill To a very great extent*
10-12	*Very Satisfactory*	*Mastered the Skill To a great extent*
7-9	*Satisfactory*	*Mastered the Skill To a moderate extent*
4-6	*Fairly Satisfactory*	*Mastered the Skill To some extent*
1-3	*Did Not Meet the Expectations*	*Did Not Master the Skill*

**Freq = Frequency, N = Number of respondents*

Students in the control group, who were not exposed to TEMI, improved their computational skills in fractions far less than the students in the experimental group, as shown in their scores in the posttest.

The 14 students were still in the "did not meet expectations" category, showing little improvement, which means that after they were taught computational skills in fractions, they still lacked the necessary skills to master the computational skills in fractions. 29 students moved up to a fairly satisfied description, which means that they have mastered computational skills in fractions to some extent; however, it was sad to note that none in the control group had scored more than 6 points out of the total of 14 items, indicating that they had only partially acquired the computational skills in fractions.

The findings imply that technologically enabled self-explanation assistance may boost students' knowledge retention and comprehension. While student justification and explanation were beneficial when the assignments were given face-to-face, they were linked to improved performance while tackling these challenging mathematics problems using TEMI [15]. By collaborating with their peers using interactive fraction-solving applications like Kahoot, students were able to assess the soundness of their reasoning, clarify their understanding, and fix any faulty mental models they may have developed as a result of their studies [16].

This finding concerning TEMI's effectiveness in teaching fractions is in line with earlier studies that have shown that digital tools like Google Classroom and

YouTube may help students make sense of complex concepts by providing contextualized explanations [3].

The level of the pretest and posttest scores of the non-TEMI and TEMI groups before and after the study in their computational skills in decimals

Table 9 shows the mean scores of respondents in the control and experimental groups before and after the introduction of TEMI in the mathematics lesson, with an emphasis on their computational skills in decimals. The pretest results for the experimental group indicated that 22 respondents did not meet expectations, suggesting that the majority of respondents did not master the skill nor did they have prior knowledge of how to add, subtract, multiply, or divide decimals. Twenty respondents obtained a fairly satisfactory score, suggesting that they had mastered the computational skill of working with decimals to some extent, while only three received a satisfactory score, showing that these three respondents had mastered the computational skill of working with decimals to a moderate extent. In this particular computational skill, none of the respondents in the experimental group received a very satisfactory or outstanding score.

The same could be said about the students in the control group's pretest results. Because 19 students were classified as "did not meet expectations," they lacked prior understanding of computational skills in decimals. As a result, the majority of students in the control group lacked knowledge of decimal calculation. 26 of the 45 students in the control group had scores ranging from 4 to 6 on a total of 13 items (fairly satisfactory), showing a weak comprehension of decimal computation.

Three respondents in the experimental group transferred to another school before the TEMI treatment ended. Only 42 students have completed the TEMI treatment.

When TEMI was applied to the experimental group, however, the students' posttest results improved dramatically. 2 students were classified as "did not meet expectations," from a high of 22 in the pretest; 17 were classified as "fairly satisfactory," from 20 in the pretest; 19 were classified as "satisfactory," from 3 in the pretest; 4 were classified as "very satisfactory, from 0 in the pretest; and none were classified as "outstanding."

Students in the control group who did not get TEMI treatment, on the other hand, showed very little improvement in their knowledge of decimal computation skills, as shown in the posttest results. Out of the 19 students who had belonged to the "did not meet expectations" category in the pretest, they made little progress, with only 5 students progressing to a "fairly satisfactory" category, while 14 were still in the "did not meet expectations" category in the posttest, indicating that they had only partially mastered the computational skills in decimals. 24 students received a fairly satisfactory rating, while 5 fit the satisfactory description.

This result is supported by the findings of Psycharis and Kalogeria [3], who stated that there has been a rise in interest in incorporating technology into the teaching and learning of mathematics. Students with good attitudes and confidence in their abilities to do mathematics, develop mathematical knowledge, and visualize abstract mathematical concepts have benefited from the use of technology in mathematics education. Teaching decimals needs concretization, and the use of virtual manipulatives has enabled the visualization of the concept of decimals that suits the level of understanding of the 7th grade students.

Table 9. the Level of the Computational Skills in Decimals of the Two Groups

Scores	Description	Experimental Group Pretest Freq	Experimental Group Posttest Freq	Control Group Pretest Freq	Control Group Posttest Freq
12 -13	Outstanding	0	0	0	0
10 -11	Very Satisfactory	0	4	0	0
7 - 9	Satisfactory	3	19	0	5
4 - 6	Fairly Satisfactory	20	17	26	24
0 - 3	Did Not Meet the Expectations	22	2	19	14
		N =45	N=42	N = 45	N = 43
	Mean Score	**3.67**	**6.69**	**3.09**	**4.28**

Score	*Description*	*Qualitative Interpretation*
12-13	*Outstanding*	*Mastered the Skill To a very great extent*
10-11	*Very Satisfactory*	*Mastered the Skill To a great extent*
7-9	*Satisfactory*	*Mastered the Skill To a moderate extent*
4-6	*Fairly Satisfactory*	*Mastered the Skill To some extent*
1-3	*Did Not Meet the Expectations*	*Did Not Master the Skill*

**Freq = Frequency, N = Number of respondents*

Another study that is consistent with the effectiveness of TEMI in teaching computational skills in decimals is the study of Kelly and Rutherford [11], which said that the utilization of new technology tools by math teachers and their students may be quite beneficial. Mathematics education, particularly in the computational skills required with decimals, has greatly benefited from the incorporation of digital tools into the classroom, such as Kahoots.com, Google Classroom, and virtual manipulatives. It might be the means by which students with cognitive impairments get a better understanding of mathematical concepts. Because students like using technology, this may drive them to learn about decimal computation and lead to enhanced computing skills [17]. Educators often lack the tools they need to properly incorporate technology into mathematics teaching, such as a student-centered curriculum and creative pedagogical approaches. As a result, children may benefit from having access to a website where teachers may learn about numerous gadgets, games, and programs such as Kahoots.com and other online resources to use in the classroom to assist with teaching arithmetic. Doing well in school may also help children feel better about themselves and boost their confidence.

Improvement of the Experimental Group in Their Level of Computational Skills Through TEMI

Table 10 illustrates the level of competence in the experimental group before and after TEMI exposure based on the results of the pretest and posttest. It demonstrates a considerable drop in the number of respondents who belonged to the "did not meet expectations" category from 32 (72% in the pretest) to 0 (%) in the posttest. In the posttest, 13 students (29%) scored "Fairly Satisfactory," compared to 0 (0%). Furthermore, 27 respondents (64%), are now in the "satisfactory" category in the posttest, 13 (31%), are in the "very satisfactory" category, and 2 (5%), are now outstanding, although none of the respondents scored in the "satisfactory" category or above competence in the pretest. Furthermore, constraints such as students not being exposed to digital platforms such as Google Classrooms, Kahoots.com, and YouTube, particularly in formal discussions on the integration of these technological tools, could be detrimental to the improvement of student performance as they would be heavily reliant on the knowledge of the teachers in discussions of computational skills in integers, fractions, and decimals. Most of the students had not been taught how to use their smartphones and computers to acquire mathematical topics, and they were unfamiliar with the majority of the ideas covered prior to the TEMI. There is a considerable improvement in the students' computational ability in integers, fractions, and decimals after exposure.

This finding is consistent with the findings of Kelly and Rutherford [11], Young [5], and Marrero [4], who state that students who are more directly involved in the learning process are more likely to be interested in potential transformational benefits, particularly in the use of interactive technological tools.

Table 10. the Overall Level of the Computational Skills of the Temi Group

Level of Computational Skills In Integers, Fractions and Decimals	Before TEMI		After TEMI	
	N	(%)	*N*	(%)
Outstanding	0	0%	2	5%
Very Satisfactory	0	0%	13	31%
Satisfactory	0	0%	27	64%
Fairly Satisfactory	13	29%	0	0%
Did not meet expectations	32	71%	0	0%
TOTAL	45	100%	42	100%

Score	***Description***	***Qualitative Interpretation***
33-40	*Outstanding*	*Mastered the Skill To a very great extent*
25-32	*Very Satisfactory*	*Mastered the Skill To a great extent*
17-24	*Satisfactory*	*Mastered the Skill To a moderate extent*
9 - 16	*Fairly Satisfactory*	*Mastered the Skill To some extent*
1-8	*Did Not Meet the Expectations*	*Did Not Master the Skill*

** N = Number of respondents*

Moreover, the results conform to the findings of DeJarnette [18], which state that TEMI, or the use of technology in enhancing the mathematics learning of the students, greatly improves the students' mathematical learning. Despite the number of studies granting almost unanimously total confidence in the use of technology to increase academic achievement in mathematics, the positive effects of these teaching practices in mathematics education across all levels are mitigated by factors such as teachers' technological preparation, budgetary constraints, and teachers' perceptions. According to Stoilescu [19], the TEMI teaching framework is still a source of contention among academics owing to its dubious effectiveness as a pedagogical tool for systematically integrating technology and various instructional domains. Nonetheless, in this particular study, the results obviously point to the effectiveness of TEMI as a great influence on the vast learning of the students, even with the constraints of limited teacher-student contact due to several unforeseen factors. Students rely solely on their own initiative and the mastery of mathematics teachers to impart knowledge of computational skills in integers, fractions, and decimals in the absence of TEMI.

The significant difference between the experimental and controlled groups before and after exposure to TEMI

The significant difference in the computational skills in integers, fractions, and decimals of the Grade 7 students of Dologon National High School before and after exposure to TEMI was determined through the use of an independent sample t-test.

Table 11. Significant Difference Between Temi and Non-Temi Groups

Computational Skills in Integers, Fractions and Decimals	Experimental Group		Controlled Group			
Number of students and mean	*N*	$\bar{X}$	*N*	$\bar{X}$	t-value	Sig. (2-tailed)
Pretest	45	10.07	45	9.07	1.77	0.080
Posttest	42	22.16	43	11.89	14.36	0.000**

*p<0.01***

Table 11 shows the result of the independent t-test on the difference in the pretest and posttest scores between the experimental and control groups. The pretest scores of the experimental group have a mean of 10.07, while the pretest scores of the control group have a mean of 9.07. The t-value of 1.77 and the p-value of 0.080 indicate that there is no significant difference between the pretest mean scores between the experimental and control groups. However, after the TEMI treatment in the experimental group, there is a big increase in the posttest mean score of 22.16, while the posttest mean score of the control group slightly increases to 11.89. When the posttest mean scores of the experimental and control groups are compared, there is a very significant difference between the means of the two groups, with a t-value of 14.36 and a p-value of 0.000. This means that the difference between the posttest mean scores of the two groups is highly significant at the 0.05 level of significance.

The experimental group's computational skills in integers, fractions, and decimals significantly differed from those of the control group when TEMI treatment was delivered to one of the groups. As a result, it was required to determine that the null hypothesis, which stated that there was no significant difference between the TEMI and non-TEMI groups' posttest scores, was not true and needed to be rejected. The data enabled this researcher to conclude that the students' computational skills improved as a direct result of their participation in the TEMI.

The results are consistent with the findings of Cargile and Harkness [20], who discovered that when students are exposed to technology-enhanced education, their attitudes and performance, including scores before and after exposure to a technology-based pedagogy, improve.

The conclusion is congruent with the findings of Kanuka et al. [21], who claim that interventions like TEMI help students become more cooperative, participative, and output-oriented. Similarly, this result is consistent with prior results. Interventions targeted at achieving revolutionary outcomes used a broad range of data sources, and richer sorts of evidence were acquired. This fact not only allowed the information to be triangulated, but it also highlighted the idea that there are several interrelated components that influence student learning. It is challenging not just to enhance students' learning within "real" settings, but it is much more difficult to describe what has been done and how it has occurred. This is due to the difficulty of demonstrating what has been accomplished and how it happened.

Furthermore, the results are similar to the findings of Cooner [22], who observed that when students adapt activities or portions of modules to provide active learning opportunities, it has been demonstrated to improve students' overall performance. Other TEMI activities, such as Kahoot, Google Classroom, and YouTube, were employed to increase mechanical engineering students' engagement in numerical techniques, resulting in higher posttest results for the responders. For example, materials were created to assist students in engaging in inquiry-based learning activities and developing computational abilities [3]. Another activity considerably boosted the respondents' output in such a manner that an existing module was changed into problem-based blended learning in TEMI employing a social constructivist approach and a mix of numerous resources [23].

According to the findings of Bouck et al. [12] and Marrero [4], interventions, including the construction of TEMI resources, were expected to result in improvement, meaningful learning, and an improvement in students' computational skills. Significant findings from several studies on improvements in assessment scores were among the most sought-after types of enhancement. According to the results, learning seems to be predominantly seen as a change in quantitative measurements, with "better learning" interpreted to signify an improvement in the pace at which knowledge is acquired and/or maintained. For example, Ngadiman and Sulaiman [24] said, "It was our hope that students would be able to remember more about the course and be happier with it." They also said that using TEMI may be a way to help students get better at math.

Furthermore, these findings are consistent with the findings of de Grez et al. [25], who conducted an experiment with a pretest and a posttest to determine whether or not students who had participated in the TEMI intervention had higher scores than students who had not participated in the intervention. It was found that students' overall scores went up when they were required to use TEMI.

Learning experiences of the students during the intervention or in the use of TEMI

Table 12 depicts the learning experiences of the TEMI group. The overall mean score of the learning experiences of the students in TEMI is 4.15, which has a description of "frequently," implying that the learning experiences of the students in the implementation of TEMI bring about a positive outcome to a great extent. The indicator "I feel that the use of TEMI was successful in this subject class" has a mean of 4.00, which is the lowest mean among all the indicators but still belongs to the description "Frequently," which means that all the respondents in the TEMI study had positive and meaningful learning and enjoyment to a great extent.

Table 12. The Description of the Learning Experiences of the Temi Group.

Indicator	Mean	Description	Interpretation
TEMI increased my attendance of lectures in Math subject	4.43	Always	To a very great extent
TEMI increased my attention in the lesson	4.20	Always	To a very great extent
TEMI increased my effort in the lesson	4.10	Frequently	To a great extent
TEMI increased my interest in the subject work/activities	4.20	Always	To a very great extent
TEMI increased my enjoyment towards the subject work/activities	4.13	Frequently	To a great extent
TEMI increased my sense of comfort towards the subject work/activities	4.07	Frequently	To a great extent
TEMI increased my willingness to learn the topic discussed	4.17	Frequently	To a great extent
TEMI aided in establishing my learning goals towards the subject	4.10	Frequently	To a great extent
I feel that the use of TEMI was successful in this subject class	4.00	Frequently	To a great extent
I would recommend also the use of TEMI in the other subjects	4.10	Frequently	To a great extent
Overall Mean	**4.15**	**Frequently**	**To a great extent**

As a result of using this intervention, students say they have been able to set their own learning objectives, feel successful in class, and always promote it to their peers.

TEMI may have a powerful mental and sensory impact. YouTube in the classroom may help students learn by grabbing their attention and focusing it. It can also help them relax and energize them for learning exercises. The results of this study have demonstrated that TEMI, which entails teaching mathematics with the aid of technology, may boost student engagement and motivation [4].

This approach is also beneficial for learning results [26]. Conceptual information should not be taught in person but rather delivered to students as part of a lecture in which they are expected to actively engage in the learning process.

According to Chotimah et al. [13], based on the data analysis and research findings, it can be determined that the usage of Kahoot as a medium in teaching reading for English Department students at STKIP PGRI Jombang in the academic year 2017–2018 had a substantial impact. Since the concept of using Kahoot in English and mathematics is the same and Kahoot is one of the components of TEMI, it can be deduced that Kahoot has made the students enjoy their TEMI experiences.

A challenge in mathematics education is providing educators with instructional approaches and frameworks that may inspire students to learn difficult ideas. Flipped classrooms, for example, are increasing student interest and learning [27]. Similarly, Taljaard [28] asserts that the incorporation of technology in education has an impact on student engagement and learning outcomes. Furthermore, according to Prensky [29], the individual student is more important in the learning cycle than exam outcomes, content, and curriculum. Furthermore, Prensky [29] recommended teachers prioritize TEMI information about students' interests and passions when developing lesson plans. While utilizing technology to study arithmetic topics, all students had the same levels of positive enjoyment and significant learning motivation [4].

4. Conclusion

The research looked at how Technology-Enhanced Mathematics Instruction (TEMI) affected students' computational abilities in integers, fractions, and decimals. The experimental group's pretest results revealed that the majority of students originally lacked proficiency in these areas, with just a handful possessing a reasonable level of knowledge. The control group's pretest findings were comparable, with most students lacking key computational abilities. Following the implementation of TEMI in the experimental group, substantial gains in posttest scores were found, with all students displaying at least some degree of competence. Furthermore, a large proportion of students had good, very satisfactory, or exceptional results, showing significant development. In contrast, the control group, which did not receive TEMI, exhibited modest improvement in computational abilities, with the majority still failing to meet expectations. According to the findings, TEMI is an excellent tool for improving students' computational abilities in integers, fractions, and decimals. Furthermore, data implies that technological integration and high-quality education have critical roles in favorably influencing student outcomes. The positive learning experiences experienced by TEMI students, such as establishing learning targets and feeling successful in class, underscore the approach's efficacy and engagement. Overall, the results support the use of TEMI in the classroom as a beneficial tool for boosting students' mathematical ability and motivation.

Recommendations

The following are recommended in light of the most important facts and conclusions:

Since TEMI has been shown to improve students' computational skills in integers, fractions, and decimals, teachers may want to explore coming up with a plan to expose them to such new developments in the classroom utilizing technology and the Internet. The development of students' 21st-century skills and their ability to meet the challenges of the modern world may necessitate the incorporation of topics on basic computer operation and internet literacy across subject areas by those responsible for drafting curriculum frameworks. Similarly, students' computational skills may benefit from additional interactive activities on the internet to fully enhance their skills. School administrators may want to consider sending teachers to seminars and workshops on subjects like TEMI and ICT integration in the classroom if resources allow. Students could be provided additional possibilities and outlets to study more about computational skills by utilizing computer-assisted instructional materials or via technology-enhanced learning instructions to decrease their worries and perceived mathematical challenges. Similar research may be undertaken and might include additional factors in algebra, trigonometry, and calculus to involve the use of technology in teaching these higher mathematical concepts. Other variables, such as the teacher factor, economic position, and environmental factors impacting their study habits, should also be examined. Lastly, because it has been established that TEMI increased the computational skills of the students in a three-week span of time, teachers may perform more research with a greater number of respondents and a longer length of intervention, such as one grading period or one semester period.

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