



Enhancing the Mastery of Basic Integer Operations Among Grade 8 Learners in Secondary Education Through MathSPARK

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ABSTRACT

Purpose of the study: Mastery of basic integer operations, an essential foundational skill, enables learners to progress into complex mathematical concepts. Accordingly, this study investigates the effect of MathSPARK as an intervention material on learners' mastery of this skill.

Methodology: This study employed an explanatory-sequential mixed methods research design, which involved Grade 8 students from a public secondary school in Sorsogon City who met specific criteria. The data were collected through validated integer tests and a researcher-made questionnaire on student perceptions. The quantitative data were analyzed using both descriptive and inferential statistics, while the qualitative data were subjected to thematic analysis.

Main Findings: The number of those who reached the "Mastered" and "Closely Approximating Mastery" levels increased, and those at the lower mastery levels were reduced. Statistical analysis of the results confirmed that the improvement in the learners' mastery is significant; hence, MathSPARK is effective. Moreover, varied insights from the learners supported the findings, highlighting both the benefits and challenges they encountered.

Novelty/Originality of this study: This study offers new insights into how to improve the mathematical skills of the learners by exploring the potential of available digital devices. It also provides an opportunity for a novel approach to enhance learning performance amidst challenges brought about by class disruptions and in an educational setting with limited resources, while taking advantage of what is available to learners.

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1. INTRODUCTION

Education upholds human rights, serving as a gateway to life and liberty, freedom from slavery and torture, and freedom of opinion and expression. This highlights the indispensable role of education in human existence. For this reason, UNESCO, as a specialized agency established in 1945, has strategic goals on enhancing education quality and accessibility [1]. Aligned to these global goals, the Philippines, as a sovereign state, enacted the Enhanced Basic Education Act of 2013 to address the inadequacy of the country's basic education system under the supervision of the Department of Education (DepEd) [2]. This legislation reflects the country's commitment to UNESCO's Sustainable Development Goal (SDG) 4 on quality education, which seeks to guarantee inclusive and equitable quality education and foster lifelong learning opportunities for all [3]. By

implementing this law, all Filipino learners are ensured to receive the education that would respond to their diverse needs and contexts.

Mathematics is taught in all grade levels in the Philippine basic education system. Its goal is to enhance students' ability to think critically and solve problems [4]. To think critically is to evaluate an idea's potential by weighing its advantages and disadvantages and providing valid, clear, and strong justifications [5]. On the other hand, to solve problems means recognizing issues, generating and evaluating potential answers, and applying the best solution [6]. Both skills are necessary for developing the 21st century competencies that learners must acquire in preparation for complex challenges that often emerge from real-world contexts [7].

The results of the most recent Program for International Student Assessment (PISA) 2022 show that Filipino students continue to perform the lowest in math globally [8]. The assessment revealed that only 16% of Filipino students achieved at least the basic or baseline level of mathematical proficiency (referred to as "level 2 proficiency" in the report). Accordingly, roughly one out of every five Filipino students who took part in PISA "can interpret and recognize, without direct instructions, how a simple situation can be represented mathematically", and the other 84% lack the mathematical skills necessary to "(compare) the total distance across two alternative routes, or converting prices into a different currency" – examples provided by PISA of basic math competencies. The findings indicate that the Philippines' basic education system urgently needs to be improved [9].

As part of initiatives in improving the country's basic education, DepEd consistently provides training aligned with teachers' priorities and needs. DepEd Secretary Angara emphasized the need to prioritize skills training for teachers [10]. Through these trainings, teachers may acquire the knowledge, skills, and competencies required to enhance their teaching methods. Helping to ensure that both the curriculum and the learners' needs are met. The Department of Education highlighted the Digital Rise Program, an educational framework that anchors on capacitating teachers in technology [11]. This program is timely and relevant for teachers to align their teaching practices with the needs of today's learners and make education more relevant to them, who are often considered digital natives. Technology integration, such as the use of educational mobile applications, not only keeps students' interest in learning but is also believed to improve their communication skills [12].

In Region V, the Google B-COOL (Bootcamp for Certification and Opportunities for Organizational Leveraging) was conducted by DepEd in partnership with the NEAP (National Educators Academy of the Philippines) to promote the enhancement of teachers' technological competence. The massive implementation of region-wide training and certification of Google for Education helped a total of 780 teachers to become globally-ready and digitally-resilient across changing seasons [13]. In this training, teacher-participants were given a chance to earn the title Google Certified Educator Level 1, aside from the usual certificate of participation given in every training conducted. In return, they were expected to apply their acquired skills and competence to their respective classrooms to improve their students' learning outcomes.

The mastery of foundational skills, such as basic integer operations, is important in advancing learning to more complex mathematical concepts would be almost impossible [14]. However, despite numerous efforts to strengthen this skill, many junior high school learners in the Philippines continue to struggle with it. For instance, an action research on a Mathematics Intervention Program among Grade 8 students showed that although post-test performance improved significantly over the pre-test, deficiencies in basic operations remained evident, especially for learners who lacked foundational fluency [15]. Other intervention studies at the national level have focused more on motivational or teacher professional development interventions [16] rather than strictly on self-paced digital learning of basic numeracy skills [17], [18]. Similarly, the Department of Education has launched various intervention programs and frameworks [19], [20] but did not clearly show self-paced or digitally mediated reinforcement of integer operations within secondary education. Moreover, many existing interventions are constrained by limited class time, resource constraints in public schools, and disruptions from shifting schedules or blended learning modes, which reduce consistent practice opportunities. The gap, therefore, lies in providing a contextually feasible, learner-centered digital tool for reinforcing integer operations in the context of Philippine secondary schools.

This study introduces MathSPARK (Mathematical Self-paced Practice Activity for Reviewing Key Integer Operations) as a contextually grounded innovation for Philippine secondary education. Unlike previous interventions, MathSPARK leverages learners' existing digital devices and underused out-of-class hours to deliver adaptive, scaffolded practice focused on integer operations. By doing so, it addresses persistent deficiencies in foundational mathematical skills while accommodating constraints such as limited face-to-face class time and inconsistent learning schedules. This approach is especially urgent in the post-pandemic era, when learning gaps have widened and foundational numeracy skills are critical to students' success in more advanced mathematics.

Given these considerations, this study aimed to determine the effect of using MathSPARK as an intervention material to enhance the mastery of purposively selected Grade 8 students in basic integer operations. Specifically, it sought to determine the students' level of mastery in basic integer operations before and after the implementation of the intervention, to examine how the use of MathSPARK influences their mastery of basic

integer operations, and to explore how learners perceive the effectiveness of MathSPARK in improving their skills in performing these operations.

This research is anchored to Oplan Kwenta, which aimed to help students master the four fundamental operations in mathematics. Oplan Kwenta was an initiative in the DepEd Sorsogon City under the leadership of Mr. Antonio J. Jintalan, Education Program Supervisor (EPS) in Mathematics, which was designed to strengthen basic math skills [21]. In addition, this research supports the Department of Education's MATATAG Agenda, particularly the directive to "TAke steps to accelerate the delivery of basic education services and provision for facilities". Aligned with these goals, the study provided learners with the opportunity to enhance their competence in performing basic integer operations through the effective use of time and available digital devices at home. Through MathSPARK, the research aims to offer new empirical evidence on how to improve mathematical mastery using low-cost, scalable interventions in actual secondary school environments, a contribution that is both timely and practically significant for Philippine education stakeholders. For these reasons, this research was undertaken to see the effectiveness of the designed learning scheme.

2. METHODOLOGY

This section details the systematic approach taken to conduct this study. It includes research design, participants and sampling, innovation, intervention and strategy, research instruments, data collection and procedures, and data analysis.

2.1. Research design

An explanatory-sequential mixed methods approach was employed in this study, beginning with quantitative data collection and analysis, and subsequently incorporating qualitative data to clarify the quantitative results [22]. The first phase was a quasi-experimental pretest–posttest design. Students' mastery of the fundamental operations of integers was assessed before (pre-test) the MathSPARK intervention was introduced and after (post-test) it was carried out, without randomly assigning participants to groups. After the post-test had been administered, the qualitative data were gathered through questionnaires. Then, a qualitative-descriptive research design was used. This research design helped in exploring the perceptions of the purposefully selected participants on the effectiveness of MathSPARK as an intervention program.

2.2. Participants and sampling

This study selected the participants using purposive sampling. In this method, participants were chosen based on their alignment with specific qualities aligned to the objectives of the study and their accessibility to the researcher [23]. A total of 128 Grade 8 learners from a public secondary school in the Philippines for School Year 2024-2025 were selected.

Specifically, these participants have met the following criteria: (1) they were Grade 8 students taught by the researchers, (2) they had access to gadgets or devices such as mobile phones or laptops, and (3) they had active Google accounts. The third criterion ensured that participants could access Google applications such as Gmail, Google Classroom, and Google Forms. Google Classroom was required to be installed on their devices before beginning the learning experience through MathSPARK. All participants were given approximately one month to prepare and ensure they met the last two requirements.

In the qualitative phase, a representative sample from each of the following categories of learners, based on their obtained scores in the pre- and post-tests, was purposefully selected by the researchers.

- Participant 1 (Competent): demonstrated the mastery of the skill for both pre- and post-tests.
- Participant 2 (Emerging): showed significant improvement from pre- to post-tests.
- Participant 3 (In-between): performed at an average level without improvement or decline.
- Participant 4 (Struggling): showed a low level of mastery from pre- to post-tests.
- Participant 5 (Regressed): mastery level dropped notably to low levels.

This sampling technique is commonly called purposeful sampling, where selected participants were chosen as subsamples. Their responses could already provide rich, relevant, and diverse information that will support the quantitative results [24]. This information could provide valuable insights into the effectiveness of MathSPARK through their responses to the questionnaires.

2.3. Innovation, intervention, and strategy

MathSPARK (Mathematical Self-paced Practice Activity for Reviewing Key Integer Operations) was an innovative, teacher-made intervention and strategy aimed at enhancing the mastery of Grade 8 students in performing basic integer operations. It was a five-week learning journey, which included the administration of pre- and post-tests to purposively selected Grade 8 students, during which the researchers recorded all results to track the students' progress.

During the first week, the pre-test was given to the target respondents in the school, followed by an orientation. In the orientation, the respondents were informed that Google Classroom would be used as the learning management system for enhancing their mastery of basic integer operations. When they already had this mobile application, they were given the class code for Google Classroom through the Messenger Group Chat. The first topic that the students encountered in Google Classroom was the “Preliminaries”. Plate 1 shows the Preliminaries of the MathSPARK.



Plate 1. Tasks under Preliminaries of the MathSPARK

The tasks under Preliminaries were intended to provide the students with an opportunity to simulate the process of completing all tasks in MathSPARK. Specifically, it included the “Trial Practice” and the instructions for completing it. The instructions, titled “Guide to Compliance of Classwork in MathSPARK”, outlined the process for the trial test, and students were informed that the same compliance procedure would apply to upcoming tasks. The Preliminaries also included the “Compliance Monitoring Tool”. Through this, learners could track their compliance with all the required tasks. All technical issues encountered by the students were addressed at this stage. One-on-one feedback was also provided to help some learners resolve challenging issues encountered, particularly for those new to using Google Classroom. Through the preliminaries, learners can be helped to feel more confident that they are on the right track by understanding the sequence of tasks they are expected to complete at home. This phase of instruction is aligned to the recommendations in [25], which draw from cognitive learning theory, stating that learning should address the needs of the learners and focus on goals aligned with what they need to accomplish, as reflected in the tasks of the MathSPARK.

The MathSPARK tasks were assigned to all the learners from the second to the fourth week, and all these tasks were to be completed by them at home. The learning setup at this school allowed the purposively selected Grade 8 learners to complete the tasks each week, every morning on weekdays, while at home. This arrangement enabled the students to work at their own pace and ensure completion of all the weekly tasks.

MathSPARK is composed of three topics: (1) Addition of Integers, (2) Subtraction of Integers, and (3) Multiplication and Division of Integers. Each topic was assigned to the students one at a time each week. They also exposed students to various cases or combinations of integer pairs to perform the specified operations. Table 1 presents all the topics and their different cases included in MathSPARK:

Table 1. Topics and Their Different Cases in MathSPARK

Topics	Cases
Addition of Integers	Case 1: Adding Two Positive Integers Case 2: Adding Two Negative Integers Case 3a: Adding a Positive and a Negative Integer (with the positive integer to have the greater absolute value) Case 3b: Adding a Positive and a Negative Integer (with the negative integer to have the greater absolute value) Case 4: Adding Integers Involving Zero
Subtraction of Integers	Case 1: Subtracting Two Positive Integers Case 2a: Subtracting a Negative Integer from a Positive Integer Case 2b: Subtracting a Positive Integer from a Negative Integer Case 3: Subtracting Two Negative Integers Case 4a: Subtracting an Integer from Zero Case 4b: Subtracting Zero from an Integer
Multiplication and Division of Integers	Case 1: Multiplying Two Positive Integers Case 2: Multiplying Two Negative Integers Case 3: Multiplying a Positive and a Negative Integer Case 4: Multiplying an Integer and Zero Case 5: Dividing Two Positive Integers Case 6: Dividing Two Negative Integers Case 7: Dividing a Positive and a Negative Integer Case 8: Dividing an Integer and Zero

All these topics were grouped and arranged sequentially in the Google Classroom. They were designed to be accomplished by the students in one week. The deadline was always set to be on Fridays of the week at 23:59:59. Plate 2 shows the sequence of all the cases under the Addition of Integers.

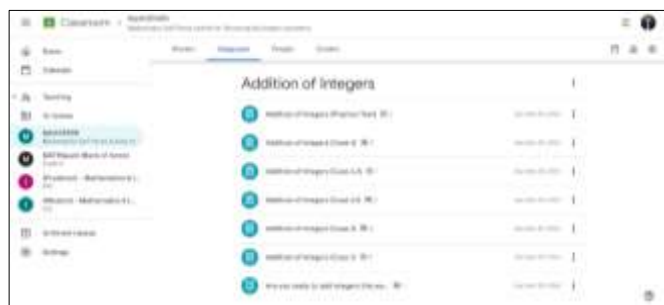


Plate 2. Task for Addition of Integers

As shown in Plate 2, a question assessing student readiness, all five different cases for Addition of Integers, and a Practice Test were included. All cases for the other topics were presented similarly. For each case, a task was assigned to the students. Plate 3 shows the task designed for Addition of Integers – Case 1, which is created in a way consistent with the other tasks.



Plate 3: Task for Addition of Integers – Case 1

As shown in Plate 3, the rule for adding two positive integers, along with three examples of how this rule was applied, is included. This is followed by instructions on how to complete the attached Google Form. The Google Form allows students to practice their skills in that specific case of an integer operation. It contains 10 multiple-choice questions, which learners can answer at their own pace within the week the task was designed. For other cases, the form contains 15 multiple-choice questions. This scheme promotes retrieval practice by actively engaging the learners in the tasks, operations on integers, that they have already learned in their previous grade levels (Grades 6 and 7). Retrieval practice has been found to be more effective than re-study in promoting long-term retention [26]. Their study also found that retrieval practice can be further reinforced through multiple-choice questions, as it stabilizes marginal knowledge, which in this case is the basic integer operations.

Using the available devices for the learners as well as internet connectivity, they accessed the Google Forms links, allowing them to independently engage with each task. Each link was set to provide a copy of the results to the student immediately after the “Submit” button was clicked. The result included the student's score and the sequence of items they answered, showing both the correct and incorrect answers. This feedback helped students identify which items they answered incorrectly and guided them on what to avoid in future attempts. Students were allowed to repeat answering the same Google Forms as many times as they wished, with the expectation that they would improve their scores in subsequent attempts. Repetition is important because it can accelerate and intensify the engagement process [27]. The chance that successful subsequent attempts would just be a product of the familiarization of the answers was addressed through the shuffled feature of Google Forms. This feature automatically rearranges the questions each time a student reopens the form. This mechanism facilitated the ongoing enhancement of the learners' mastery through the MathSPARK, where each case of performing basic integer operations is designed.

Upon completing the Google Forms for each case, students were required to send screenshots of their compliance to their teacher via direct message on Facebook Messenger for faster tracking. The teacher would then immediately reply to acknowledge their work. Additionally, the "Compliance Monitoring Tool" in the "Preliminaries" was manually updated by the teacher from time to time upon receiving their messages, providing students with another way to track their progress as they accomplish the tasks in MathSPARK. The Google Sheet

linked to this tool was also shared in the Messenger Group Chat as an alternative means of access. Each week, their work was returned to them through Google Classroom.

All students successfully completed the MathSPARK tasks by the end of the fourth week. They were encouraged to review the topics and prepare for the post-test, which would be given to them the following week. They were instructed to review key integer operations by taking the Practice Test. The Practice Test is a task that includes all the different cases for each key integer operation.

2.4. Research instruments

This study utilized two instruments: (1) the 30-item Integer Test for Primary Operations (ITPO) and (2) the 4-item researcher-made questionnaire on student perceptions. The first instrument was used to assess students' mastery before and after the MathSPARK had been implemented. It was a practical and validated test on basic integer operations developed by researchers [28]. Three forms of the test were available, but only two were used—one for the pre-test and another for the post-test. All tasks in MathSPARK were developed by the researchers and designed to cover various cases of integer operations, as outlined in Table 1 under Innovation, Intervention, and Strategy.

The second instrument, the researcher-made questionnaire, aimed to determine perceptions of the students after learning the basic integer operations through the MathSPARK. Tagalog translations of each of these questions were provided for better understanding of the learners of these questions, which can help in getting accurate answers from the learners. The learners were also allowed to write their answer using any language they prefer the most, allowing freedom to express their thoughts. Moreover, the instrument provided qualitative insights to support and explain the results obtained from the ITPO.

2.5. Data collection and procedures

The researchers sought approval to conduct the study from the Schools Division Superintendent (SDS), with the request duly endorsed by the Head Teacher in Mathematics, the researchers' immediate supervisor. Afterward, the study's proposal was scheduled for presentation in accordance with a memorandum from the SDS. The researchers then complied with the suggestions and recommendations of the research panel committee, after which approval to conduct the research was granted. Only after this were all procedures in implementing the study in the school undertaken.

Form A of the ITPO was administered to the purposively selected participants to determine their mastery of the basic integer operations. After this, they were given an orientation on how the MathSPARK intervention would be conducted. With all the students secured to have their Google accounts, a simulation of a task involved in the intervention was conducted. The simulation gave them the chance to practice in the classroom what they would be expected to do at home. All technical problems encountered by the students were addressed during the orientation. After ensuring that all students were ready for the learning journey, the MathSPARK started in accordance with the procedures stipulated under the Innovation, Intervention, and Strategy.

When all the tasks in MathSPARK were completed, Form B of the ITPO was given to the students to evaluate their mastery of the basic integer operations. This was followed by a four-item researcher-made questionnaire given to purposefully selected participants. To guarantee result integrity, Forms A and B of the ITPO and the questionnaire were administered in person. This study adhered to the Research Management Guidelines of the Department of Education in conducting data collection and procedures [29].

2.6. Data analysis

The quantitative and qualitative data gathered were interpreted using descriptive and inferential statistics, and thematic analysis, respectively. The quantitative data came from the results of the pre- and post-tests administered before and after the MathSPARK intervention was implemented. Percentage scores were calculated to interpret each student's score. Table 2 shows how the corresponding percentage scores of each score were then interpreted. It was prescribed by the Department of Education for data utilization, such as in this case, implementing an intervention [30].

Table 2. Mastery Level of the Students

Mean Percentage Score	Descriptive Equivalent
96% - 100%	Mastered
86% - 95%	Closely Approximating Mastery
66% - 85%	Moving Towards Mastery
35% - 65%	Average
15% - 34%	Low
5% - 14%	Very Low
0% - 4%	Absolutely No Mastery

The Shapiro–Wilk test, a test of normality, was also carried out to check if the differences between pre- and post-test scores conformed to a normal distribution. Doing this is important to avoid the risk of misinterpretation, as assuming normality implies that the mean is an appropriate and representative summary of the data [31]. Having been found as not normally distributed through this test, medians and interquartile ranges of both the pre- and post-tests scores were computed to summarize the data. Also, to assess whether there was a significant change in student mastery pre- and post-intervention, the Wilcoxon Signed-Rank test was performed. It was conducted at a significance level of $p < 0.05$. To provide further support to the results, the matched-pairs rank biserial correlation coefficient was employed to evaluate the effect size of the change in mastery. This is interpreted as in Table 3 [32].

Table 3. Interpretations of the Effect Size

Effect Size	Interpretation
0.10 to < 0.30	Small
0.30 to < 0.50	Medium
≥ 0.50	Large

Qualitative data, obtained through a four-item researcher-made questionnaire, were organized and summarized following a specific pattern based on the responses of five purposively selected participants. The presentation involved the straightforward informational content of the responses in a logical and coherent manner. The data analysis focused on the descriptive categorization of the participants' experiences and characteristics.

3. RESULTS AND DISCUSSIONS

3.1. The mastery level of the students in basic integer operations before and after the study

Figure 1 presents the number of students at each mastery levels before and after the study.

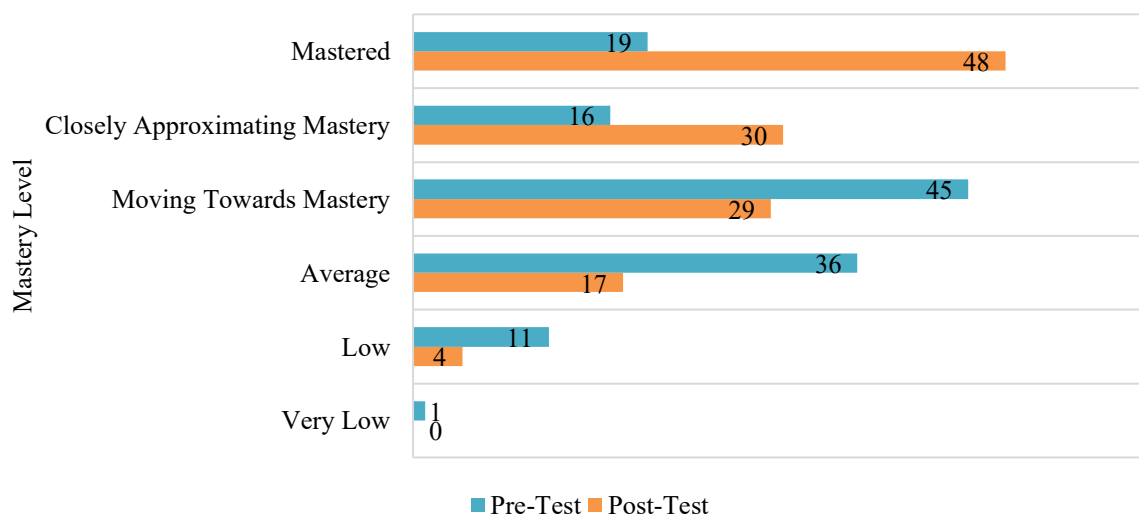


Figure 1: The Mastery Level of the Students in Performing Basic Integer Operations Before and After the Study

Figure 1 shows the distribution of each category of mastery levels of the 128 students during the pre- and post-test of MathSPARK. A total of 19 students (14.84%) were in the “Mastered” category during the pre-test, and this number increased to 48 students (37.50%) in the post-test. In the “Closely Approximating Mastery” category, the number of students rose from 16 (12.50%) in the pre-test to 30 (23.44%) in the post-test. On the other hand, the number of students in the “Moving Towards Mastery” category decreased from 45 (35.16%) to 29 (22.66%) during the pre- and post-test, respectively. The number of students in the “Average” category also went down, dropping from 36 students (28.13%) to 17 students (13.28%). The “Low” category likewise declined, from 11 students (8.59%) in the pre-test to only 4 (3.13%) in the post-test. Lastly, only one student (0.78%) belonged in the “Very Low” category during the pre-test, and no student was in this category during the post-test.

The mastery level of the students during the pre-test, as revealed by the data above, confirmed the inclusion of performing basic integer operations as one of the least mastered competencies in Grade 7 Mathematics in the Division of Sorsogon City [33]. Now that these students are in Grade 8, the mastery level as determined before the study showed that they had not yet met the expected standards for performing operations on integers. The mastery of integers is essential as it serves as a foundational skill necessary for success in other mathematical

concepts [34]. Hence, immediate action to prevent this skill from remaining unmastered has to be taken, in this case, the MathSPARK.

After the MathSPARK has been implemented, a clear upward trend in the students' mastery level was observed, with a notable increase in the number of students classified as "Mastered" and "Closely Approximating Mastery", as revealed in the figure. Consequently, the number of students at lower mastery levels, such as "Low" and "Very Low," was reduced. The foregoing results showed that the mastery level of the students improved after they were exposed to the tasks in the MathSPARK, hence it may have been an effective intervention. The results can be explained by the increase in students' engagement due to technology integration. The integration of technology into the learning experience allowed the students to maintain their interest by providing them with an engaging learning environment [35]. This encouraged students to pursue learning at their own pace. Therefore, its use in the implementation of MathSPARK, along with its clearly defined learning objectives, contributed to its success. Such findings support enhancing students' mastery amidst challenges brought about by class disruptions and in an educational setting with limited resources, while taking advantage of what is available to learners

3.2. The impact of MathSPARK on the mastery of the learners in performing basic integer operations

Table 4 presents the impact of MathSPARK on the mastery of the learners in performing basic integer operations.

Table 4: The Impact of MathSPARK on the Mastery of the Learners of the Key Integer Operations

Measure	Number of Students	Summary of Scores				Z	p-value	Effect size (r)	Interpretation
		Pre-Test	IQR	Post-Test	IQR				
Student Mastery	128	22	9.0	27	7.0	7.20	<0.001	0.6801	Significant increase

The table presents the summary of the mastery of the 128 students who participated in the study. As shown in the table, the median score during the pre-test was 22 with an interquartile range (IQR) of 9.0. In the post-test, the median increased to 27 with a reduced IQR of 7.0. The increase in the median score indicates an overall improvement in the mastery of the students during the post-test. At the same time, the decrease in the IQR shows that the dispersion among the scores obtained by students after the intervention was reduced. The Wilcoxon signed-rank test resulted in a z-value of 7.20, which at a p-value less than 0.001, suggests that the improvement in the scores obtained by the students was statistically significant. The computed effect size, $r = 0.6801$, indicated that MathSPARK had a "Large" effect on student mastery. This result supports the finding that MathSPARK made a strong and meaningful difference in student mastery.

All these information led to the interpretation that MathSPARK, as an intervention, significantly improved students' mastery in the basic integer operations. The data also confirmed that the use of Google Applications with Google Classroom as a learning management system in a remote learning set-up was effective. This finding aligns with previous studies reporting that the utilization of Google Classroom as an instructional tool is effective across both basic and tertiary education levels [36], [37].

3.3. The perceptions of the student on the Effectiveness of the MathSPARK

This study explored the perceptions of the learners on the effectiveness of the MathSPARK on the following themes:

Theme 1: Insights on how the MathSPARK enhanced the Skill in Performing Basic integer operations of the Learners

The participants perceived MathSPARK as a helpful intervention for strengthening their skills in performing basic integer operations. The extent of perceived improvement, however, varied among the participants. Participant 4 stated, "*Kahit papano natulungan ako ng MathSPARK na matuto ng basic integer operations*" [Somehow, MathSPARK helped me learn the basic integer operations], suggesting the partial yet meaningful assistance provided by the intervention. Participant 5 highlighted a two-in-one experience gained from the intervention, describing it as "... *a little tricky but fun at the same time*". This experience suggests that while some tasks challenged the learner, the participant still found the experience engaging. Participant 1 specifically noted an improvement, stating that MathSPARK "... *enhance(d) my skill in integers, that I was struggling in the past. ...*", particularly emphasizing that the MathSPARK helped him understand more about subtracting integers. Similarly, Participant 3 acknowledged the MathSPARK's role in enhancing his skill by saying, "... *dahil makakadagdag ito sa aking kasanayan sa pag solve ng integers.*" [... because this will help improve my skills in solving integers.]. Participant 2 provided a definite example of progress after doing all the tasks in the MathSPARK by sharing that "...*but now I got only 1 mistake in the post-test*". As a whole, the responses suggest that the

participants generally recognize MathSPARK as an effective learning tool that supported the enhancement of their skill, conceptual understanding, and motivation in learning the basic integer operations.

Theme 2: Problems, Challenges, or Difficulties Encountered by the Students in Using the MathSPARK

Participants reported that they have encountered conceptual difficulties and technical issues as problems or challenges while doing the assigned tasks in MathSPARK. Conceptual difficulties were highlighted by Participant 4, who shared, “*Mayroon, nalilito ako kapag may mga negative ang isang number. Kagaya ng $(-2 + (-5))$, $(8 - (-7))$, $(-10 + 8)$ at $(-12 - (-17))$* ” [Yes, I get confused when a number has negatives, like $(-2 + (-5))$, $(8 - (-7))$, $(-10 + 8)$, and $(-12 - (-17))$]. Technical issues were also reported by Participant 5, who explained, “*Yes, I had encountered two problems in MathSPARK. The 1st problem was that when I already answered it, my answer keeps resetting, my second problem was that Gmail kept on changing*”. Participant 3 mentioned internet connectivity, another technical issue, as his problem, stating, “*Meron dahil ang aming wifi ay minsan ay nawawala kaya’t hindi ko nagagawa ng maaga ang aking MathSPARK*”. [Yes, because our Wi-Fi sometimes goes out, so I am unable to finish my MathSPARK tasks early.] On the other hand, Participants 1 and 2 expressed no issues: Participant 1 said, “*None, there are no problems in MathSPARK. It was running smoothly in my device*”, while Participant 2 noted, “*None, MathSPARK was really easy for me*”. Overall, these responses reveal that while some learners navigated MathSPARK smoothly, others faced both technical and conceptual difficulties that may have influenced their learning experience.

Theme 3: The Experiences in Completing Each Task in the MathSPARK

Participants generally described their experience with MathSPARK classwork positively, highlighting the feelings of happiness, engagement, and personal satisfaction. Participant 4 shared, “*Para sa akin habang ginagawa ko ang bawat gawain ako ay masaya dahil natututo ako*” [For me, while doing each task, I feel happy because I am learning], reflecting an enjoyable and meaningful learning process. Participant 5 briefly described the experience as “*fun*”, indicating positive emotional engagement. Participant 1 expressed fulfillment linked to performance, stating, “*It was very fulfilling because when I get a high score, and I got very happy because of that*”. Meanwhile, Participant 3 emphasized a practical approach to avoid errors, sharing, “*My experience in MathSPARK classwork habang ginagawa ko ito ay meron akong scratch para hindi magkamali*” [My experience in MathSPARK classwork is that while doing it, I have a scratch paper so I don’t make mistakes]. Participant 2 reflected on a nostalgic feeling, noting, “*It is like a nostalgic experience for me because it reminds me of all the equations of integers I once answered back then*”. Collectively, these responses suggest that learners experienced MathSPARK as both enjoyable and rewarding, with a balance of emotional satisfaction and thoughtful engagement.

Theme 4: Recommendations Based on the Experiences in Using the MathSPARK

All the participants expressed their willingness to recommend MathSPARK to their classmates or friends as an effective tool for enhancing skills in fundamental integer operations. Participant 1 noted the practical advantage for peers who face challenges with integer addition and subtraction, saying, “*Yes, because some my friends struggle in Addition, Subtraction, etc. with integers. So MathSPARK might help*”. Participant 2 emphasized the program’s capacity to improve skills, stating, “*I would, because it would boost our skills in performing basic integer operations*”. The engaging and enjoyable nature of MathSPARK was highlighted by Participant 5, who shared, “*Yes. I would recommend using MathSPARK because it’s fun and enjoyable*”. Participants 3 and 4 gave straightforward endorsements, with Participant 3 saying, “*Yes... because it is correct*”, and Participant 4 affirmed, “*Yes*”. These responses collectively suggest a strong positive perception of MathSPARK’s usefulness and appeal among learners.

The discussions above collectively provided insight into the potential of MathSPARK as an intervention material for enhancing skills, highlighting identified areas for improvement. First, the participants’ reports of enhanced skills and conceptual understanding in basic integer operations align with findings showing that interactive digital features in learning can lead to measurable gains in mathematical performance and understanding [38]. Second, the challenges encountered by the participants, such as the conceptual confusion with negative numbers and the technical difficulties, emphasize the critical role of scaffolding, troubleshooting support, and instructional design to maximize the effectiveness of the MathSPARK. Third, the enjoyment, fulfillment, and emotional engagement described by the participants resonate with findings that positive emotions in interactive learning environments improve task efficiency and engagement [39]. Lastly, the participants’ willingness to recommend MathSPARK echoes conclusions that enjoyment and perceived usefulness can drive learner endorsement and long-term utilization [40]. As a whole, these findings show that the effectiveness of the MathSPARK intervention is attributed not only to its capacity to enhance the skills of the students in performing basic integer operations but also to its ability to motivate, engage, and be appreciated by the learners. For this reason, it was established as a good example for implementing interactive digital tools to address unmastered pre-requisite skills in mathematics.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the results and discussion, the study concluded that MathSPARK served as an effective tool for enhancing Grade 8 learners' mastery of the four basic integer operations, with more learners attaining higher mastery levels and fewer remaining at lower levels at the end of the study. Its integration of structured digital practice and technology-based engagement demonstrated the value of self-paced learning tools. These tools have been found to successfully support mastery of foundational mathematical skills in secondary education. Moreover, learners' positive perceptions of MathSPARK highlight its potential not only to improve mastery of a foundational skill but also to promote motivation and positive attitudes toward mathematics.

In light of these conclusions, it is recommended that educators adopt interactive digital interventions such as MathSPARK to reinforce least-mastered skills and optimize available learning time, not only in mathematics but also across other learning areas where similar digital tools can address least-learned competencies. Schools and administrators should likewise provide the necessary infrastructure, accessibility, and technical support to sustain such digital learning initiatives. Policymakers are encouraged to promote low-cost, scalable, and contextually relevant digital tools that complement classroom instruction, while future researchers may explore MathSPARK's application to other least-learned mathematical content domains, learning modalities, and grade levels, as well as the development of similar interventions for other disciplines to further expand their impact on student learning.

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