**Improving Numeracy Skills with Technology:**

**An Evaluation of FlashDrills for Integer Operations**

***Abstract***

The Philippines faces challenges with basic math skills, particularly in integer operations such as addition, subtraction, multiplication, and division. Mastering these operations is essential, as they lay the foundation for more advanced concepts. This mixed-method study examined the effectiveness of FlashDrills, a digital pre-class drill tool, in improving the numeracy skills of Grade 7 learners in integer operations at a secondary public school. Grounded in Constructivist, E-learning, and Engagement Theories, the study addressed learners' persistent difficulty in mastering fundamental integer operations—an issue reflected in national and international assessments. The study was conducted in a public secondary school in Barotac Nuevo, Iloilo, encompassing both Junior and Senior High School learners. For the quantitative aspect, a Quasi-Experimental Pre-test-Post-test Design was used, where learners in pre-existing groups were assessed before and after the intervention. The quasi-experiment involved 60 learners who were matched in pairs into experimental and control groups.Over eight weeks, the experimental group integrated FlashDrills while the control group received traditional instruction, such as oral and chalkboard. Pre-test scores showed no significant difference at the start. However, post-intervention results showed that the experimental group significantly outperformed the control group, with scores from "low proficiency" to "nearly proficient," reflecting relatively improved skills and more confident handling of integer operations. Qualitative data from FGDs and classroom observations revealed that learners found FlashDrills easy to follow and visually engaging, and boosted their confidence in learning math. Its immediate feedback and structured format improved motivation and conceptual understanding. Learners shifted from math anxiety to active participation, though some expressed challenges related to time pressure and complex items. The need for scaffolding and pacing emerged as key insights. This study showed that FlashDrills is an effective tool for improving Grade 7 students' numeracy skills, especially in integer operations. Overall, FlashDrills was not just a digital resource skills-enhancing supplement but a transformative tool that supported learning and reshaped learners' experiences with mathematics. The study recommends continued integration of FlashDrills, incorporating self-paced activities with flexible, student-centred instruction to maximise its impact on mathematics education.

*Keywords: FlashDrills, Integer Operations, Numeracy Skills, Digital Pre-Class Drills, Mathematics Education*

**Introduction**

Mathematics is crucial in developing skills like logical reasoning, critical thinking, and problem-solving, which are vital for academic success and everyday life. Scholars and educators worldwide have focused on developing critical thinking skills in Mathematics education. Many studies have tried to discover why it is crucial to develop critical thinking skills among students and techniques for embedding them in Mathematics syllabi (Jamil et al., 2024; Hoogland, 2023). However, many students in the Philippines face challenges with basic math skills, particularly in integer operations such as addition, subtraction, multiplication, and division. Mastering these operations is essential, as they lay the foundation for more advanced concepts (Sutama et al., 2020).

Global assessments highlight this issue. For example, the 2022 PISA ranked the Philippines 77th out of 81 countries, with only 16% of students reaching basic math proficiency, showing that over 80% struggle with fundamental concepts like comparing distances or converting units—skills that rely on integer operations (PISA, 2022). Similarly, the 2019 TIMSS report highlighted a decline in numeracy levels among Filipino students, stressing the need for innovative teaching approaches.

Recent research on educational technologies has recognised the potential of adaptive learning environments for supporting personalised learning. Adaptive learning environments are digital learning systems that analyse data about learners and their contexts to tailor learning activities (e.g., learning contents, instructional approaches) to the individual learner and to support learning processes (Fromm & Ifenthaler, 2024). Research suggests that pre-class drills and structured practice can effectively reinforce foundational skills. Alsharif and Younes (2020) found that regular drills not only boost retention but also enhance student confidence and engagement. Studies by Fuchs et al. (2018) and Bautista (2020) show that repeated exposure to core operations increases math fluency, especially when combined with technology.

Reyes and Mendoza (2020) discovered that using digital flashcards in Grade 7 math classes led to higher engagement and performance in integer operations. These interactive tools allowed students to better grasp positive and negative values, with those struggling initially showing significant improvement after consistent use.

The approach proposed in this study, FLASHDRILLS: A Digital Resource Pack for Mastering Integer Operations, is grounded in educational research and Self-Determination Theory (Deci & Ryan, 2021), which emphasises that students are more motivated when their needs for autonomy, competence, and connection are met. FlashDrills aims to improve computational accuracy through digital pre-class drills, creating a more engaging and positive learning environment in line with ISUFST's focus on innovative teaching and emerging technologies in education (ISUFST Research Agenda #7).

**Statement of the Problem**

This study aimed to explore how effective FlashDrills is in improving Grade 7 learners' skills with integer operations. It also looked into the students' learning experiences, including the challenges they faced, their motivation, and how engaged they felt while using FlashDrills to learn integer operations.

Specifically, this study sought to answer the following questions:

1. What are the level of numeracy skills of the learners using standard pedagogy and those using FlashDrills in the pre-test and post-test?
2. What is the mean gain of the learners using standard pedagogy and those using FlashDrills?
3. Is there a significant difference in the pre-test scores of the learners using standard pedagogy and those using FlashDrills?
4. Is there a significant difference in the post-test scores of the learners using standard pedagogy and those using FlashDrills?
5. Is there a significant difference in the mean gain scores of the learners using standard pedagogy and those using FlashDrills?
6. What challenges and successes do Grade 7 learners encounter while learning integer operations through FlashDrills?
7. How do Grade 7 learners perceive their motivation and engagement in learning integer operations when using FlashDrills?

**Objectives**

This study aimed to evaluate how FlashDrills improves Grade 7 learners' numeracy skills in integer operations. Specifically, it focused on:

1. Measuring the impact of FlashDrills on learners' performance in integer operations;
2. Comparing the performance of learners using FlashDrills with those using traditional teaching methods, based on pre- and post-test scores;
3. Exploring the challenges, motivation, and engagement learners experience while using FlashDrills; and
4. Identifying factors that contribute to the success of FlashDrills, such as increased confidence, clearer understanding, and better participation.

**Theoretical and Conceptual Frameworks**

This study combined several learning theories to support the use of FlashDrills in enhancing Grade 7 students' numeracy skills, particularly in integer operations. It drew on the three theories, namely Constructivist Learning Theory, E-Learning Theory, and Engagement Theory. Constructivist Learning Theory (Piaget, 1952) emphasises learners actively constructing knowledge through interaction with their environment. In the FlashDrills approach, students build on their existing knowledge through guided practice, connecting new concepts with what they already know. The E-Learning Theory, under Cognitive Load Theory (Sweller, 1988), highlights how reducing cognitive overload through structured drills improves learning by allowing students to focus on mastering foundational skills. The Engagement Theory (Kearsley & Schneiderman, 1999) underscores the importance of student involvement through interactive, technology-based tasks, which in this study, is supported by FlashDrills’ visual drills and peer collaboration.

Conceptually, as shown in Figure 1, this study compared traditional teaching methods with the FlashDrills strategy, focusing on how five-minute pre-class drills can improve Grade 7 students' performance in integer operations through their numeracy scores. The study also looked into the challenges and successes, as well as the motivation and engagement, of the students when using the FlashDrills-based activities. The independent variables were the traditional method (pre-class drills done traditionally) and the FlashDrills approach (pre-class drills done using FlashDrills). The dependent variables included students’ level of performance through their numeracy scores (quantitative), assessed through pre- and post-tests. Through thematic analysis, the narratives of the learners having FlashDrills were also deduced and themed. The study used purposive sampling to select students with numeracy difficulties, ensuring a balanced comparison between experimental and control groups. This study aligns with ISUFST’s research agenda by promoting innovative teaching methods (Research Agenda #7) and leveraging technology to improve educational outcomes.

The study can be summarised by the paradigm below.

Figure 1. Research Paradigm

Traditional

Numeracy Scores

FlashDrills

Challenges and Successes

Motivation and Engagement

**Methodology**

**Research Design**

This study used a Mixed-Method Design, combining both quantitative and qualitative approaches to provide a fuller understanding of the research problem. By integrating numerical data for generalisation and textual data for deeper insights (Creswell & Plano Clark, 2018), the study effectively addresses the research questions.

Figure 2: Sample Digital Packet

For the quantitative aspect, a Quasi-Experimental Pre-test-Post-test Design was used, where learners in pre-existing groups were assessed before and after the intervention. The T-test for Dependent Samples was applied to evaluate significant differences between groups (Creswell & Creswell, 2018). For qualitative analysis, a Narrative Inquiry approach was used to explore learners’ experiences, challenges, and engagement with the FlashDrills intervention, employing Thematic Analysis to uncover key themes (Braun & Clarke, 2006).

**Locale of the Study**

The study was conducted in a public secondary school in Barotac Nuevo, Iloilo, encompassing both Junior and Senior High School learners.

**Participants**

Purposive sampling was used to select two Grade 7 sections based on their typical classroom learning characteristics. Matched-pair random sampling ensured that each group consisted of 30 learners, with one group assigned to the experimental and the other to the control group through a coin toss. The experimental group used FlashDrills, while the control group followed traditional teaching methods. Additionally, six students from the experimental group were selected following a selection criterion for the Focus Group Discussion (FGD).

Table 1: Proficiency Level in Numeracy



**Sampling Technique**

For the quantitative component, matched-pair random sampling was applied within two purposively selected Grade 7 sections to control for variables. For the qualitative component, purposive sampling was used to select six students for the narrative inquiry and FGD, focusing on diverse learner experiences. These combined sampling methods ensured reliable and meaningful results (Creswell & Plano Clark, 2018).

*Figure 3: Data Collection Procedure Flowchart.*



**Research Instrument**

The primary intervention tool was a Digital Packet (Figure 2) of integer drills, designed as a 5-minute pre-class activity for the experimental group. Pre- and post-tests were administered using a researcher-designed 40-item E-RUNT-aligned questionnaire, validated by three DepEd teachers, and confirmed for reliability through the KR-20 formula (Tavakol & Dennick, 2011). Table 1 shows the Level of Numeracy used in analysing the data. On the other hand, qualitative data were collected through FGD, interviews, and teacher-researcher observations.

**Data Collection Procedure**

After securing permission from the school principal and obtaining informed consent from parents, pre-tests were administered to both groups to assess baseline knowledge. The experimental group received the FlashDrills intervention, while the control group continued with traditional methods. Post-tests followed the intervention to evaluate learning outcomes. FGDs with the experimental group provided further insights into learners’ experiences. See Figure 3: Data Collection Procedure Flowchart for more details.

**Data Analysis**

Data were analysed using descriptive and inferential statistics, including mean, standard deviation, and paired sample t-tests. Thematic analysis was also used to analyse qualitative data using a digital application, exploring learners’ motivation, engagement, and challenges.

This methodology aligns with ISUFST's research agenda, particularly in the area of "Innovative Teaching and Learning" (Research Agenda #7), by integrating technology to improve educational outcomes.

**Results and Discussion**

The results of this study demonstrate the effectiveness of the FlashDrills strategy in improving Grade 7 learners' numeracy skills, particularly in their ability to perform integer operations.

In Table 2, the pre-test results revealed that both the control and experimental groups had similar levels of proficiency at the beginning of the study. Both groups were categorised under the "Low Proficiency" range of the DepEd Proficiency Level Scale for Numeracy, with the control group scoring a mean of 18.1 and the experimental group scoring a slightly lower mean of 17.0. These initial results suggest that learners in both groups had relatively weak numeracy skills, particularly in the four basic operations involving integers (addition, subtraction, multiplication, and division), and required significant instructional support to improve.

**Table 2***: Level of Numeracy Skills of the Learners in the Pre-test*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Category | N | Mean | SD | Mean % | Description |
| Control | 30 | 18.1 | 3.36 | 45.25% | Low Proficiency |
| Experimental | 30 | 17.0 | 1.92 | 42.5% | Low Proficiency |

*Note: 0%-24% (Not Proficient),25%-49% (Low Proficiency), 50%-74% (Nearly Proficient), 75%-89%(Proficient),90%-100% (Highly Proficient).*

However, the post-test results in Table 3 revealed a striking difference between the two groups. The control group showed minimal improvement, with their mean score rising only slightly to 19.7, still placing them in the "Low Proficiency" range. On the other hand, the experimental group, which used the FlashDrills intervention, showed significant improvement, with a mean score of 25.7, moving them into the "Nearly Proficient" category. This substantial difference indicates that the FlashDrills strategy was effective in enhancing learners' understanding, accuracy, and confidence in solving integer-related problems. These results are consistent with the findings of previous studies that emphasised the importance of structured practice and interactive learning tools in improving students' academic performance (Alsharif & Younes, 2020; Fuchs et al., 2018).

**Table 3:** *Level of Numeracy Skills of the Learners on the Post-test*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Category | N | Mean | SD | Mean % | Description |
| Control | 30 | 19.7 | 3.01 | 46% | Low Proficiency |
| Experimental | 30 | 25.7 | 4.50 | 64% | Nearly Proficient |

*Note: 0%-24% (Not Proficient),25%-49% (Low Proficiency),50%-74% (Nearly Proficient), 75%-89% (Proficient),90%-100% (Highly Proficient).*

The mean gain scores shown in Table 4 provided further evidence of the impact of FlashDrills. While the control group's mean gain was a modest 1.6 points (from 18.1 to 19.7), the experimental group demonstrated a much more substantial gain of 5.9 points (from 17.0 to 25.7). This dramatic difference in mean gains emphasises that the FlashDrills strategy was not only effective in improving learners' skills but also in boosting their confidence and motivation. The higher standard deviation for the experimental group (2.68) compared to the control group (1.61) suggests that while there was greater variation in the experimental group’s performance, the overall improvement was more pronounced, further highlighting the success of the intervention.

**Table 4***: Mean Gain Scores of the Learners Between the Two Groups*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Category | N | SD | Mean Pre-test | Mean Post-test | Mean Difference |
| Control | 30 | 1.61 | 18.1 | 19.7 | 1.63 |
| Experimental | 30 | 2.68 | 17.0 | 25.7 | 5.90 |

The statistical analysis, as shown in Table 5, using a t-test for dependent samples, revealed a significant difference between the two groups' pre-test and post-test scores. The pre-test t-statistic of 1.60 (p = 0.121>0.05) showed that the two groups had very similar starting points in terms of their numeracy skills, indicating that there was no meaningful distinction in their abilities before the intervention. However, the post-test t-statistic of -5.53 (p < .001) indicated that the experimental group made significantly greater progress than the control group, supporting the conclusion that FlashDrills had a meaningful impact on learners' numeracy skills. Additionally, the analysis of the mean gain scores as shown in Table 6 confirmed this result, with a t-statistic of -7.96 (p < .001), providing strong evidence that the FlashDrills intervention led to a statistically significant improvement in learners’ performance compared to those who received traditional instruction.

**Table 5***: Difference in the Pre-test and Post-test Scores of the Two Groups*

|  |  |  |  |
| --- | --- | --- | --- |
|  | Statistic | df | p |
| Pre-test | Student’s t | 1.60 | 29.0 | 0.121 |
| Post-test | Student’s t | -5.53 | 29.0 | <.001 |

*Note: Significant at alpha level 0.05.*

**Table 6***: Difference in the Mean Gain Scores of the Two Groups.*

|  |  |  |  |
| --- | --- | --- | --- |
|  | Statistic | df | p |
| Mean Gain | Student’s t |  -7.96 | 29.0 | <.001 |

*Note: Significant at alpha level 0.05*

### The qualitative results from this study revealed important insights into how Grade 7 learners experienced FlashDrills in enhancing their numeracy skills, particularly in integer operations. One key theme that emerged was the increased visual learning and concept clarity. Learners in the experimental group appreciated how the visual elements and animations in FlashDrills made understanding mathematical concepts easier. Maya, not here real name, shared, “Mahapos intindihon” (It’s easy to understand), and Theo added, “Gina-explain gid tuo, Ma’am” (It’s really well explained, Ma’am). Nina also emphasized the importance of visuals, saying, “Para makita gid” (So I can see it).

### The teacher also observed that learners were more engaged when visuals were used. The math teacher-observer Maria, not her real name, remarked, “Their eyes stay on the screen—mas attentive sila when visuals are used. Ang iban gani nga tamaran magsulat, nagahulat gid mag-appear ang next slide" (They are more attentive when visuals are used. Some learners who usually avoid writing eagerly wait for the next slide to appear). This supports Mayer’s (2021) Cognitive Theory of Multimedia Learning, which suggests that combining visual and auditory elements enhances learning, especially when abstract concepts like integer operations are involved.

### Another prominent theme was active learning through timely feedback. FlashDrills provided immediate feedback, which helped learners correct their mistakes and stay engaged. Theo noted, “Ginagamitan dayon, masabat, kag gina-explain” (It’s used right away to answer and explain), and Maya added, “Nakabulig gid, Ma’am” (It really helped, Ma’am). The teacher also noticed the positive energy in the classroom when learners received instant feedback. Mrs. Maria observed, "When learners saw their mistakes, they were eager to try again. Instead of just listening, they actively participated in correcting their answers." This aligns with Hattie and Timperley’s (2007) research on the importance of timely feedback in improving learning and retention.

### The theme of enjoyment and positive reinforcement also emerged as an essential factor in the success of FlashDrills. Many learners expressed that the interactive and fun nature of the platform made learning more enjoyable. Princess, not her real name, shared, “Masadya ang klase, Ma’am” (Class is fun, Ma’am), and Theo, not his real name, said, “Naga-alam Ma’am” (I get smarter). Teacher Biocales noticed that even the typically disengaged learners became more enthusiastic, stating, "Maski ang mga tamaran naga-raise hand kay excited mag-answer" (Even the passive learners raise their hands because they’re excited to answer). The enjoyment sparked by FlashDrills, driven by its visual and interactive features, contributed to increased motivation and engagement, which is consistent with Mayer’s (2021) findings on the impact of enjoyable multimedia environments on learning.

### Despite these successes, learners also encountered several challenges. One of the most significant challenges was the time constraints for complex items. The 10-second limit per problem worked well for simpler tasks but caused stress and frustration for more complex problems. Maya said, “Igo lang kung hapos, pero kulang kung mabudlay” (Enough for the easy ones, not for the hard ones), and Theo added, “Kung mabudlay, indi enough ang 10 seconds” (If it’s hard, 10 seconds isn’t enough). Learners also expressed anxiety when faced with problems that required more time and thought, which aligns with Sweller’s (1994) Cognitive Load Theory, suggesting that excessive time pressure can overwhelm learners and hinder their ability to process information effectively. This highlights the need to adjust the pacing of FlashDrills to ensure that students are not rushed when solving complex tasks.

### Another challenge was the cognitive struggles with higher-order problems, especially those involving negative signs and mixed integer operations. Liam, not his real name, admitted, "Galingin ulo kay indi ko kabalo" (It confuses my head when I don’t know), while Nina said, "Budlay mag-isip" (It’s hard to think). These responses indicate that while FlashDrills was effective in helping learners master basic operations, more complex problems created confusion and hesitation. Teacher Maria observed, "Ang iban gapabilin sa basic, indi pa ready for higher-level questions" (Some learners remain at the basic level and are not yet ready for more advanced questions). Vygotsky’s (1978) Zone of Proximal Development theory suggests that learners benefit from structured support when transitioning from simpler to more complex tasks, implying that more scaffolding is needed for learners to tackle advanced concepts confidently.

### Lastly, learners expressed a desire for more support and scaffolding. Several students mentioned that they needed more time, clearer explanations, or peer support to feel confident in solving problems. Maya shared, “Gusto ko hinay-hinay lang para may time sa pagpanumdum” (I want more time to think), and Evan emphasised, “Kung may guide, mas klaro” (If there’s guidance, it’s clearer). The teacher and researchers observed that learners who struggled often stayed after class for additional help, demonstrating their eagerness to learn but also their need for more instructional support. Researcher Duque noted, "Learners benefited from peer collaboration. Those who struggled were more confident when their classmates explained the steps to them." This supports Vygotsky’s emphasis on scaffolding, where learners thrive when provided with structured guidance and peer collaboration.

### In terms of motivation and engagement, learners were driven by the challenge presented by FlashDrills. The combination of easy and difficult tasks motivated learners to persist, despite nervousness. Theo said, "May kulba man maam, basi sala maam" (I feel nervous, perhaps I am mistaken, Ma'am), but continued to participate. Maya noted, "Mahapos ang iban, ang iban mabudlay" (Some are easy, others are difficult), showing her resilience in facing both simple and challenging tasks. This aligns with behaviourist learning theories, where immediate feedback and challenges encourage persistence and improvement.

### Learners also expressed a strong preference for FlashDrills over traditional methods. They found the digital platform more engaging, with Theo stating, “Makita sa TV para masulod sa utok, Ma’am” (Seeing it on TV helps it enter my mind), and Maya adding, “Nami ang makita sa TV para matandaan, Ma’am” (It’s nice to see it on TV to remember). This preference aligns with Paivio’s (1986) Dual Coding Theory, which suggests that combining visual and verbal information enhances memory and learning.

### Finally, peer support played a crucial role in encouraging learners. Maya said, "Mas nami may upod para may matudlo" (It’s better with someone to teach you), and Evan added, "Kung kabalo si Liam, buligan niya ko" (If Liam knows it, he helps me). This peer collaboration fostered a supportive learning environment and increased learners' confidence. Teacher Maria observed, “Ang mga tamaran gina budlayan sa group, pero kay may naga bulig, gina-try man nila” (Those who faltered in groups still tried because they had assistance). This supports Vygotsky’s (1978) Zone of Proximal Development, which emphasises the importance of social interaction and peer support in the learning process.

### Conclusions

This study shows that FlashDrills is an effective tool for improving Grade 7 students' numeracy skills, especially in integer operations. The experimental group saw significant gains in their post-test scores, clearly demonstrating the value of using structured, visual, and interactive drills in learning. Beyond boosting math performance, FlashDrills also increased student engagement and motivation, as reflected in their positive feedback and active participation in lessons.

That said, the study also highlighted some challenges, particularly around time limits for more complex problems and the need for additional support with more advanced tasks. These challenges suggest that while FlashDrills is a valuable tool, it should be integrated into a more balanced learning approach that also includes traditional methods and additional scaffolding for more difficult concepts.

### Recommendations

Drawing from the results of this study, a few practical steps can help make FlashDrills even more effective in the classroom. First, teachers might consider blending it with their usual strategies—using FlashDrills not to replace traditional methods but to enrich how we teach integers and strengthen students’ number sense. Second, giving students a bit more time for complex drills, especially those involving negative numbers and multiple steps, could help ease frustration and support deeper understanding.

It would also be helpful to give extra support or guided practice to those who may be struggling with the tougher parts of the drills. A mix of teaching styles—some digital, some familiar chalk-and-talk—can go a long way in meeting different learning needs. For the long haul, more research should look into how tools like FlashDrills impact learning over time and whether they can work well for other math topics too.

Lastly, helping teachers feel confident with tech tools through training and support systems is key. When teachers are supported and empowered, students truly thrive. By embracing these recommendations, we can build classrooms that are not only more engaging but also better tailored to each student’s unique pace, strengths, and learning path.

By following these recommendations, educators can optimise the use of FlashDrills to create a more engaging, inclusive, and effective learning environment that addresses the diverse needs of all students.

**Ethical Approval and Consent:**

After securing Approval from School Administration and obtaining written informed consent from parents, pre-tests were administered to both groups to assess baseline knowledge.

**Disclaimer (Artificial intelligence)**

**The Authors, affirm that ChatGPT, Grammarly, and Quillbot were used as support tools in writing and editing this manuscript. ChatGPT assisted in refining structure and phrasing, Grammarly helped correct grammar and clarity issues, while Quillbot was used for rewording to improve readability. These tools were used only to enhance the quality of writing—never to generate original content or replace the author's critical thinking, analysis, or voice.**

**All outputs were thoroughly reviewed, edited, and humanized by the author, and were tested using ZeroGPT.com to ensure authenticity and originality. The author maintained full control over the research, ideas, and final text.**

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