

**A MOBILE APPLICATION PROGRAM ON BASIC MATH SKILLS  
ENHANCEMENT FOR ELEMENTARY PUPILS**

An IT Capstone Project Proposal  
Presented to the Faculty of the  
College of Information and Computing Sciences  
Zamboanga Peninsula Polytechnic State University

In Partial Fulfillment of the Requirements  
for the degree in Bachelor of Science in Information Technology

By  
Sef Amsid  
Jericho Divino  
Jecell Fajardo  
Kristel Joy Neo

BELYN R. ENGUERRA, MEngg.Ed.  
Adviser

April 2025

## **CHAPTER 1**

### **INTRODUCTION**

Math is a crucial component of any child's skill set, both academic and personal development. However, a lot of elementary school students find it difficult to understand the fundamental math ideas, which results in poor progress and affects their ability to study, in the math subject. Mobile apps are now regarded as a significant factor in drawing pupils and enhancing their academic performance as the majority of technology is integrated into the classroom.

Innovative ways to enhance students' educational experiences are presented by the widespread use of mobile learning devices. According to research, interactive digital platforms can greatly increase students' mathematical interest and comprehension. The use of math instruction significantly increased student engagement and learning results, according to a study. The goal of this project is to produce a mobile application that will improve primary school students' basic math skills by incorporating real-time monitoring, interactive activities, and a real-time feedback into a fun learning environment Maryana et al. (2024).

According to an evaluation, a program using mobile devices positively affects the development of math and reading skills in elementary school and places. These findings clearly indicate the need for adaptive learning tools, as the majority of elementary students struggle to understand addition, subtraction, multiplication, and division as their basic mathematical operations Traditional teaching may not reach all kinds of pupils' various learning styles, making it harder for some children to fully understand the essential concepts of mathematics. This mobile application is meant to minimize issues that are applicable to elementary learners' basic math skills. It will include problem-solving activities, interactive exercises, and a customized learning plan designed to accommodate each student's learning style. According to research reviewed, educational strategies like this can improve students' motivation and comprehension of mathematics. The goal of the app is to motivate and engage kids so they can cooperate with their teachers to improve their mathematical abilities Dorris et al. (2024).

To address the difficulties faced by elementary students in learning math, this project proposes the development of a mobile application designed specifically to enhance their mathematical skills. The application will provide an engaging and adaptive learning experience through interactive exercises, problem-solving activities, and personalized learning plans. By incorporating real-time progress tracking and tailored feedback, the app aims to cater to different

learning styles, ensuring that students receive the necessary support to build a strong foundation in basic mathematical operations such as addition, subtraction, multiplication, and division.

The mobile application's main features will include practice modules for all basics of operation, progress tracking capabilities, and adjustable difficulty levels for further individualized learning opportunities. These will enable the students to learn and practice mathematical ideas at their own speed in a way that develops a deeper comprehension and memory of mathematical concepts. Successful examples of how to include technology into education show that it can bridge gaps in traditional teaching techniques and provide more efficient ways to teach mathematics.

## 1.1 Project Context

The current approach to teaching mathematics in elementary schools is still based on traditional methods of textbook instruction, chalkboard presentations, and written work practice. The teacher would typically lecture on concepts followed by assessments of practices, and giving assignments. While these methods have been used for decades, they rely heavily on rote memorization and repetitive problem-solving, which may not cater to all learning styles.

Typically, during math lessons, the teacher introduces a new topic by lecturing and using the blackboard to demonstrate concepts. Then guided practice begins, with students using their textbooks or worksheets. Afterward, students are given certain exercises to solve independently, while the teachers monitor their progress and help out where necessary. However, this conventional way of teaching has its challenges. For some students, it becomes increasingly difficult for them to understand mathematical concepts because of a lack of time, lack of interaction, and visual learning tools. Also, large class sizes mean that teachers do not have enough time to give special attention to any one student, and some fall behind as a result. It also becomes time-consuming assessing student progress nowadays, given that teachers have to check every single assignment and quiz accurately. An additional problem is that the math coaches students manually to solve Ninja Number and Cross math, which means they also manually check for errors, and the process takes a significant amount of time.

The lack of an interactive and adaptive learning system will cause students to have a bad attitude toward mathematics, which will affect their performance in other subjects. Teachers will also be unable to access real-time data on student progress, even to address areas where these students may need better.

To address these challenges, the researchers will develop a Mobile Application Program on Basic Math Skills Enhancement for Elementary Pupils. This application will complement learning by interactive exercises, real-time feedback, real-time monitoring, and includes cross math and ninja numbers which provide level of difficulty in grade-specific challenges. This program aims to ease the process of learning mathematics for both students and teachers by changing how technology is integrated into the educational process.

## **1.2 Purpose and Description**

The main purpose of this capstone project is to develop a mobile application that enhances elementary pupils' basic math skills through interactive and engaging learning activities. The proposed capstone project, entitled "A Mobile Application Program on Basic Math Skills Enhancement Program for Elementary Pupils," will be designed and developed by the researchers for elementary students to improve their math proficiency and learning engagement, and also for the teachers to monitor the progress of the students.

The project will primarily benefit elementary students by making learning math more enjoyable and accessible. Teachers will also benefit from this application as it provides real-time progress tracking and adaptive exercise specialized to every student needs. Parents can also monitor their child's progress and encourage continuous learning at home.

The mobile application stands out for its gamification features, including reward-based learning, progress tracking, and interactive problem-solving exercises. Unlike traditional worksheets, this app allows students to learn through engaging challenges that adapt to their skill level. Additionally, the application enables teachers and parents to assess student progress effectively.

The lack of interactive and adaptive learning systems contributes to students developing negative attitudes toward mathematics, adversely affecting their performance in other subjects. This concern is underscored by recent assessments of Filipino students' mathematical proficiency. The 2019 Southeast Asia Primary Learning Metrics (SEA-PLM) revealed that only 17% of

Filipino Grade 5 learners achieved the desired proficiency in mathematics necessary for a smooth transition to secondary education. Furthermore, the 2019 Trends in International Mathematics and Science Study (TIMSS) ranked the Philippines last among 58 countries, with Filipino fourth graders scoring an average of 297 in mathematics, significantly below the low benchmark of 400. Additionally, a study examining foundational skills among Filipino students over 19 years found a significant decline in foundational mathematics skills, indicating that not all higher-grade students master the skills taught by grade 3. These findings highlight the urgent need for educational reforms to enhance mathematics instruction and student engagement.

The main function of the project is to serve as a digital learning tool that enhances the mathematical skills of elementary pupils. Through interactive exercises, quizzes, and challenges, the app helps students practice and master fundamental math concepts. It also tracks their progress and provides instant feedback, allowing learners to identify areas for improvement and gain confidence in their abilities. Furthermore, the app serves as a bridge between traditional and modern learning methods, making math education more dynamic and accessible.

This project proposes an interesting and interactive mobile application that aims to improve elementary school pupils' basic math skills. It works with adaptive learning technology, game-based activities, and real-time feedback to personalize the learning experience. In addition to enabling parents participate in their children's education at home, the app can serve as a tool for teachers to enhance their own lessons in the classroom. A reward system and progress reports provide ongoing skill improvement, which keeps students inspired to get better at solving problems. In a digital setting, these meeting spots showcase creativity and transform the arithmetic learning process into something valuable and enjoyable.

### **1.3 Objectives of the study**

This study aims to develop a mobile application program that enhances the basic math skills of elementary pupils by providing an interactive and engaging learning platform.

1. To gather data in order to determine the user and system requirement
  - A. Conduct Surveys and Interviews
  - B. Analyze Existing Educational Tools and Learning Gaps
  - C. Determine User Profiles and Accessibility Needs

D. Technical Feasibility and System Requirements

2. To design and develop the mobile application with the following features:
  - A. Interactive game-based exercises for math skills enhancement, including Crossmath and Ninja Number.
  - B. Adaptive learning to personalize lessons.
  - C. Real-time feedback and progress tracking.
  - D. Reward system to motivate students.
3. To evaluate the usability according to the following parameters
  - A. System usefulness
  - B. Information quality
  - C. Interface quality
  - D. Overall
4. To help the users by developing users documentation

## **1.4 Scope and Limitations**

### **Scope**

- This study focuses on developing a mobile application designed to enhance the basic math skills of elementary pupils through interactive and engaging learning activities. The application aims to support young learners by incorporating game-based exercises, real-time feedback, progress tracking, and adaptive learning mechanisms.
- Its primary objective is to provide an alternative learning tool that supplements traditional math education both in classrooms and at home. The target users for the application include elementary school students and teachers. While students engage with the app to improve their math skills, teachers can monitor student progress and provide additional support outside the classroom.
- Key features of the application include game-based exercises to make learning enjoyable, real-time feedback to guide learners, an adaptive learning system that

adjusts to individual skill levels, progress tracking to monitor improvements, and a reward-based mechanism to motivate students.

- The features also includes Cross math and Ninja Number, which provide grade-specific challenges and encourage skill development through personalized learning experiences.
- The application will be developed for mobile devices, specifically Android-based smartphones and tablets, ensuring accessibility for a wide range of users. The effectiveness of the app will be evaluated through improvements in students' math performance, levels of engagement, and feedback from both students and teachers.

### **Limitations:**

- The application will not cover advanced mathematical topics, focusing instead on enhancing basic math skills suitable for elementary pupils.
- It will not fully represent all students across different regions and educational backgrounds, as the content and design are tailored to a general elementary-level curriculum.
- It will not be available for online use, meaning users must download and access it on Android-based smartphones and tablets without requiring an internet connection.

### **1.5 Significance of the Study**

This study is significant as it addresses the challenges elementary pupils face in learning basic mathematical concepts. By developing a mobile application, the study provides an interactive and engaging platform to enhance student learning. The app supports traditional education through game-based exercises, real-time feedback, and adaptive learning, making it a timely response to the increasing integration of technology in education.

This study benefits several groups by addressing challenges in elementary mathematics education through an interactive mobile application. Elementary students will gain an engaging and self-paced learning experience, allowing them to improve their understanding of math concepts through real-time feedback and interactive exercises. Teachers will benefit from a supplementary tool that helps them monitor student progress, identify learning gaps, and provide targeted instruction, making their teaching more effective. Schools can integrate the application into their curriculum to enhance math education, bridge gaps in traditional teaching methods, and improve

overall student performance. Parents will also find value in the app as it provides an accessible platform to support their children's learning at home, allowing them to track progress and reinforce math concepts outside the classroom.

In terms of contribution to the fund of knowledge, this study adds to research on technology-enhanced learning by demonstrating how game-based and adaptive learning tools improve engagement and performance. It also provides a model for developing similar educational resources.

The possible implications of the study include encouraging the broader adoption of digital learning tools in elementary education, influencing future educational policies, and inspiring further research on the long-term impact of mobile learning applications.

## **1.6 Definition of Terms**

To ensure a clear understanding of the study, the following key terms are defined:

**Adaptive Learning** - a personalized learning approach where educational content and difficulty levels adjust based on the student's progress and performance.

**Basic Math Skills** - fundamental arithmetic operations including addition, subtraction, multiplication, and division, which form the foundation of mathematical learning.

**Crossmath:** An interactive math puzzle feature with adaptive difficulty levels for Grades 1-6, designed to develop mental computation and problem-solving skills.

**Interactive Learning** - a form of education that involves active participation through digital tools, activities, and exercises designed to enhance student engagement and comprehension.

**Mobile Learning** - a method of learning that utilizes mobile devices such as smartphones and tablets to access educational content and activities.

**Ninja Number:** A gamified exercise where students solve problems to advance through levels, promoting fluency and accuracy in mathematical operations.

**Progress Tracking** – a feature that allows students and teachers to monitor learning improvements over time through recorded data and performance analytics.

**Real-Time Feedback** - immediate responses provided to users based on their actions or inputs, helping them learn from mistakes and improve performance

## **CHAPTER II**

### **LITERATURE REVIEW**

This chapter reviews literature and systems related to teaching basic mathematics in elementary school. It covers both foreign and local perspectives to provide a comprehensive understanding of different approaches and strategies.

#### **2.1 Review Related Literature**

##### ***The Impact of Digital Game-Based Learning on Primary School Mathematics Achievement***

According to Li and Tsai (2013) conducted a meta-analysis to examine the effectiveness of digital game-based learning on primary school students' mathematics achievement. The study reviewed various research papers and concluded that educational games significantly enhanced students' mathematical learning outcomes. The findings suggested that integrating digital games into the curriculum helped improve students' problem-solving skills, engagement, and retention of mathematical concepts.

##### ***Game-Based Learning for Primary School Mathematics: A Case Study of the 'Monkey Tales' Game***

According to Kebritchi et al. (2010) evaluated the effectiveness of the "Monkey Tales" game in improving primary students' math skills. The study found that students who used the game demonstrated significant improvement in their mathematical performance compared to those who did not. The research highlighted how interactive and immersive learning experiences positively influence students' motivation and comprehension in mathematics.

##### ***Improving Proficiency in the Four Fundamental Operations in Mathematics in Grade Two SPED FL/GT Pupils of Don Emilio Salumbides Elementary School through the Implementation of Vedic Math Techniques***

Mathematics is a fundamental subject that plays a crucial role in pupils' academic and professional success. However, some students struggle with mastering the four fundamental operations, which are essential for solving more complex mathematical problems. This challenge is more significant for pupils in the Grade Two SPED Fast Learner/Gifted Talented program.

Therefore, this action research aims to explore the effectiveness of implementing Vedic Math techniques in improving the proficiency in the four fundamental operations of Grade Two SPED Fast Learner/Gifted Talented pupils of Don Emilio Salumbides Elementary School. According to Lawrence (2016) pupils rarely study math and reading at the same time, and it's not often considered that a pupil needs to excel at one to be successful with the other. By reading plays a vital role in math as pupils are presented with increasingly difficult mathematical problems throughout their schooling.

#### ***Enhancing Grade 4 students' mathematical problem-solving skills using manipulatives***

Integrating manipulatives in enhancing students' problem-solving skills involves using physical or virtual objects that students can manipulate to better understand and solve mathematical problems (Bartolini and Martignone,2020). These manipulatives serve as a bridge between abstract concepts and concrete understanding, making it easier for students to grasp complex ideas (Aghli et al.,2016). According to a research by Lanante (2019), which involved Grade 2 elementary students from the Central Philippines, the usage of manipulative materials improved students' problem-solving abilities and enrichment activities.

#### ***Enhancing Grade 6 Students' Multiplication Automaticity through Interactive Taped Problems***

Arithmetic operations are fundamental mathematical processes used to manipulate and calculate numbers. The four basic arithmetic operations are the Addition, Subtraction, Multiplication and Division. In the study of Umar and Widodo (2021), student's numeracy skills during the pandemic are low. It means that there are numbers of students who are not able to read four-digit numbers, have not been able to determine place values and not been able to do basic arithmetic operations. The study shows that most of the students still have difficulty in counting multiplication operations with a total of 48%. In the other hand, Sooknanan and Seemungal (2023) revealed that the Covid-19 pandemic has made the state of education worse and widened the learning gap in mathematics among young learners.

#### ***Mobile DaMath: A Game for Basic Numeracy Exercise***

According to Ramos et al. (2013), Mobile DaMath is a digital adaptation of the Filipino educational game DaMath, which integrates traditional board game mechanics with mathematical operations. The study aimed to provide a more engaging method for students to practice basic numeracy skills, leveraging interactive gameplay to enhance learning. The findings indicated that

students who played Mobile DaMath showed improved computation skills and increased motivation to practice mathematics. The game also helped develop critical thinking and strategic decision-making, as players had to choose optimal moves based on mathematical calculations.

### ***MathQuest: Enhancing Problem-Solving Skills Through Digital Games***

According to Villanueva et al. (2022) developed MathQuest, a locally designed mobile game that helps elementary students enhance their problem-solving skills through interactive math challenges. The study found that students who played MathQuest regularly showed better logical reasoning and improved problem-solving strategies. The game incorporated real-world math scenarios, making it easier for students to apply concepts in daily situations.

### ***Husay sa Hating-Bilang: A Game-Based Learning Approach for Fractions***

According to Dizon and Bautista (2021) created Husay sa Hating-Bilang, a mobile game aimed at improving elementary students' understanding of fractions. The study showed that learners who used the game demonstrated a better grasp of fraction concepts compared to those who relied solely on traditional learning methods. The game used interactive activities such as visual models, drag-and-drop exercises, and step-by-step tutorials to help students master fractions in an engaging way.

### ***Game-Based Learning Strategy and Mathematics Performance***

According to Garcia and Pasia (2024) conducted a study on the effects of game-based learning strategies on Grade 2 pupils' performance in mathematics. Their findings indicated significant improvements in numeracy skills, reinforcing the effectiveness of game-based learning in early mathematics education. The research showed that students exposed to game-based learning displayed higher accuracy in solving mathematical problems and exhibited a more positive attitude toward learning math. The interactive and competitive elements of the game-based approach helped students develop problem-solving skills and maintain focus on mathematical exercises.

### ***Mathematical Patterns and Structures in Game-Based Learning***

According to Lozano et al. (2023) developed a mobile application that assists learners in practicing mathematical patterns and structures. The study emphasized the role of game-based learning in reinforcing mathematical concepts through interactive and engaging exercises, helping learners develop critical thinking skills in mathematics. The application incorporated progressive

difficulty levels, ensuring that students gradually built their understanding of patterns and algebraic structures. The findings suggested that students who used the game consistently improved their pattern recognition abilities and demonstrated a deeper understanding of mathematical relationships.

## 2.2 Review Related System

### *An Instructional Tool for Grade VI Mathematics: A Mobile Application*

According to Dee, C., Ellorda, M., Salvador, T., Olalia, R., & Olalia Jr., J. (2018), examines the role of mobile applications in improving mathematical comprehension among elementary students. Both studies focus on the problem of students struggling with math, often due to traditional teaching methods that rely too much on memorization. This review follows a problem-cause-solution approach, explaining the learning difficulties, their reasons, and how mobile apps can help. It also follows a general-to-specific approach, starting with the importance of educational apps before looking at game-based learning. These studies show how mobile applications can improve math learning and make it more effective for students.

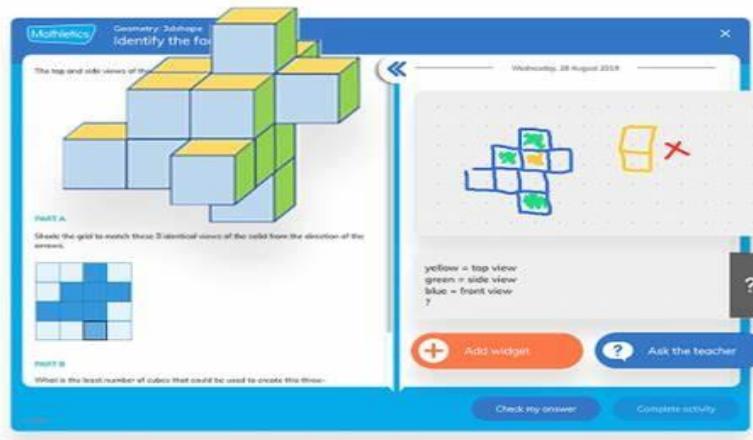


Figure 2.6 An Instructional Tool for Grade VI Mathematics: A Mobile Application

### ***Number Ninja Math Game***

According to Turner, A. R. (2025), which explores the impact of interactive and adaptive gameplay on students' mathematical comprehension and problem-solving abilities. The review explores key topics including the role of technology in mathematics education, the impact of math apps and educational games on learning outcomes, challenges in implementation, and comparative studies between traditional and app-based instruction. Understanding the significance of these digital tools is crucial for educators and policymakers to develop effective instructional strategies. Organized in a general-to-specific approach, this review synthesizes relevant studies to provide evidence supporting the use of math apps in elementary education and their potential to enhance student engagement and achievement.

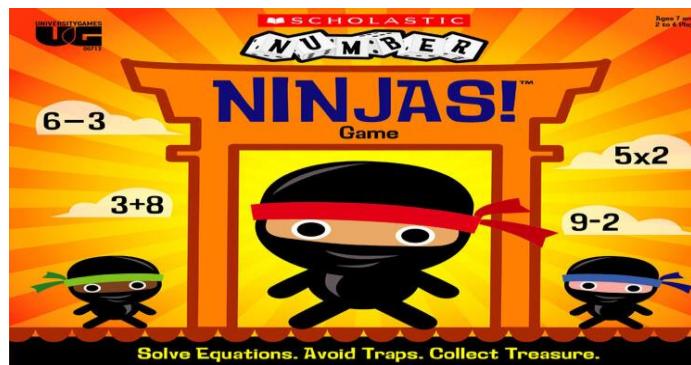


Figure 2.7 Number Ninja Math Game

### ***Damath***

According to Huenda, J. (1980), which introduced a board game approach to teaching mathematical concepts and strategic thinking, laying the groundwork for modern game-based learning in mathematics education. The review explores key topics including the role of technology in mathematics education, the impact of math apps and educational games on learning outcomes, challenges in implementation, and comparative studies between traditional and app-based instruction. Understanding the significance of these digital tools is crucial for educators and policymakers to develop effective instructional strategies. Organized in a general-to-specific approach, this review synthesizes relevant studies to provide evidence supporting the use of math apps in elementary education and their potential to enhance student engagement and achievement.

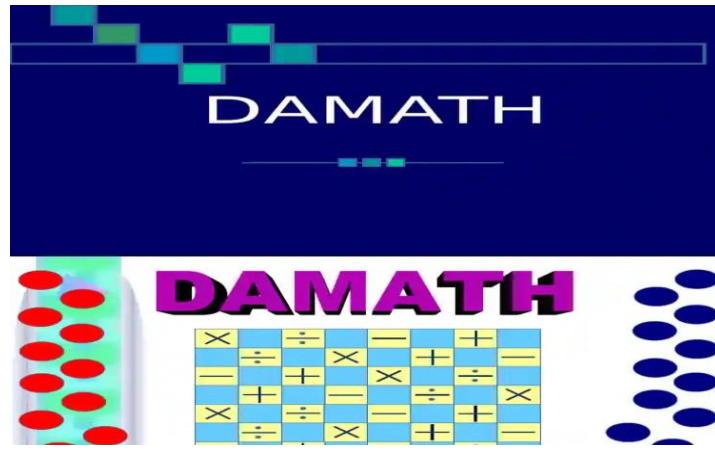


Figure 2.8 Damath

### ***Ateneo, DepEd unveil math apps for students in ‘new normal’***

According to Pinaroc, J. (2020), which highlights the development and implementation of math apps to support distance learning and improve students' mathematical proficiency in response to the educational challenges brought by the COVID-19 pandemic. The review explores key topics including the role of technology in mathematics education, the impact of math apps and educational games on learning outcomes, challenges in implementation, and comparative studies between traditional and app-based instruction. Understanding the significance of these digital tools is crucial for educators and policymakers to develop effective instructional strategies. Organized in a general-to-specific approach, this review synthesizes relevant studies to provide evidence supporting the use of math apps in elementary education and their potential to enhance student engagement and achievement

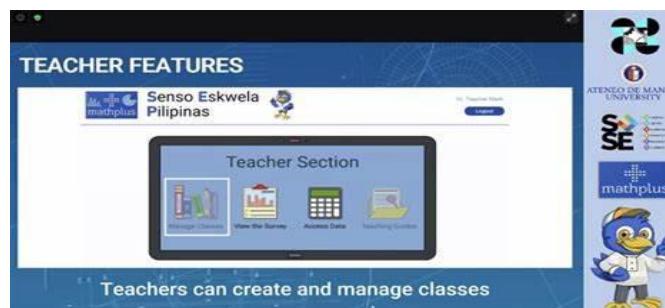


Figure 2.9 Ateneo, DepEd unveil math apps for students in ‘new normal’

### ***Mathinik***

According to Canasa, H. (2020), *Mathinik* is a learning system designed to help students improve their math skills through interactive activities and guided lessons. It aims to make learning easier by providing exercises that match students' needs and track their progress. Teachers can use the system to see which areas students struggle with and give extra help where needed. Studies show that learning tools like *Mathinik* can keep students engaged, help them understand math better, and improve their overall performance in the subject.



Figure 2.10 Mathinik

### ***DragonBox: Algebra Through Play***

According to Habgood and Ainsworth (2011), Dragon Box Algebra 5+ is a mobile app designed to help students understand algebra through fun and interactive puzzles instead of traditional math problems. The game introduces algebra concepts step by step, allowing students to explore and solve equations in a stress-free way. And because of that they found out that students who played Dragon Box understood algebra better than those who learned through regular classroom lessons. The game helps students become more confident in solving equations by teaching them in a visually engaging way before introducing numbers and symbols. This method reduces math anxiety and makes learning more enjoyable.



Figure 2.1 DragonBox: Algebra Through Play

### ***Motion Math: Enhancing Number Sense***

According to Riconsciente (2013), Motion Math is an educational game that helps students improve their understanding of fractions through interactive activities. Many students find fractions difficult, but Motion Math makes learning easier by using pictures and movement to explain the concepts. Compared to students who played Motion Math with those who used traditional worksheets. The results showed that students who played the game improved their fraction skills more than those who used regular paper-based exercises. The game also gives instant feedback, helping students learn from their mistakes right away. The study also found that students who played Motion Math were more confident when working with fractions. Confidence is important because students who feel less nervous about math are more likely to practice and improve their skills.

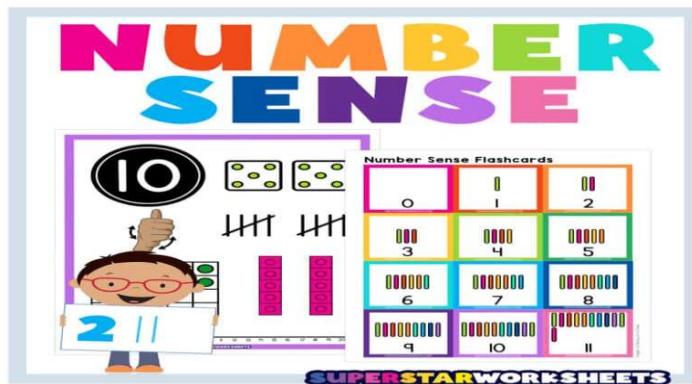


Figure 2.2 Motion Math: Enhancing Number Sense

### ***Prodigy: A Math Game for Skill Development***

According to Shute et al. (2016), Prodigy is an online math game that adjusts to each student's skill level, making learning personalized. Unlike regular math exercises, Prodigy includes role-playing elements, such as earning rewards and leveling up, which make learning exciting and motivating. The study found that students who played Prodigy were more interested in math and performed better on tests than those who used traditional learning methods. One reason for this is that Prodigy gives students problems at the right level, so they feel challenged but not overwhelmed.



Figure 2.3 Prodigy: A Math Game for Skill Development

### ***Reflex: Math Fact Fluency***

According to Baroody et al. (2009), Reflex is a math game that helps students quickly recall basic math facts, such as addition, subtraction, multiplication, and division. Knowing these facts by heart is important because it makes solving more complex problems easier. The study found that students who used Reflex regularly could solve math problems faster and with fewer mistakes than those who practiced using worksheets. The game keeps students motivated by making learning fun and interactive, so they are more likely to practice without feeling bored. Reflex also adjusts to each student's learning pace, meaning it gives them questions based on their level. This helps students build their confidence and improve at their own speed.



Figure 2.4 Reflex: Math Fact Fluency

### ***Math Blaster: Space Zapper***

According to Ke (2008), Math Blaster is a space-themed game that combines action and learning to help students improve their math skills. The game challenges players to solve math problems while navigating through space missions, making learning exciting and interactive. They found that students who played Math Blaster were more engaged in learning and performed better in quick-recall tasks than those who used traditional methods. The game encourages fast thinking and improves students' mental math skills. One reason Math Blaster is effective is that it creates a fun environment where students can practice math without worrying about making mistakes. Instead of using repetitive worksheets, students solve problems while playing an exciting game, which helps them stay motivated and focused.



Figure 2.5 Math Blaster: Space Zapper

## 2.4 Synthesis

The integration of game-based learning in mathematics education has been widely studied, with various research findings supporting its effectiveness in improving students' mathematical proficiency. Studies by Li and Tsai (2013) and Kebritchi et al. (2010) emphasized that digital game-based learning enhances students' engagement, problem-solving skills, and retention of mathematical concepts. Similarly, Bartolini and Martignone (2020) highlighted the role of manipulatives in making abstract mathematical concepts more tangible for young learners, which aligns with Lanante's (2019) findings that manipulative materials significantly improve students' problem-solving abilities. These studies suggest that interactive learning strategies, whether through digital games or physical tools, contribute positively to students' mathematical development.

A key similarity among these studies is the emphasis on engagement as a critical factor in mathematical learning. Interactive games such as "Monkey Tales" (Kebritchi et al., 2010), "Motion Math" (Riconsciente, 2013), and "DragonBox" (Habgood & Ainsworth, 2011) have been shown to boost student motivation and confidence in mathematical problem-solving. Shute et al. (2016) found that the personalized learning approach of "Prodigy" improved students' performance by adapting to their individual skill levels, a concept also present in Reflex (Baroody et al., 2009), which focuses on math fact fluency. Similarly, Sooknanan and Seemungal (2023) noted that game-based interventions help bridge learning gaps exacerbated by the COVID-19 pandemic, reinforcing the importance of adaptive educational tools in mathematics instruction.

While foreign studies highlight the benefits of game-based learning, local studies provide additional insights into culturally relevant applications. Ramos et al. (2013) and Villanueva et al. (2022) developed Filipino-designed games such as Mobile DaMath and MathQuest, demonstrating that game-based learning is effective across different educational contexts. Dizon and Bautista (2021) emphasized that local games like "Husay sa Hating-Bilang" improve fraction comprehension, mirroring the results of "Motion Math" in foreign studies. Furthermore, Lozano et al. (2023) and Garcia and Pasia (2024) reinforced the idea that game-based learning not only enhances numeracy skills but also fosters positive attitudes toward mathematics.

Despite the evident benefits, some studies, including those by Umar and Widodo (2021), highlight ongoing challenges in mathematics education, particularly in students' arithmetic skills. Their findings suggest that while digital tools are effective, traditional instructional methods and teacher support remain crucial in reinforcing mathematical foundations. This aligns with the

perspectives of Dee et al. (2018) and Turner (2025), who argue that while math apps and games are valuable, they should complement rather than replace traditional learning strategies.

The proposed study aims to build on these findings by exploring the combined effects of interactive digital games and traditional methods in improving students' mathematical performance. Unlike previous research that focused solely on digital games or manipulatives, this study will integrate multiple approaches to provide a more holistic learning experience. Additionally, by incorporating local educational games such as DaMath and MathQuest alongside internationally recognized tools like Reflex and Prodigy, the study will assess how culturally relevant materials impact student engagement and learning outcomes. The synthesis of these studies suggests that while digital game-based learning is highly effective, a balanced approach that includes adaptive learning technologies and teacher guidance is key to maximizing students' mathematical proficiency.

## References

- Aghli, M. T., et al. (2016). The effect of using manipulative materials on mathematics learning of students with learning disabilities. *Journal of Learning Disabilities*, 49(5), 517-526.
- Baroody, A. J., et al. (2009). Fostering at-risk preschoolers' number sense. *Early Education and Development*, 20(1), 80-121.
- Bartolini Bussi, M. G., & Martignone, F. (2020). Manipulatives in mathematics education: A didactical analysis. *ZDM – Mathematics Education*, 52(2), 297-310.
- Canasa, H. (2020). *Mathinik: An interactive learning system for mathematics*. [Unpublished manuscript/report].
- Dee, C., et al. (2018). An instructional tool for Grade VI mathematics: A mobile application. *Philippine Journal of Information Technology*, 11(1), 45-58.
- Dizon, M. R., & Bautista, R. A. (2021). Husay sa Hating-Bilang: A game-based learning approach for fractions. *Journal of Educational Technology in the Philippines*, 3(1), 22-35.
- Dorris, T., et al. (2024). Enhancing student engagement through mobile-based learning tools: A case study in elementary mathematics education. *Educational Technology Journal*, 32(2), 45-60.
- Garcia, L. M., & Pasia, R. C. (2024). Game-based learning strategy and mathematics performance of Grade 2 pupils. *Philippine Journal of Educational Research*, 18(1), 67-82.
- Habgood, M. P. J., & Ainsworth, S. E. (2011). Effect of extrinsic rewards on flow experience in digital game-based learning. *Learning and Instruction*, 21(4), 469-479.
- Huenda, J. (1980). *Damath: A board game approach to mathematics education*. [Unpublished manuscript/report].
- Ke, F. (2008). Computer games for educational purposes: A critical literature review. *Journal of Educational Technology & Society*, 11(1), 164-184.
- Kebritchi, M., et al. (2010). The effects of modern mathematics computer games on mathematics achievement and class motivation. *Computers & Education*, 55(2), 427-443.
- Lanante, C. (2019). The use of manipulative materials in improving the problem-solving skills of grade 2 elementary students. *Philippine Journal of Education*, 98(2), 112-125.
- Lawrence, B. (2016). Reading and math: The importance of literacy in mathematics. *Journal of Educational Research*, 110(3), 299-305.

- Li, C. H., & Tsai, C. C. (2013). Game-based learning in science education: A meta-analysis of empirical research. *Computers & Education*, 63, 33-51.
- Lozano, A. B., et al. (2023). Mathematical patterns and structures in game-based learning. *Philippine Journal of Mathematics Education*, 16(2), 90-105.
- Maryana, L., et al. (2024). The impact of interactive digital platforms on elementary students' mathematical skills. *Journal of Digital Learning Research*, 15(1), 23-40.
- Pinaroc, J. (2020). Ateneo, DepEd unveil math apps for students in 'new normal'. *Philippine Daily Inquirer*.
- Ramos, A. L., et al. (2013). Mobile DaMath: A game for basic numeracy exercise. *Journal of Educational Technology in the Philippines*, 1(1), 10-23.
- Riconscente, M. M. (2013). Learning fractions with improper and proper fractions computer games: Adding apples and bananas. *Computers & Education*, 69, 320-332.
- Shute, V. J., et al. (2016). The power of play: The effects of video game play on cognitive and affective learning. *Thinking Skills and Creativity*, 20, 58-67.
- Sooknanan, P., & Seemungal, R. (2023). The impact of COVID-19 on mathematics education: Learning loss and recovery strategies. *Journal of Educational Technology*, 17(2), 123-138.
- Southeast Asia Primary Learning Metrics. (2019). *SEA-PLM 2019 Main Report: Assessing Learning Outcomes in Southeast Asia*. Retrieved from [official website or source].
- Trends in International Mathematics and Science Study (TIMSS). (2019). *International mathematics performance ranking: TIMSS 2019 results*. International Association for the Evaluation of Educational Achievement.
- Turner, A. R. (2025). Number Ninja Math Game: Impact of adaptive gameplay on mathematical comprehension. *Philippine Journal of Educational Technology*, 18(1), 30-45.
- Umar, T., & Widodo, A. (2021). Analysis of students' numeracy skills during the COVID-19 pandemic. *Journal of Mathematics Education*, 14(3), 210-225.
- Villanueva, R. S., et al. (2022). MathQuest: Enhancing problem-solving skills through digital games. *Philippine Journal of Educational Innovation*, 15(2), 78-93.
- World Bank. (2023). *Foundational learning crisis: The decline of math proficiency in developing nations*.

## **CHAPTER III**

### **Technical Background**

This chapter provides an overview of the technical background of the A Mobile Application Program on Basic Math Skills Enhancement For Elementary Pupils. It outlines the Back-end and Front-end technologies used in the application's development.

#### **3.1 Technicality of the Project**

This project is a mobile learning app designed to work on both Android and iOS devices. It is built using Flutter, a framework that makes it easy to develop apps for different platforms. The app is programmed in Dart, which helps it run smoothly and allows for a customizable design. To store user progress, scores, and other important data, the app uses Firebase and SQLite. Firebase keeps data updated in real-time, while SQLite allows users to access the app even without an internet connection. The app's design is created using Flutter widgets, making it easy to use and visually appealing. Animations and interactive elements help make learning more engaging. The system also includes database queries to manage and retrieve user data efficiently. With this technology, the app ensures a smooth and enjoyable learning experience for users, whether they are online or offline.

#### **Front-End Tech Stack:**

- Flutter – Framework for cross-platform development (Android & iOS).
- Dart – Primary programming language for UI and application logic.
- Flutter Widgets – Used for creating a visually engaging and interactive UI.
- Animations & Interactive UI Components – Enhances the learning experience.

#### **Back-End Tech Stack:**

- Firebase – Provides real-time synchronization for user data.
- SQLite – Manages local data storage for offline functionality.
- Database Queries – Used for retrieving and managing user progress, scores, and other data.

### **3.2 Details of Technology to be used**

#### **Software**

Software Flutter was chosen by the developers because it allows for cross-platform development, ensuring that the mobile learning app runs efficiently on both Android and iOS devices. Dart is used as the primary programming language due to its fast performance and strong support for UI customization. For database management, Firebase or SQLite is integrated to store user progress, scores, and other essential data. Firebase offers real-time synchronization, while SQLite provides an offline-first approach, making the app functional even without an internet connection. Programming elements such as animations, interactive UI components, and database queries are implemented to enhance the learning experience. The use of Flutter widgets allows for a seamless and visually engaging application interface, making mathematical exercises interactive and easy to navigate.

#### **Hardware**

- Smartphone or Tablet – The app is designed to be accessible on mobile devices, allowing students to learn anytime and anywhere.
- Computer – Used during the development phase to write, test, and debug the application's code.
- Monitor – Helps developers visualize the app layout, user interactions, and design elements while coding.
- Keyboard and Mouse – Essential tools for programming, debugging, and managing UI components efficiently.
- Storage (Cloud & Local) – Firebase cloud storage is used to store user-generated content and progress, while local storage (internal device storage) supports offline learning features.
- Internet Connection – Required for real-time database synchronization, user authentication, and app updates, ensuring an up-to-date learning experience.

### **3.3 How the Project Will Work**

The Agile methodology is being applied in the development of a mobile learning application designed to enhance elementary students' math skills. Below is an overview of the Agile process implemented:

#### **1. Planning**

##### Objective

Develop a mobile learning application to improve elementary students' math skills. The app will focus on fundamental operations such as addition, subtraction, multiplication, and division, while also helping students manage their time effectively. It will work both online and offline, ensuring accessibility for all users.

##### Key Stakeholders:

- Students – Use the app to practice and enhance their math skills.
- Teachers – Monitor students' progress and suggest exercises.
- Parents – Track their child's learning and improvement.
- App Developers – Maintain and improve the app's performance.

##### Scope & Goals:

- Develop a Flutter-based mobile app for cross-platform compatibility.
- Use Firebase for real-time data storage and SQLite for offline functionality.
- Implement interactive UI elements and animations for an engaging learning experience.
- Ensure data security and fast performance for seamless user interaction.

#### **2. Requirements Analysis**

##### Functional Requirements:

1. Mathematical Exercises – The app provides interactive exercises in addition, subtraction, multiplication, and division.
2. Local Storage – User progress and scores are stored locally using SQLite when offline.
3. Synchronization – Data syncs with Firebase when an internet connection is available.

4. Time Management Features – The app includes timers and progress tracking to help students manage their study time.
5. Role-Based Access Control (RBAC):
  - Students – Access learning modules and track progress.
  - Teachers – Monitor student performance and suggest activities.
  - Parents – View progress reports and set learning goals.
6. Admin Panel – Admins manage user accounts and oversee system functionality.

Non-Functional Requirements:

- Security – Ensures data protection and secure user authentication.
- Scalability – Supports a growing number of students and exercises.
- Usability – User-friendly interface for students, teachers, and parents.
- Performance – Optimized for smooth learning experiences with minimal lag.

### **3. System Design**

Architecture:

Flutter Mobile App

- Cross-platform application for Android and iOS.
- Stores data locally using SQLite for offline access.
- Synchronizes data via Firebase when online.
- Engaging UI with animations and interactive elements.

Back-End System

- Firebase – Real-time database for cloud storage and synchronization.
- SQLite – Local database to ensure offline functionality.
- Database Queries – Manage user progress, scores, and exercise data efficiently.

## Database Design

### SQLite (Mobile Database)

Tables:

- student\_progress (id, student\_id, score, timestamp, sync\_status)
- exercises (id, type, difficulty, question, answer)

### Firebase (Cloud Database)

Collections:

- students (id, name, age, parent\_email, created\_at)
- progress\_records (student\_id, score, timestamp, status)

Data Flow:

1. Offline Data Collection: Students complete math exercises and store their progress in SQLite.
2. Synchronization: Once an internet connection is available, data syncs with Firebase.
3. Progress Tracking: Teachers and parents can view students' performance through the cloud database.

## 4. Development

Tech Stack:

- Flutter (Dart) – Mobile app development
- SQLite – Local storage for offline use
- Firebase (Firestore & Authentication) – Cloud database and user authentication
- REST API (Node.js & Express) – API for data synchronization

Development Phases:

### 1. Mobile App:

- Develop UI for math exercises

- Implement offline storage (SQLite)
- Build data sync functionality via API

## 2. Web Dashboard:

- Design admin panel in Firebase
- Implement progress tracking system
- Manage role-based access control

## 3. API Development:

- Secure API endpoints for data synchronization
- Implement authentication & authorization

## 4. Testing & Debugging:

- Unit testing for mobile and API endpoints
- User testing with students and teachers
- Performance optimization for fast synchronization

## 5. Testing

### Testing Strategies:

1. Unit Testing
  - Verify the accuracy of mathematical exercises and calculations
  - Ensure offline data storage and synchronization work as expected.
  - Test UI responsiveness and animations for a smooth user experience.
2. Integration Testing
  - Ensure seamless data synchronization between SQLite (offline) and Firebase (cloud).
  - Verify role-based access control (RBAC) for students, teachers, and parents.
  - Check communication between the mobile app and the backend API.
3. Security Testing

- Test authentication mechanisms (Firebase Auth) to prevent unauthorized access.
- Validate encryption of stored and transmitted data.
- Ensure compliance with student data privacy regulations.

#### 4. Performance Testing

- Measure app loading speed and responsiveness.
- Stress test the system with multiple concurrent users.
- Optimize database queries to improve efficiency.

#### 5. User Acceptance Testing (UAT)

- Conduct trials with students, teachers, and parents in real-world scenarios.
- Collect feedback to refine usability and learning experience.
- Verify that the app meets its educational objectives..

### 6. Deployment

Deployment Steps:

1. Set up a production server for the Laravel web dashboard.
2. Distribute the Flutter mobile app as an offline APK or IPA file for manual installation.
3. Configure database backups and security measures for SQLite (offline) and Firebase Firestore (cloud).
4. Deploy the Node.js API to Google Cloud Functions or Firebase Functions.

### 7. Maintenance & Updates

Ongoing Tasks:

- Monitor performance and fix bugs.
- Update security patches regularly.
- Improve features based on feedback

Using Agile approach for this project helps ensure a smooth development process while keeping the app flexible and responsive to the needs of students, teachers, and parents.