

Development and Evaluation of a Gamified Mathematical Mobile Application in Learning Integer Operations

Jeneline R. Castro

Cebu Technological University, Danao City, Cebu, Philippines

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Email of Author: jeneline.castro@deped.gov.ph

Abstract

This study developed and evaluated a gamified mathematical mobile application designed to improve Grade 8 students' understanding of integer operations. The study was anchored on constructivism, behaviorism, cognitivism, Self-Determination Theory, Flow Theory, the Technology Acceptance Model, and the TPACK framework, which collectively emphasized learner engagement, motivation, scaffolding, feedback, and technology integration in mathematics education. A quasi-experimental one-group pretest-posttest design combined with a Research and Development (R&D) approach was employed. The study involved approximately 40 Grade 8 students from D.T. Durano Memorial Integrated School in Danao City, Cebu during the School Year 2025–2026. Data were gathered using a paper-and-pencil pretest, an in-app posttest, and an expert-validated questionnaire based on the Technology Acceptance Model. Descriptive statistics, weighted mean, and paired sample t-test were utilized to analyze the gathered data. The findings revealed that the gamified mathematical mobile application received highly favorable evaluations in terms of user interface, gamification features, instructional content, interactivity and feedback, and visual and audio components. Students demonstrated improved performance in integer operations after using the application, with significant differences observed between pretest and posttest scores across easy, average, and difficult levels. Learners also perceived the application as useful, engaging, and easy to use, indicating strong acceptability and positive attitudes toward mobile-based mathematics learning. Although actual usage remained moderate, the application effectively functioned as a supplementary instructional tool that enhanced students' motivation, participation, comprehension, and problem-solving skills in integer operations. The study concluded that the gamified mathematical mobile application is an effective and acceptable learning intervention for Grade 8 mathematics instruction. The study supports Sustainable Development Goal 4 (Quality Education) through the promotion of innovative and technology-based instructional strategies and Sustainable Development Goal 9 (Industry, Innovation and Infrastructure) through the integration of digital learning technologies in education. The research contributes to educational and technological sustainability by encouraging learner-centered instruction, strengthening digital learning environments, and supporting the continuous integration of mobile learning applications in mathematics education.

Keywords: Constructivism, Gamification, Integer Operations, Mathematics Education, Mobile Learning, Technology Acceptance Model, User Engagement

1. Introduction

Mathematics plays a vital role in developing logical reasoning, critical thinking, and problem-solving skills, particularly in foundational topics such as integer operations (Sachdeva & Eggen, 2021). Despite its importance, many learners experience persistent difficulties in performing addition, subtraction, multiplication, and division of integers due to misconceptions involving sign rules and mixed operations (Alviar & Solon, 2023; Harun et al., 2023). To address these concerns, researchers and educators have increasingly explored gamification and technology-enhanced learning approaches that promote engagement, motivation, and improved mathematical performance (Lampropoulos & Sidiropoulos, 2024; Szilágyi et al., 2025). This study focuses on the development and evaluation of a gamified mathematical mobile application designed to improve Grade 8 students' understanding of integer operations. Anchored on constructivist, behaviorist, cognitive, motivational, and technology integration theories, the study aims to provide an engaging, curriculum-aligned, and learner-centered instructional tool. The application incorporates game-based features such as challenges, levels, rewards, and immediate feedback to enhance conceptual understanding, motivation, and participation in mathematics learning.

1.1 Background of the Study on Gamified Mobile Learning in Integer Operations

Learning mathematics is fundamental in developing learners' analytical and problem-solving abilities (Sachdeva & Eggen, 2021). Integer operations, including addition, subtraction, multiplication, and division, serve as foundational mathematical skills necessary for higher-level mathematical concepts and real-life applications (Fitriasari et al., 2025). However, students frequently struggle with sign rules, mixed operations, and procedural consistency, resulting in poor mathematical performance and misconceptions (Alviar & Solon, 2023; Harun et al., 2023). These difficulties negatively affect learners' confidence, motivation, and readiness for more advanced mathematical topics. To address these concerns, educators

increasingly utilize gamification and technology-enhanced learning. Gamified applications create motivating and interactive learning environments through points, levels, rewards, and challenges (Ciprian, 2021). Research demonstrates that these tools improve engagement and mathematical achievement (Lampropoulos & Sidiropoulos, 2024; Szilágyi et al., 2025). Studies such as Galon and Valdez (2025) revealed that a mobile Damath game significantly enhanced Grade 8 students' performance in integer operations. Similarly, De Las Peñas et al. (2018) developed AlgeOps, a mobile application integrating number-line and neutralization models, which improved learners' conceptual understanding and interest (Verzosa et al., 2018). Interactive educational games have also demonstrated effectiveness in improving mathematics achievement. Aryanti et al. (2024) developed an HTML5-based instructional game for integer operations that increased students' mean scores from 55.3 to 82.1. Other applications such as Integer Operations, Integers Quiz Pro, Math Practice – Integers, and Integers for Monkeys provide drills and visual aids, although limited evidence exists regarding their actual effectiveness in learning enhancement. In the Philippine context, gamification has positively influenced students' engagement, retention, collaboration, and performance in mathematics (Nob et al., 2024; Luzano, 2024; Daliva, 2024). Project iSolve further demonstrated statistically significant improvements in conceptual understanding and performance among Grade 8 learners through game-based learning approaches (Atuel et al., 2025). Despite the availability of international mobile learning applications such as KooBits and Brilliant Math App, these tools are often not aligned with the Philippine curriculum and may not provide focused practice on integer operations (De Las Peñas et al., 2018; Verzosa et al., 2018). Consequently, the development of a localized, curriculum-aligned gamified application becomes necessary to address the needs of Filipino learners.

1.2 Themes and Insights from Related Literature on Gamification and Integer Operations

Existing literature highlights several recurring themes regarding gamified learning and mathematics education. One major theme is the effectiveness of gamification in increasing learner engagement, motivation, and academic achievement. Studies indicate that game-based elements such as points, badges, levels, and instant feedback encourage active participation and sustained interest in learning mathematics (Ciprian, 2021; Lampropoulos & Sidiropoulos, 2024; Nob et al., 2024). Another significant theme involves the role of mobile learning applications in improving conceptual understanding. Applications integrating visual aids, structured exercises, and interactive activities help learners better understand abstract mathematical concepts such as integer operations (De Las Peñas et al., 2018; Aryanti et al., 2024). Immediate feedback mechanisms also support error correction and reinforce learning retention. Research further emphasizes the importance of contextualized and curriculum-aligned instructional technologies. Studies show that localized gamified applications are more effective when designed according to learners' educational contexts and curricular standards (Lampropoulos & Sidiropoulos, 2024; Nob et al., 2024). This highlights the need for instructional tools specifically tailored to Filipino learners and the K to 12 curriculum.

1.3 Local, National, and Global Context of Gamified Mathematical Mobile Applications

Globally, educational institutions increasingly adopt gamified and technology-enhanced learning approaches to improve mathematics instruction. Mobile learning applications and educational games have been widely recognized for promoting engagement, motivation, and academic achievement in mathematics education (Lampropoulos & Sidiropoulos, 2024; Szilágyi et al., 2025). Nationally, Philippine educational research supports the effectiveness of gamification in mathematics classrooms. Gamified interventions improved learners' motivation, retention, collaboration, and mathematical performance across various educational settings (Nob et al., 2024; Luzano, 2024; Daliva, 2024). These findings support the integration of game-based learning tools within the Philippine educational system. Locally, students in one of Danao City's schools continue to experience difficulties in understanding integer operations despite repeated instruction and practice. Learners commonly misapply sign rules, perform incorrect operational procedures, and struggle with mixed operations. These persistent misconceptions reduce mathematical confidence and hinder progression toward advanced mathematical concepts. This situation underscores the necessity of developing innovative and engaging instructional interventions such as a gamified mathematical mobile application.

1.4 Theoretical and Conceptual Basis of the Gamified Mathematical Mobile Application

The study is grounded in several educational, motivational, and technology integration theories. Constructivism, developed by Piaget and Vygotsky, emphasizes that learners actively construct knowledge through meaningful experiences and guided interaction. Xi and Lantolf (2021) expanded on Vygotsky's (1978) Zone of Proximal Development by emphasizing scaffolding, which supports learners as they progress through increasingly challenging tasks. The gamified application applies this principle by providing guided activities and continuous feedback (Kalkan, 2024). Behaviorism and reinforcement theory by Skinner (1953) emphasize the role of rewards and feedback in learning. The application incorporates points, badges, and instant feedback to reinforce correct responses and encourage continuous engagement. Cognitivism, particularly Bruner's (1960) scaffolding theory, supports the gradual progression of learning tasks from simple to complex concepts. The application structures integer operation activities progressively to strengthen comprehension and retention. The study also utilizes Self-Determination Theory (Deci & Ryan, 1985), which emphasizes autonomy, competence, and relatedness in motivating learners. The application allows learners to progress independently, develop mastery, and interact through competitive and collaborative game elements. Flow Theory (Csikszentmihalyi, 1990)

explains that learners become highly engaged when task difficulty matches their skill level. The application maintains learner engagement through progressive challenges, immediate feedback, and achievable objectives (Hwang et al., 2021; Sung et al., 2022). Additionally, the Octalysis Framework (Chou, 2015) identifies motivational drivers such as achievement and empowerment, which are integrated through rewards, progress tracking, and challenges. Davis's (1989) Technology Acceptance Model (TAM) supports the importance of perceived usefulness and ease of use in technology adoption, while the TPACK Framework (Mishra & Koehler, 2006) emphasizes the integration of technology, pedagogy, and content knowledge in effective instructional design. The study is further supported by Republic Act No. 10533 or the Enhanced Basic Education Act of 2013, which promotes learner-centered and innovative teaching approaches. Department of Education Order No. 21, s. 2019, encourages flexible and technology-driven instructional strategies, while Department of Education Order No. 42, s. 2017, emphasizes ICT integration and innovative teaching practices through the Philippine Professional Standards for Teachers.

1.5 Research Gaps and Rationale for the Development of a Gamified Mathematical Mobile Application

Although numerous mobile learning applications and gamified educational tools exist, many are designed for international audiences and are not aligned with the Philippine curriculum (De Las Peñas et al., 2018; Verzosa et al., 2018). Existing applications also provide limited evidence regarding their effectiveness in improving integer operation skills among Filipino learners. Furthermore, learners continue to demonstrate misconceptions involving sign rules and mixed operations despite traditional classroom instruction. These persistent learning difficulties reveal the need for innovative, localized, and engaging instructional tools that can supplement classroom teaching and improve conceptual understanding. This study addresses these gaps by developing and evaluating a curriculum-aligned gamified mathematical mobile application specifically designed for Grade 8 Filipino learners. The application integrates gamification, scaffolding, and immediate feedback to improve engagement, confidence, and mathematical competency in integer operations.

1.6 Alignment with Relevant Sustainable Development Goals (SDGs)

This study aligns with several Sustainable Development Goals (SDGs), particularly SDG 4 – Quality Education and SDG 9 – Industry, Innovation and Infrastructure. SDG 4 promotes inclusive, equitable, and quality education through innovative teaching approaches and improved learning opportunities. The development of a gamified mathematical mobile application supports this goal by providing an engaging, learner-centered, and technology-based instructional intervention that enhances students' understanding of integer operations. The study also supports SDG 9 by promoting educational innovation through mobile technology integration. The application demonstrates how digital tools and gamification can strengthen instructional delivery and improve educational accessibility and effectiveness. Additionally, the study contributes to SDG 8 – Decent Work and Economic Growth by strengthening foundational mathematical competencies essential for future academic achievement and workforce preparedness.

1.7 Importance of the Study to Multidisciplinary Sustainability

The study contributes to educational sustainability by promoting innovative and technology-enhanced teaching practices that support long-term learning improvement. By integrating gamification into mathematics instruction, the study encourages sustainable learner engagement, motivation, and academic development. The research also contributes to technological sustainability through the development of localized educational technology aligned with curricular standards and learner needs. The integration of mobile applications into instruction supports digital transformation in education and promotes adaptive learning environments. From a socio-economic perspective, strengthening learners' mathematical competencies may improve educational outcomes and future opportunities. The study also supports institutional sustainability by providing educators, schools, curriculum developers, and policymakers with evidence-based instructional innovations that align with 21st-century learning standards and national educational goals.

2. Material and methods

2.1 Research Design

The study employed a quasi-experimental research design combined with a Research and Development (R&D) approach. The R&D methodology was appropriate because the study aimed to develop, validate, and evaluate a gamified mathematical mobile application intended to improve students' understanding of integer operations. The effectiveness of the application was assessed using a one-group pretest-posttest quasi-experimental design. The research process followed the simplified R&D cycle of Borg and Gall (1983), which included planning and learner needs analysis, prototype design and development, expert validation, pilot testing, evaluation of usability and effectiveness, and application revision and finalization. The study also utilized the Input-Process-Output (IPO) framework. The input phase focused on identifying students' common learning difficulties in addition, subtraction, multiplication, and division of integers. The process phase included the systematic design, development, validation, pilot testing, and evaluation of the gamified mobile application. The design stage involved planning the application structure, integrating gamification elements such as points, badges, and levels, and aligning the content with the Grade 8 mathematics curriculum. The development phase included coding, interface creation, integration of integer operation drills, and embedding of the in-app posttest. Validation involved expert

review by educators, ICT specialists, and content experts to assess accuracy, usability, and curriculum alignment. Pilot testing was conducted with selected students to identify technical issues and improve application features. The evaluation phase used pretests, posttests, and acceptability surveys to determine the application's effectiveness and usability. The resulting output of the study was a gamified mathematical mobile application designed to improve Grade 8 students' comprehension and proficiency in integer operations. The application incorporated progressive learning stages, interactive problem-solving activities, immediate feedback, progress monitoring, badges, and rewards to sustain learner engagement and motivation. The application underwent expert validation and pilot testing before being evaluated for effectiveness and acceptability in mathematics learning.

2.2 Locale of the Study

The study was conducted at D.T. Durano Memorial Integrated School located in Poblacion, Danao City, Cebu Province, Philippines, along Upland National Road. The school provides an inclusive learning environment that supports technology integration in both elementary and secondary education. Its diverse student population and accessibility to instructional technologies made it suitable for educational research involving innovative teaching strategies and digital learning tools. The school environment enabled the implementation and evaluation of the gamified mathematical mobile application within an actual classroom setting. It also allowed the researcher to observe students' interaction with mobile-based learning tools and examine how gamification elements influenced students' motivation, engagement, and understanding of integer operations.

2.3 Respondents of the Study

The respondents of the study were Grade 8 students from an integrated school in Northern Cebu during the School Year 2025–2026. This grade level was selected because integer operations are included in the Grade 8 mathematics curriculum. The respondents were generally between 12 and 14 years old and possessed basic literacy in using mobile devices, making them appropriate participants for the study. Most respondents were 14 years old, while the remaining participants belonged to the ages of 13, 15, and 16 years old. Female students comprised the majority of the respondents, while male students represented the remaining portion of the sample population.

2.4 Sample and Sampling Procedure

The study employed purposive sampling in selecting the respondents. This sampling technique was appropriate because participants needed to satisfy specific qualifications aligned with the objectives of the study. The respondents were required to be currently enrolled in mathematics classes covering integer operations and must have access to Android devices necessary for using the developed mobile application. A sample size of approximately 40 students was considered sufficient and represented about 80% of the Grade 8 population in the school. This sample allowed the researcher to gather adequate information for evaluating the effectiveness and acceptability of the gamified mathematical mobile application.

2.5 Research Instrument

The study utilized an expert-validated questionnaire based on the Technology Acceptance Model (TAM) to evaluate the application's perceived usefulness, perceived ease of use, attitude toward use, intention to use, and actual use. The instrument consisted of several sections designed to measure students' mathematical performance and evaluation of the developed mobile application. The first section consisted of a pretest that measured students' prior knowledge of integer operations, including addition, subtraction, multiplication, and division of integers. The questions were categorized into easy, moderate, and difficult levels to assess varying degrees of understanding. The second section evaluated the design of the gamified application. Students assessed the application's user interface, gamification elements, instructional content, interactivity and feedback, and visual and audio features. Responses were measured using a four-point Likert scale ranging from 4 (strongly agree) to 1 (strongly disagree). This section aimed to determine how effectively the application's design and features supported student engagement and learning. The third section evaluated the acceptability of the gamified mathematical mobile application using indicators from the Technology Acceptance Model (TAM). The indicators included perceived usefulness, perceived ease of use, attitude toward the application, intention to use, actual use, and general acceptability. Responses were also measured using a four-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). Questions regarding the frequency and purpose of application use were included to assess actual usage behavior. These instruments provided the necessary information for evaluating the effectiveness of the application in improving students' understanding of integer operations and its acceptability as a learning tool.

2.6 Data Gathering Procedure

The data gathering process consisted of pre-data gathering, actual data gathering, and post-data gathering phases. During the pre-data gathering phase, the researcher prepared and developed the research materials and tools. This included conducting a needs analysis, reviewing related literature, and designing the gamified mobile application aligned with the mathematics curriculum. After development, experts evaluated the application's content accuracy, usability, and

instructional suitability using validation checklists. A pilot test or dry run was then conducted with a small group of students to identify technical concerns and instructional gaps before the actual implementation. The actual data gathering phase began with the administration of a paper-and-pencil pretest to determine students' baseline understanding and performance in integer operations. After the pretest, the gamified mobile application was introduced and integrated into students' learning activities for approximately two to three weeks. During this intervention period, students used the application and completed the provided learning activities and exercises. At the end of the intervention, students completed an in-app posttest, and the results were automatically recorded. They also answered the Technology Acceptance Model (TAM)-based acceptability survey to assess the application's usefulness, usability, and overall acceptability. The post-data gathering phase focused on organizing, verifying, and preparing the collected data for statistical analysis. The researcher retrieved the pretest papers, posttest results, and survey responses, which were then tallied and organized. Necessary revisions and improvements were made to the application based on the evaluation results and respondents' feedback. A user manual was also developed to guide future implementation and proper use of the gamified mathematical mobile application.

2.7 Data Analysis Techniques

The study employed descriptive statistics such as frequency, percentage, mean, and standard deviation to summarize respondents' profiles, pretest and posttest scores, and acceptability ratings of the gamified mathematical mobile application. A paired sample t-test was utilized to determine whether a statistically significant difference existed between the students' pretest and posttest scores after using the gamified mobile application. Weighted mean was used to assess students' perceptions regarding the application's perceived usefulness, perceived ease of use, attitude toward use, intention to use, and actual use based on the Technology Acceptance Model (TAM).

3. Results and Discussion

3.1 Design and Evaluation of the Gamified Mathematical Mobile Application

3.1.1 User Interface of the Gamified Mathematical Mobile Application

The findings revealed that respondents strongly agreed that the user interface of the gamified mathematical mobile application was organized, visually appealing, and easy to navigate. Learners positively evaluated the layout, menu organization, icons, and color scheme, indicating that the application was user-friendly and accessible. The responses also showed consistency, suggesting that students shared similar favorable perceptions regarding the interface design. These findings imply that the application successfully provided a clear and efficient learning environment for integer operations. A well-structured interface enhances usability and supports learner engagement, which are essential components of gamified educational applications. The positive perceptions of the application's design suggest that it effectively promoted smooth interaction and improved students' learning experiences in mathematics (Ofosu-Asare, 2024).

3.1.2 Gamification Elements of the Application

The results showed that respondents strongly agreed that the gamification elements of the application increased their motivation and engagement in learning integer operations. Students perceived points, badges, leaderboards, levels, challenges, animations, sound effects, and immediate feedback as effective features that encouraged continuous practice and active participation. The responses also indicated that the application maintained an appropriate level of challenge while providing immediate guidance during learning activities. These findings suggest that the gamified features created an engaging and motivating learning environment. The consistent positive responses demonstrate that students recognized the value of rewards, challenges, and multimedia elements in enhancing participation and interest in mathematics. According to Fred Davis' Technology Acceptance Model (TAM), learners are more likely to adopt technology when they perceive it as useful and easy to use. The favorable assessment of the gamification elements indicates that the application enhanced both perceived usefulness and ease of use, which contributed to students' willingness to utilize the application for learning integer operations (Mohd et al., 2025).

3.1.3 Instructional Content and Accessibility

The findings indicated that respondents strongly agreed that the instructional content of the application was clear, organized, and easy to access. Students found it easy to locate lessons and understood that the application adequately covered addition, subtraction, multiplication, and division of integers. The responses reflected agreement regarding the clarity, completeness, and accessibility of the instructional materials. These findings indicate that the application effectively supported students' understanding of integer operations through structured and accessible learning content. Organized digital instructional materials enable learners to engage in guided and self-paced learning. Previous studies have shown that mobile learning applications become more effective when instructional resources are well-structured and aligned with learning objectives. Suartama et al. (2024) emphasized that organized instructional content improves engagement and understanding, while Alsawaier (2021) highlighted that usability and content structure contribute to more effective digital learning experiences. Similarly, Anobah and Ansah (2024) found that mobile-based mathematics platforms with guided examples significantly improve learners' problem-solving skills.

3.1.4 Interactivity and Feedback Features

The results revealed that respondents strongly agreed that the application provided effective interactivity and feedback during learning activities. Students believed that the application allowed active participation in solving mathematical problems and provided immediate feedback after answering questions. Learners also reported that the feedback system helped them identify correct and incorrect answers and encouraged them to retry when mistakes were made. Interactive activities were also perceived to make learning more engaging. These findings suggest that the application effectively supported active learning, self-correction, and sustained engagement. Immediate and meaningful feedback helped students recognize errors and improve their problem-solving skills while maintaining participation in learning tasks. These results support previous research emphasizing the importance of feedback and interactivity in digital learning environments. Short et al. (2022) found that timely corrective feedback improves learner comprehension and engagement, while Barrio et al. (2021) noted that interactive educational applications increase students' interest and participation in mathematics. Rita et al. (2024) also emphasized that feedback-based learning environments help learners overcome difficulties and improve understanding.

3.1.5 Visual and Audio Features of the Application

The findings showed that respondents strongly agreed that the visual and audio features of the application enhanced their learning experience. Students positively evaluated the use of colors, graphics, animations, and sound effects, indicating that these multimedia components made learning activities more engaging and interesting. Learners also believed that visual elements helped them understand mathematical concepts better and sustained their attention while using the application. These findings imply that multimedia integration improved students' motivation, engagement, and comprehension in learning integer operations. Dynamic visual and audio elements contribute to a more stimulating learning environment that supports sustained interest in mathematics. Previous studies support these findings, as Papadakis (2021) emphasized that visually rich instructional applications enhance students' understanding and engagement in mathematics. Barrio et al. (2023) also noted that graphics, animations, and audio features support attentiveness in mobile learning environments. Rita and Oliveira (2022) further explained that effective multimedia design increases students' perseverance and motivation in completing mathematical activities.

3.2 Students' Performance in Integer Operations

3.2.1 Pretest and Posttest Performance of Students

The findings revealed that students' performance improved after using the gamified mathematical mobile application. Increases in scores were observed across easy, average, and difficult levels of integer operation tasks from pretest to posttest. The overall scores indicated that students performed better after the intervention, demonstrating improvement in both basic and more complex mathematical tasks. These findings suggest that the gamified application positively influenced students' learning outcomes and mathematical performance. The improvement in scores indicates enhanced conceptual understanding and procedural fluency in integer operations. These results are consistent with studies showing that gamified instructional materials improve academic achievement in mathematics. Sailer and Homner (2020) and Su and Cheng (2019) explained that gamification strategies improve learning outcomes through interactive challenges, scaffolding, and immediate feedback. Similarly, Alsawaier (2018) and Ratinho et al. (2023) found that mobile gamification supports incremental learning and builds learners' confidence in handling complex mathematical tasks. Meta-analytic studies also indicate that students in gamified learning environments significantly outperform those receiving traditional instruction (Zainuddin et al., 2020; Koivisto & Hamari, 2019).

3.2.2 Significant Difference Between Pretest and Posttest Scores

The findings showed a statistically significant difference between students' pretest and posttest scores across easy, average, and difficult levels after using the gamified mathematical mobile application. The results demonstrated consistent improvements in students' mathematical performance following the intervention. These findings indicate that the application effectively enhanced students' understanding and performance in integer operations. Gamified learning environments promote conceptual understanding and procedural skills through engaging activities, immediate feedback, and progressive learning tasks. The results support previous studies showing that gamification improves learners' motivation, engagement, and academic achievement in mathematics (Sailer & Homner, 2020; Su & Cheng, 2019). The significant improvements further demonstrate that the gamified mathematical mobile application served as an effective instructional intervention for learning integer operations.

3.3 Acceptability and Actual Use of the Gamified Mathematical Mobile Application

3.3.1 Level of Acceptability of the Application

The findings indicated that respondents strongly agreed on the acceptability of the gamified mathematical mobile application. Students perceived the application as useful in improving their understanding of integer operations and simplifying problem-solving tasks. They also found the application easy to use and navigate. Learners expressed positive attitudes toward using the application, describing it as enjoyable and engaging. Most respondents also indicated willingness to continue using the application and recommend it to their classmates. These findings suggest that the application

successfully met students' expectations regarding usability, usefulness, and enjoyment. The favorable perceptions support the principles of the Technology Acceptance Model, which emphasizes perceived usefulness and ease of use as key factors influencing technology adoption. The positive attitudes toward the application also indicate that gamification features enhanced learner motivation and engagement. These findings are consistent with earlier studies showing that gamified learning environments improve students' cognitive engagement, attitudes, and acceptance of educational technologies (Sailer & Homner, 2020; Buckley & Doyle, 2018; Zainuddin et al., 2020). Research also indicates that learners are more likely to adopt and continue using gamified educational applications when they perceive meaningful benefits and enjoyable learning experiences (Hamari et al., 2019; Koivisto & Hamari, 2019).

3.3.2 Frequency of Actual Use of the Application

The findings revealed moderate actual use of the gamified mathematical mobile application among Grade 8 students. Most students used the application for short sessions lasting five to fifteen minutes and typically accessed it once or twice a week. Learners primarily used the application to practice solving integer problems rather than exploring gamification features, reviewing lessons, or completing assigned tasks. Students also expressed neutral perceptions regarding the application becoming part of their regular study routine and its effect on improving their mathematical skills. These findings suggest that the application functioned mainly as a supplementary practice tool rather than a consistent component of students' daily study habits. The moderate and brief usage patterns reflect early-stage integration of the application into learners' routines. The findings also indicate the need for additional motivational features and stronger curriculum integration to encourage sustained engagement and habitual use. Studies by Hwang et al. (2021), Sung et al. (2022), and Chen et al. (2023) support the idea that brief but consistent practice sessions combined with gamification strategies and spaced repetition can gradually improve learners' mathematical skills and engagement.

4. Conclusion and Recommendations

The study concluded that the developed gamified mathematical mobile application is an effective and acceptable instructional tool for teaching integer operations among Grade 8 students. The application significantly improved students' performance, as reflected in the increased posttest scores and statistically significant difference between pretest and posttest results. Its user interface, gamification features, instructional content, interactivity, feedback mechanisms, and multimedia components contributed to an engaging and learner-friendly environment that enhanced students' comprehension, motivation, participation, and problem-solving skills in mathematics. The application also demonstrated strong learner acceptability, indicating that students found it useful, enjoyable, and easy to use as a supplementary learning resource.

The gamified mathematical mobile application may be utilized as a supplementary instructional tool in Grade 8 mathematics classes to improve students' understanding of integer operations and strengthen engagement in learning activities. Teachers are encouraged to integrate the application into classroom instruction, practice exercises, and review sessions to maximize its effectiveness. Continuous refinement of the application's gamification features, instructional content, and interactive components based on user feedback is also recommended to maintain its relevance and effectiveness. Furthermore, implementing the application in other schools may help expand its educational benefits and further improve students' mathematical skills and interest in learning mathematics.

The study was limited to Grade 8 students from DT Durano Memorial Integrated School in Danao City, Cebu during the School Year 2025–2026. The respondents were selected through purposive sampling and were required to have access to Android devices for the use of the gamified mathematical mobile application. The study focused only on the learning of integer operations, specifically addition, subtraction, multiplication, and division, and utilized a one-group pretest-posttest design without a control group. The implementation period was also limited to the scheduled intervention sessions conducted during the study.

Compliance with ethical standards

The authors declare no conflict of interest. This study received no external funding and was conducted at D.T. Durano Memorial Integrated School with the participation of Grade 8 students during the School Year 2025–2026. Participation in the study was voluntary, and informed consent was obtained prior to data collection through non-invasive procedures, including pretests, posttests, and survey questionnaires administered using the gamified mathematical mobile application. All information gathered from the participants was treated with strict confidentiality, and no identifying personal information was disclosed in the study.

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