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"Math Games: Math For Kids Learning App" and learners' proficiency level in numeracy

Dandie A. Busquit, Jr.
Capiz State University Main Campus
College of Education Graduate Programs
Roxas City, Philippines
Email: dandiebusquit2@gmail.com

Abstract: Amid growing concerns over declining national numeracy proficiency, learning applications play a pivotal role in enhancing learners' performance in numeracy. This study evaluated the effectiveness of the "Math Games: Math for Kids" learning application in improving the numeracy skills of Grade 3 pupils at Banica Elementary School during the School Year 2024–2025. Specifically, it aimed to determine the learners' proficiency levels in numeracy before and after the intervention, assess whether a significant difference existed between the pretest and posttest results, and measure the intervention's effect size. The study employed a quasi-experimental, single-group pretest-posttest design involving 26 Grade 3 pupils who scored below the proficient level in the Enhanced Regional Unified Numeracy Test (ERUNT). A 45-item standardized numeracy test covering addition, subtraction, and multiplication was administered before and after a four-week intervention using the learning app. Data were analyzed using the mean, paired sample t-test at a 0.05 significance level, and Cohen's d to determine the effect size. Results showed that the pupils' proficiency level in numeracy before the intervention was "low proficient." After the intervention, it improved to "proficient." Statistical analysis revealed a significant difference in the pretest and posttest results, favoring the posttest scores. Moreover, Cohen's d indicated a very large effect size, suggesting that the "Math Games: Math for Kids" app had a substantial positive impact on learners' numeracy skills. These findings highlight the app's effectiveness as a digital learning tool for strengthening foundational math competencies in young learners.

Keywords: Math Games, Numeracy Levels, Learning Apps, Game-Based Learning, Mathematics Education, Proficiency Levels

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INTRODUCTION

The results of national standardized assessments conducted across the country have highlighted several concerning trends in numeracy performance, raising alarms about students' current state of mathematical proficiency. These assessments, which are designed to gauge the level of understanding and competence in key mathematical areas, have shown a noticeable decline in the ability of students to perform basic arithmetic operations, solve complex problems, and apply mathematical reasoning effectively. Such trends reflect a worrying stagnation in numeracy skills and point to deeper issues within educational systems, teaching methods, and resource allocation.

As these results continue to emerge, there is an increasing concern among educators, policymakers, and parents about the long-term implications for students' future academic success and their preparedness for the workforce. Without prompt and targeted interventions, these trends may lead to an even wider achievement gap and hinder the development of critical skills needed in today's data-driven and technology-centered world.

One of the most sought-after competencies for learners and educators in today's educational landscape is developing and applying 21st-century skills. Instructional delivery must incorporate technology, including online and offline learning applications, to ensure students become more competitive in a rapidly evolving world. Research by Sailer et al. (2017) has demonstrated that gamified apps significantly enhance student engagement and motivation, leading to increased time spent practicing math skills. Studies by Sung et al. (2015) further support the effectiveness of gamified apps in improving students' mastery of fundamental operations, such as addition, subtraction, and multiplication. Additionally, research by Mishra et al. (2019) and Chiou et al. (2020) highlighted that gamified learning can reduce math anxiety in some students, potentially accelerating their learning progress. Moreover, some apps offer adaptive learning pathways that adjust based on individual performance, ensuring that they cater to diverse learning styles and needs, as evidenced by Vásquez et al. (2019).

It has been observed that several Grade 3 learners have started to lose interest in their studies and struggle with basic math skills in recent months. Despite various efforts to engage and motivate them, these learners are reluctant to participate in learning activities.

Specifically, in the Schools Division of Roxas City, Banica Elementary School, District II, the Enhanced Regional Unified Numeracy Test (E-RUNT) administered to Grade 3 learners during the first week of the 2023-2024 school year showed troubling results. Out of 181 learners, 57, or 31.5%, scored below the Proficient Level in 1-digit addition, subtraction, and multiplication of whole numbers.

These results are particularly alarming, as they highlight a significant gap in students' understanding and application of essential mathematical concepts, which may hinder their future academic progress and proficiency in more advanced topics.

Given the pressing need to address the negative impact this decline in engagement has on their numeracy performance, the researcher aimed to explore the effect of the “Math Games: Math for Kids” Learning App, a gamified learning tool, on enhancing the numeracy proficiency of Grade 3 learners at Banica Elementary School.

As a mathematics teacher, the researcher is concerned about the declining interest and struggles with basic mathematics skills observed among his Grade 3 learners. He believes that these foundational skills are crucial for their future learning, and he wants to understand why these challenges are happening and how to help them overcome them. The results of the Enhanced Regional Unified Numeracy Test (E-RUNT) show that a significant portion of learners at Banica Elementary School are falling below the proficient level in basic Mathematics concepts. Despite efforts to engage and motivate them, the low proficiency rates suggest that current methods may not address the root causes of the problem.

This study aimed to explore these underlying issues and introduce a tool that may support struggling learners, ultimately helping them build confidence and succeed in Mathematics. The findings could guide his teaching and lead to meaningful improvements across the school.

Objectives of the study

This study aimed to determine the effectiveness of “Math Games: Math for Kids” Learning App in improving the numeracy proficiency level of Grade 3 learners of Banica Elementary School, School Year 2024-2025. Specifically, it aimed to:

1. determine the proficiency level in numeracy of Grade 3 learners before and after the intervention of “Math Games: Math for Kids” learning app;

2. determine if there is a significant difference in the proficiency level in numeracy of the Grade 3 learners before and after the intervention of "Math Games: Math for Kids" learning app; and

3. determine the effect size of "Math Games: Math for Kids" learning app on the proficiency level in numeracy

METHODOLOGY

This quasi-experimental study using the single-group pretest-posttest design was limited to evaluating the effectiveness of the "Math Games: Math for Kids" learning app on the proficiency level in numeracy of Grade 3 learners of Banica Elementary School in the Division of Roxas City during the School Year 2024-2025.

This study involved 26 Grade 3 learners, 13 males and 13 females. The participants were identified based on the results of a pre-test administered by the researcher using the Enhanced-Regional Unified Numeracy Test (E-RUNT). Out of 105 pupils who took the pre-test, 26 scored below the proficient level. They were purposively selected as participants and provided the intervention utilizing the "Math Games: Math for Kids" learning app.

The research instrument used to gather the needed data was the 45-item Enhanced-Regional Unified Numeracy Test (ERUNT), a comprehensive and standardized assessment framework developed by the Department of Education, Region VI—Western Visayas, as outlined in Regional Memorandum No. 630, s. 2023.

The mean was used for descriptive analysis, while the T-test for Paired Samples, set at a .05 alpha level, was used for the inferential analysis. Cohen's d was used to measure the effect size of "Math Games: Math for Kids" learning app on the proficiency level in numeracy. The Statistical Package for Social Science (SPSS) Software was used to analyze the data.

DISCUSSION OF FINDINGS

Proficiency level in numeracy of grade 3 learners before and after the intervention of "Math games: Math for kids" learning app

The researcher found the data on the pretest reveals that the level of proficiency in numeracy of Grade 3 pupils before the introduction of the intervention was a "low proficient" as shown by the overall mean of 22.08 (SD = 10.61). In contrast, the posttest result reveals that the level of proficiency in numeracy of Grade 3 pupils after the intervention was "Proficient" because of the overall mean of 37.85 (SD = 7.66).

The classification of "low proficient" in numeracy implies that many Grade 3 pupils lacked a solid understanding of basic mathematical concepts and skills, which are essential for mastering more advanced topics in later grades. This performance indicates potential gaps in foundational knowledge, such as number sense, basic operations, and problem-solving strategies. These gaps could widen over time without appropriate intervention, hindering students' academic progress in mathematics and related subjects. Hence, the pretest results highlight the urgent need for targeted and effective instructional strategies to support and improve numeracy development at this critical stage in their education.

On the other hand, the result of "Proficient" numeracy level after utilizing "Math Games: Math for Kids" learning app implies that using the learning mobile application was highly effective in improving the numeracy skills of Grade 3 pupils. The marked increase from a "low

proficient" level in the pretest to a "proficient" level in the posttest demonstrates that using the learning app substantially and positively impacted students' academic performance. Furthermore, this improvement implies that the app helped reinforce fundamental mathematical concepts and provided an engaging, interactive, and learner-friendly platform that motivated students to participate more actively in their learning process. The digital format likely catered to diverse learning styles and allowed for individualized pacing, immediate feedback, and repetitive practice, all critical factors in mastering numeracy skills at the elementary level.

Moreover, this outcome highlights the growing importance and effectiveness of integrating technology into the classroom, especially when it aligns with curriculum goals and student needs. It supports the idea that well-designed educational apps can be powerful tools to address learning gaps, foster interest in mathematics, and promote better retention and understanding of concepts. As such, the intervention can be considered a valuable instructional strategy that educators may adopt or scale up to improve mathematics performance across similar learning contexts.

The findings of the present study on the use of the "Math Games: Math for Kids" App are in consonance with the results of the Organization for Economic Cooperation and Development(OECD), PISA 2018, which revealed that a significant percentage of Filipino students scored below the minimum proficiency level in mathematics, ranking among the lowest globally.

In addition, these results align closely with the findings of Thai et al. (2023), which examined the impact of the My Math Academy app on early elementary students' mathematics performance. Integrating an interactive, game-based learning platform into classroom instruction significantly improved students' numeracy proficiency in both studies. In this study, Grade 3 learners progressed from a "low proficient" level in the pretest to a "proficient" level in the posttest, with a notable increase in the mean score. Similarly, Thai et al. (2023) found that students who used My Math Academy outperformed their peers in the control group, demonstrating statistically significant learning gains, particularly among younger learners such as kindergarteners. Both interventions highlight the effectiveness of game-based learning apps in creating engaging and adaptive learning environments. These applications' personalized learning pathways, immediate feedback, and interactive design contribute substantially to learners' understanding and retention of mathematical concepts. Moreover, both studies emphasize the value of using technology to bridge learning gaps and enhance student motivation. Hence, the positive outcomes observed in this study affirm and support the findings of Thai et al. (2023), providing further evidence that game-based educational tools can be powerful allies in promoting numeracy development, especially in the early years of schooling.

Meanwhile, Surendeleg et al. (2017) emphasized that gamified learning environments enhance learners' enthusiasm and outcomes in mathematics. This observation resonates with the improved performance of Grade 3 pupils after the intervention, where the engaging nature of the learning app may have provided a low-pressure context for students to practice core math skills repeatedly. Likewise, this study's result parallels the study of Steinkuehler and Duncan (2015), which highlighted the motivational power of intrinsic engagement through game-based learning. This likely contributed to the high posttest performance observed among the participants. Interactive mathematics games significantly improve learners' understanding of basic concepts by offering an engaging environment for practice (Chien et al., 2018). This affirms the present

findings, where learners demonstrated enhanced numeracy through repeated and interactive exposure to math exercises via the mobile app.

The current study further aligns with Lee and Lee (2019), who reported that mobile learning apps that feature real-time feedback and interactive exercises promote a more personalized learning experience, supporting diverse student needs and pacing. These characteristics were also present in the "Math Games: Math for Kids" app and likely contributed to improved learning outcomes. Similarly, Highfield and Goodwin (2017) noted that educational apps in primary schools made abstract math concepts more accessible. This aligns with how the intervention in the present study provided visual and interactive representations of mathematical ideas, aiding conceptual understanding. The result further supports the study of Carpenter et al. (2016), which showed that the increasing complexity of tasks within learning apps supports skill progression. This may explain the steady improvement in students from pretest to posttest in this study. The design of the app matched learners' evolving proficiency levels, promoting critical thinking and application.

Finally, the findings of Schacter and Jo (2016), who demonstrated that well-designed educational apps significantly improved early math skills through features like adaptive difficulty and real-time feedback, further validate the outcomes of the present study. The "Math Games: Math for Kids" app embodied many of these features, likely contributing to the measurable improvement in numeracy proficiency among Grade 3 learners.

Difference in the proficiency level in numeracy of the grade 3 learners before and after the intervention of "Math Games: Math for Kids" learning app

The result revealed a mean difference of 15.77 in favor of the posttest result. This mean difference was significant because the t-value of -19.067 had a p-value of .000, which was less than the 0.05 alpha. This implies a substantial enhancement in the proficiency level in numeracy of Grade 3 learners between the pretest and posttest sessions after their exposure to the "Math Games: Math for Kids" Learning App during the 4-week intervention period.

These results led to the rejection of the hypothesis, which states that there is no significant difference in the numeracy proficiency level of Grade 3 learners before and after the intervention of the "Math Games: Math for Kids" Learning App.

The findings of the present study, which revealed a significant improvement in numeracy proficiency from pretest to posttest after Grade 3 learners used the "Math Games: Math for Kids" Learning App, corroborate with the results of Lozano et al. (2023), who developed a game-based learning application aimed at helping students practice mathematical patterns and structures. Both studies highlight the effectiveness of game-based learning in improving students' mathematical abilities by incorporating interactive features and real-time feedback, which actively engage students while reinforcing critical skills. In Lozano et al.'s study, challenges, rewards, and adaptive difficulty levels were essential in maintaining student motivation, much like the features of the "Math Games: Math for Kids" App, which likely kept students engaged and motivated throughout the 4-week intervention period. The immediate feedback provided by both applications played a crucial role in correcting misconceptions and personalizing the learning experience, ensuring that students could progress at their own pace. Moreover, the significant improvement in students' numeracy proficiency observed in this study mirrors Lozano et al.'s findings that game-based learning can enhance engagement and conceptual understanding. Both studies emphasize the potential of gamification as a powerful tool in mathematics education, recommending further refinement to expand these applications' scope

and effectiveness in fostering more profound understanding and mastery of mathematical concepts.

The positive impact of educational apps on numeracy development, as evidenced in the present study, is further supported by the findings of Santos and Bismonte (2019), which revealed that students exposed to the math apps demonstrated significantly better conceptual understanding and problem-solving skills. This improvement was attributed to app features such as step-by-step guides, real-time feedback, and interactive exercises, which enhanced comprehension and addressed diverse learning styles. Similarly, the present study showed that the interactive nature of the "Math Games: Math for Kids" app contributed to substantial gains in numeracy proficiency among Grade 3 learners. In addition, this result is supported by the study of Nurnberger-Haag, Wernet, and Benjamin (2022), which explored how classroom games impact student motivation and learning in mathematics. Their study highlighted the importance of design elements such as competition, collaboration, and immediate feedback in reinforcing mathematical concepts. These elements are closely mirrored in the present intervention, where the game-based features of the app likely contributed to increased learner motivation and active participation. The emphasis on aligning game mechanics with curriculum goals in their study also resonates with the effectiveness of the app used in this research, which was clearly structured to address fundamental numeracy competencies appropriate for Grade 3 learners.

Moreover, this further supports the study of Garcia and Dela Cruz (2020), which provided valuable insights into how digital tools can improve math learning outcomes. Their findings underscored that game-based learning boosted engagement and participation and enhanced students' problem-solving skills and computational accuracy. Much like the current study, their results highlighted the role of mobile games in encouraging self-paced learning and promoting confidence in numeracy skills. Notably, their emphasis on accessibility, through offline functionality, mirrors the importance of designing interventions that cater to various learning contexts. This factor enhances the scalability and inclusiveness of digital education tools.

Effect size of the "Math Games: Math for Kids" learning app on proficiency level in numeracy

The Cohen's d effect size value was 1.77, which is higher than the 0.8 value, suggesting a large effect of the application on the proficiency level in numeracy of the learners.

The result implies that the "Math Games: Math for Kids" Learning App has significantly influenced the students' learning performance. The effect size indicates that using the app is an effective tool for enhancing numeracy skills. Therefore, the researcher suggests incorporating the "Math Games: Math for Kids" learning app into regular classroom instruction to significantly improve students' numeracy proficiency.

The findings of the present study on the "Math Games: Math for Kids" learning app align closely with the research conducted by Morales and Tolentino (2023) on the use of mathematical applications (apps) to address learning gaps in mathematics, particularly those arising from disruptions caused by the COVID-19 pandemic. Similar to the study by Morales and Tolentino, the present study demonstrates that game-based learning apps such as "Math Games: Math for Kids" significantly bridge learning gaps by reinforcing foundational mathematical concepts, such as number sense, which is essential for more advanced mathematical learning.

In both studies, the use of interactive and adaptive content was crucial in providing personalized learning experiences. In Morales and Tolentino's study, students used mathematical

apps to revisit core concepts they had missed or struggled with, which helped improve their numeracy skills. Likewise, in this study, students who used the "Math Games: Math for Kids" App during the 4-week intervention period exhibited a significant improvement in numeracy proficiency, as reflected in the shift from a "low proficient" to a "proficient" level in numeracy. This suggests that the app's ability to engage students with interactive challenges, immediate feedback, and adaptive learning paths supports solidifying core numeracy skills.

The results from both studies highlight the effectiveness of mathematical apps in addressing academic gaps, fostering a deeper understanding of key mathematical principles, and improving students' ability to apply them in problem-solving situations. As such, both studies underscore the potential of game-based learning applications as powerful tools for enhancing mathematical proficiency and addressing learning disruptions, whether due to the pandemic or other challenges, by offering students a flexible, engaging, and personalized learning environment.

CONCLUSION

The findings of this study clearly demonstrate that the use of the “Math Games: Math for Kids” learning app significantly improved the numeracy proficiency of Grade 3 learners. Initially, students exhibited a “low proficient” level in numeracy, as reflected by their pretest scores, indicating substantial gaps in foundational mathematical skills such as number sense, basic operations, and problem-solving. However, following a four-week intervention using the educational app, posttest scores revealed a remarkable shift to a “proficient” level, affirming the effectiveness of the intervention in enhancing learners' mathematical abilities.

Statistical analysis further validated this improvement. The mean difference of 15.77 between pre- and posttest scores was statistically significant, supported by a p-value of .000 and a high Cohen's d effect size of 1.77, indicating a large effect. These results confirm that the app not only enhanced performance but did so with substantial impact. The transition from low to proficient reflects the app’s ability to facilitate individualized pacing, provide real-time feedback, and reinforce mathematical concepts through engaging, interactive methods. Learners responded positively to the game-based format, which helped reduce anxiety, promote active participation, and maintain motivation—factors crucial to academic success in mathematics.

These outcomes are consistent with prior research, including studies by Thai et al. (2023), Surendeleg et al. (2017), and Morales & Tolentino (2023), which found that mobile math applications and gamified learning significantly enhance numeracy and conceptual understanding. Like other effective platforms, “Math Games: Math for Kids” provided adaptive learning environments that allowed for differentiated instruction, improved focus, and deepened comprehension.

Overall, the study affirms the value of integrating technology into early grade mathematics education. The strong effect observed suggests that educational apps can be potent instructional tools for addressing learning gaps, enhancing engagement, and promoting lasting skill development in numeracy. Therefore, it is recommended that “Math Games: Math for Kids” or similarly structured apps be considered for broader adoption in elementary classrooms, especially in contexts where foundational math skills need reinforcement. With proper integration into the curriculum and guided use, digital tools like this can help cultivate a generation of confident and capable math learners.

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REFERENCES

Alkhalaf, S. (2018). Attitudes towards using mobile applications in teaching mathematics in open learning systems. International Journal of Emerging Technologies in Learning, 13(5), 103-117. files.eric.ed.gov.

Anderson, D. (2020). Sick schools: Diagnosis, cure, and prevention of school maladies. Wipf and Stock Publishers. ISBN 1532696868, 9781532696862.

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020, December). Purposive sampling: complex or simple? Research case examples. J Res Nurs, 25(8), 652-661. https://doi.org/10.1177/1744987120927206.

Canilao, C. M., &Gurat, M. G. (2023). Effect of mobile app on students' mathematics and technology attitude. American Journal of Educational Research, 11(10), 722-728.

Çakıroğlu, Ü., &Gökoğlu, S. (2019). The effects of mobile technology on learning performance and motivation in a secondary school mathematics course. Education and Information Technologies, 24(2), 1205-1221. pmc.ncbi.nlm.nih.gov.

Chien, S., Chou, P., & Lee, S. (2018). The Effectiveness of Mobile Math Apps on Primary School Children's.

Cruz, M. A., & Reyes, J. F. (2023). Enhancing the numeracy skills of Grade 8 students through Quizizz: An interactive learning approach for improved mathematical proficiency. Journal of Interdisciplinary Perspectives, 2(12), 382-390. RESEARCHGATE.NET.

DepEd Order 013 s.2023. National Learning Recovery Program.

Domanais, E. S. (2015). Improving the least mastered competencies on number and number sense of Grade 7 learners. International Journal of Education and Research, 3(12), 123-136.

Etubcan, J. O., &Pantinople, L. D. (2018). The use of math apps and the mathematics performance of Grade 8 students. EPRA International Journal of Research and Development, 3(5), 1-11. eprajournals.com.

Frost, J. (2021). What is the mean in statistics? Statistics By Jim. https://statisticsbyjim.com/basics/mean_average/.

Gersten, A. (2016). What we are learning about Mathematical interventions and conducting research on Mathematical interventions. https://www.researchgate.net/publication/308699602_What_We_Are_Learning_About_Mathematicsematics_Interventions_and_Conducting_Research_on_Mathematicsematics_I.

Gee, J. P. (2003). What video games have to teach us about learning and literacy. Computers in Schools, 20(3-4), 113-136. https://doi.org/10.1300/J025v20n03_09.

Gonzales, A. B., & Torres, M. C. (2023). Literacy as a predictor of math proficiency among Filipino learners. Journal of Educational Psychology, 45(2), 150-162.

Highfield, K., & Goodwin, K. (2017). Using apps for teaching and learning mathematics: A socio-technological perspective. ERIC, ED592503.

Lee, J., & Lee, Y. (2019). Mobile Learning Apps: Enhancing Numeracy Skills of Elementary Students. Journal of Educational Research and Practice, 9(1), 15-25.

Lozano, A. S., Canlas, R. J. B., Coronel, K. M., Canlas, J. M., Duya, J. G., Macapagal, R. C., Dungca, E. M., & Miranda, J. P. P. (2023). A game-based learning application to help learners practice mathematical patterns and structures. arXiv preprint arXiv:2306.13685.

Meyer, M., Adkins, M., & Lyons, L. (2022). Understanding how educational math apps can enhance learning: A content analysis and qualitative comparative analysis. British Journal of Educational Technology, 53(4), 1234-1252. https://doi.org/10.1111/bjet.13339.

Morales, M. P. E., & Tolentino, L. A. (2023). Bridging the mathematics gap through the use of mathematical apps. Ateneo de Manila University. archium.ateneo.edu.

Morata, F. M. (2022). The use of digital game-based learning on numeracy of grade 7 students in the Philippines. Sindh University Research Journal (Science Series), 54(3), 429-434. sci-int.com.

Montague, A. (2017). Mathematics in early years education. Routledge. ISBN 1351745115, 9781351745116.

Nurnberger-Haag, J., Wernet, J. L., & Benjamin, J. I. (2022). Gameplay in perspective: Applications of a conceptual framework to analyze features of mathematics classroom games. Journal of Research in Mathematics Education, 11(3), 273-299.

Nguyen, H. A., & McLaren, B. M. (2023). Digital learning games in artificial intelligence in education: A review. In Handbook on AI in Education. https://doi.org/10.1007/978-3-031-26588-7_17.

Outhwaite, L. A., Faulder, M., Gulliford, A., & Pitchford, N. J. (2018). Interactive apps promote learning of basic mathematics in children with special educational needs and disabilities. Frontiers in Psychology, 9, 262. https://doi.org/10.3389/fpsyg.2018.00262.

Outhwaite, L. A., Gulliford, A., & Pitchford, N. J. (2019). Raising early achievement in math with interactive apps: A randomized control trial. Journal of Educational Psychology, 111(2), 284-298. https://doi.org/10.1037/edu0000286.

OECD. (2019). PISA 2018 Results (Volume I) What Pupils Know and Can Do: What Pupils Know and Can Do. OECD Publishing, 2019. ISBN 9 264541888, 9789.

OECD. (2022). PISA 2022 Results: Mathematics Performance. Retrieved from https://www.oecd.org/pisa/publications/PISA-2022-results-mathematics-performance.pdf.

Opitz, E. (2016). Remediation for pupils with Mathematical difficulties: An intervention study in middle schools.

https://www.researchgate.net/publication/307945552_Remediation_for_Pupils_With_Mathematicsematics_Difficulties_An_Intervention.

Palinkas, L. A., Horwitz, S. M., & Green, C. A. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. Administration and Policy in Mental Health and Mental Health Services Research, 42(5), 533–544. [PMC free article] [PubMed] [Google Scholar] [Ref list].

Papastergiou, M. (2015). Mathematics Learning Apps: Their Impact on Student Engagement and Achievement. Computers & Education, 89, 13-24.

Rapp, D., & Gagnon, D. (2020). The Impact of Math Apps on Learners' Numeracy and Academic Performance. International Journal of Educational Technology in Higher Education, 17(1), 20.

SAGE Publications (2019). Quasi-Experimental and Single-Case Experimental Designs. Retrieved January 26, 2020, from https:///us.sagepub.com/sites/default/files/upmbinaries/89876_Chapter_13_Quasi_Experimental_and_Single_Case_Designs.pdf

Santos, R. G., &Bismonte, L. A. (2019). The use of math apps and the mathematics performance of grade 7 students. EPRA International Journal of Research and Development (IJRD), 4(2), 45-50.

Santos, R. P., & Hernandez, L. M. (2021). Development of a gamified number line app for teaching integers in a mobile learning environment. Proceedings of the 29th International Conference on Computers in Education, 648-656. icce2021.apsce.net.

Schacter, J., & Jo, B. (2016). A meta-analysis of the effects of educational apps on preschool to grade 3 children's literacy and math skills. Educational Research Review, 19, 85-98. https://doi.org/10.1016/j.edurev.2016.07.002.

Schweizer, M. L., Braun, B. I., &Milstone, A. M. (2016). Research Methods in Healthcare Epidemiology and Antimicrobial Stewardship—Quasi-Experimental Designs. Infection Control & Hospital Epidemiology, 37(10), 1135–1140. https://doi.org/10.1017/ice.2016.117.

Squire, K., & Jenkins, H. (2016). The Role of Mobile Learning in Developing Numeracy Skills. Educational Technology Research and Development, 64(5), 865-884.

Surendeleg, G., et al. (2017). Gamification in education: A review of the literature. Computers in Human Behavior, 71, 1-14.

Turney, S. (2023, June 21). Frequency distribution | Tables, types & examples.

Wu, S., Amin, H., Barth, M., Malcarne, V., & Menon, V. (2012). Mathematics anxiety in second and third graders and its relation to Mathematical achievement.