

MathGALING (Games, Activities, and Lectures to Improve Numeracy Grasp) of Learners: Transformative Innovation in Elementary Mathematics

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Abstract— This study examined the impact of MathGALING (Games, Activities, and Lectures to Improve Numeracy Grasp), a game-based learning approach designed to enhance numeracy skills among elementary learners. Recognizing the alarming decline in numeracy proficiency, the research investigates the effectiveness of integrating interactive games into mathematics education. Employing a qualitative research design, the study involved 40 elementary students from diverse socioeconomic backgrounds, utilized semi-structured interviews, observations, and teacher interviews to gather data. Key findings revealed that MathGALING significantly reduced students' anxiety towards mathematics and increased their confidence, with male students favoring the game-based elements and female students appreciating collaborative learning. Socioeconomic factors played a crucial role, as students from lower socioeconomic backgrounds reported a lack of access to engaging educational resources, which MathGALING effectively addressed. Parental educational attainment influenced student engagement, while different grade levels exhibited varying benefits from the program. The study underscored the importance of innovative, interactive learning environments in mathematics education and suggests implications for educators, policymakers, and curriculum developers. Limitations included sample size and reliance on self-reported data, leading to recommendations for longitudinal and comparative studies to further explore the long-term effects of game-based learning on numeracy skills.

Keywords— Games-based learning in mathematics, hands-on math activities, MathGALING, targeted math lectures.

INTRODUCTION

Recent studies have been conducted to integrate games within an educational setting (Johnson & Smith, 2022). They created a dynamic way of teaching and learning most subjects imparted to learners at this elementary level, including basic numeracy (Miller, 2021). With much emphasis on basic numeracy as part of life, educators embraced games as great tools for capturing young minds, thus allowing for meaningful learning (Wilson, 2023). The inherent appeal of gameplay was utilized for educating mathematics while encouraging active participation, critical thinking, and problem-solving skills (Anderson & Brown, 2020).

Games provided an exciting path to instruction: learning through discovery, collaborative learning, and immediate feedback (Davis, 2022). Whether playing board games, digital apps, or interactive activities, math was likely to be discovered as exciting, replete with discovery and triumph when an otherwise overwhelming challenge was made manageable (Thompson, 2021). Additionally, games catered to the needs of all learning styles, including visual, auditory, kinesthetic, and tactile types of learners (Garcia & Lee, 2020; Plass et al., 2014).

Grounded in constructivist learning theories, GBL aimed at understanding knowledge to be constructed by interacting with the environment or through social collaboration (Piaget, 1970; Vygotsky, 1978). Playing games took the motivational aspect of playing and developed the entertaining aspect of learning activities; thus, students took part very actively and critically thought about ideas. There have been many experiments on GBL that have delivered positive results concerning the motivational aspects of students towards math. According to Hamari et al. (2016), the presence of game elements was a vital factor that heightened both motivation and engagement in any learning context. Another important meta-analysis done by Clark et al. (2016) discovered that GBL not only heightened motivation but also improved attitudes—an important factor in alleviating math anxiety. Research has repeatedly shown that GBL led to improved numeracy skills in elementary students. In the study conducted by Kafai and Burke (2015), it was ascertained that children in the treatment group that conducted game-based math activities experienced a greater increase in test scores concerning numeracy competencies compared to their traditional counterparts.

Games had that interactive component, through which mathematical ideas could be experimentally discovered by exploring, manipulating numbers, and visualizing mathematical concepts (Gee, 2017). Ahmed and Patel (2021) examined the effect of game-based instruction on math memory retention. The researchers found that students who used game-based learning showed higher retention of mathematical concepts and problem-solving skills. MathGALING aimed to enhance numeracy through interactive games and activities. GBL was an effective way of achieving the goal of reaching all learners because it catered to different learning styles. Plass et al. (2014) argued that games accommodated visual, auditory, and kinesthetic learners, meaning that students would have various pathways of understanding mathematical concepts.

Such flexibility was also crucial in elementary education since learners displayed a wide range of abilities and preferences (Adams & McCarthy, 2018). Research has also focused on how GBL influences different genders in mathematics learning. Wang et al. (2019) point out that male students would more often engage with competition aspects of the game and that female students would experience more benefits from the cooperative aspects of GBL. In this regard, both genders could benefit alike, although their engagement might vary based on the game design and the strategies used in teaching (Baker et al., 2021).

It has been said that socioeconomic status (SES) determines access to educational resources among students and even affects academic performance in general. Based on Sirin's argument (2005), the gap between SES attainment of achievement results has proven true; kids coming from lower-class backgrounds often did not get the chance to read about fascinating topics. The application of GBL may therefore bridge the gap because GBL allows interactive resources for the facilitation of learning that could reach any student, irrespective of the student's SES background (Bennett & Sweeney, 2020).

This study shall inform educators and curriculum developers about the problem concerning low numeracy performance across elementary school learners globally. The findings are quite helpful in informing how the use of such an educational game as MathGALING in curriculums is appropriate and viable. A successful result can contribute to boosting more engagement in game-based learning and hence improve performance among numeracy learners, along with higher interest in

math disciplines. The outcome will then be added to the existing body of knowledge on effective instructional strategies to enhance numeracy skills and therefore inform evidence-based practice choices at the educational field level.

Statement of the Problem

Whereas numeracy was one of the basic skills for any human to be successful (Smith, 2020), it became quite disturbing that numeracy levels had drastically reduced among the present learners of elementary schools (Jones & Lee, 2021). The traditional approaches to teaching mathematics seemed to disengage the learners; thus, leading to a lack of motivation and weak comprehension, hence inadequate performance (Brown, 2019). The issue became more problematic for the instructor to address, as it encompassed various types of learners' diversity and needs (Garcia, 2022).

This study hoped to address the current critical problem by considering a fresh game-based learning method: MathGALING—Games, Activities, and Lectures to Improve Numeracy Grasp. Its dynamic nature, with engaging activities included, aimed to combine the most helpful interactive games, collaboration, and focused lectures into developing better grasps of math concepts and enhancing numeracy skills in elementary learners (Taylor, 2023).

The research study seeks answers to the following questions:

1. What are the perceptions and lived experiences of elementary learners regarding their numeracy skills before their exposure to the MathGALING program?
2. How do the experiences of learners in the MathGALING program differ based on factors such as sex, socioeconomic status, grade level, and parental educational attainment?
3. What innovative strategies can be derived from the insights gained through the MathGALING program to enhance mathematics teaching and learning in elementary education?

This research study attempted to contribute to this massive body of literature on game-based learning and how to alter mathematics education through answering the following questions. Therefore, results offered insights into MathGALING's potential in improving numeracy at the elementary school level and providing better learner outcomes while engaging learners more effectively for everyone.

METHODOLOGY

This study used a qualitative research design to explore the effects of MathGALING on the numeracy skills and engagement of elementary learners. The study was designed to investigate the lived experiences and perceptions of participants, thus yielding rich and nuanced understanding of the program's effectiveness. The study enrolled a purposive sample of 40 elementary school learners in grades 5 and 6 from different socio-economic backgrounds and learning styles.

Participants were chosen according to their willingness to participate in the study and exposure to MathGALING. Data was collected by a combination of methods comprised of the following: Semi-structured interviews: Interviews with the students and instructors were aimed at uncovering their experience with MathGALING, perception of benefits and challenges associated with it, and the general involvement in mathematics in general. Observations: Researchers conducted observation sessions in classroom sessions where MathGALING was implemented to observe how the learners responded, level of engagement during learning sessions, and manner of responses.

RESULT AND DISCUSSION

This qualitative study explored the impact of the MathGALING program on elementary learners' numeracy skills, yielding several significant findings categorized by participant demographics.

Anxiety towards Mathematics

The study found that many learners initially experienced anxiety towards mathematics, as expressed by one participant who said, "Math always makes me nervous."

However, after participating in MathGALING, they reported increased confidence in their abilities. This newfound confidence was attributed to the engaging and interactive nature of the program's game-based learning approach.

Sex, Socioeconomic Status, Parental Involvement, Grade Level: Factors on Transformative Game-Based Mathematic Learning

Further analysis revealed gender differences, with males particularly enjoying the game-based elements, as one male participant stated, "I love playing math games; it makes learning fun!" Females, on the other hand, valued the collaborative aspects, with one female participant noting, "Working with my friends on math games helped me understand better." Socioeconomic status also

played a role, with low SES learners highlighting the importance of accessible resources, as one participant shared, "I didn't have access to fun math games before." Middle SES learners expressed increased motivation to participate, with one participant stating, "I want to play more games in math class!"

Parental educational attainment also impacted learners' experiences, with those whose parents had completed high school reporting more homework support, as one participant shared, "My parents always help me with my homework." Those with college-educated parents felt a greater expectation to excel, as one participant noted, "My parents expect me to do well in math; they help me study."

Grade level differences were observed, with Grade 5 learners appreciating hands-on learning experiences, as one participant shared, "Using games helped me see math in a different way." Grade 6 learners reported improved problem-solving skills, with one participant stating, "I can think of different ways to solve problems now."

Finally, educators involved in the study noted that incorporating games into their lessons transformed their teaching strategies, leading to higher levels of learner engagement and understanding, with one teacher sharing, "Incorporating games into lessons has changed how I teach."

CONCLUSION

This study provided strong evidence demonstrating that MathGALING, a game-based approach to learning, could quite appropriately address the challenges placed on the numeracy skills of elementary learners. Through the dynamic and interesting nature of the program - a combination of interactive games, collaborative activities, and focused lectures- anxiety among students towards math was reduced, and besides, confidence was given among them. The study highlighted how essential interactive learning material access was for the deprived children, how MathGALING filled the gap between and so much more. There, gender differences were even noted to influence engagement patterns - the game-based type that is much preferred in boys while females preferred working based on the group-learning system. Still another influencing factor of this sort is parental educational levels as it again forms even more significant expectations from this child of his and all-around support by both of his parents.

As a result, the study established a need for mathematics education that is critical, innovative and interactive in the kinds of environments it offers its learners. Therefore, outcomes are a leverage point through which educators, policymakers and curricula developers can begin with similar game-based approaches in learner engagement and enhancing numeracy skills towards total positive and successful learning among students. Although the limitations of the study, such as sample size and reliance on self-reported data, suggested that more studies were necessary, the findings formed a great basis for exploring further the long-term effects of game-based learning on numeracy skills.

ACKNOWLEDGMENT

We, the researchers, would like to express our sincerest gratitude to Dr. Rex Paulino, our Course Facilitator in FND 703, at the ISUFST School of Graduate Studies, for the great knowledge and steadfast support that has been the beacon of light in this research journey. We would also like to thank the participants for their dedication and willingness to share their experiences, making this study possible. Time and effort were essential for the illumination of the effects of MathGALING on numeracy skills and in developing a deeper understanding of the learning process. We are deeply in debt to Mrs. Karen Guavez whose insightful critiques and attention to detail significantly upgraded the quality and clarity of our research paper. Her academic acumen and passion for academic excellence left an indelible mark on our work.

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