International Journal of Multidisciplinary Research and Growth Evaluation.

Unlocking Mathematical Mastery: Game-Based Strategic Intervention Materials (G-Sims) For Grade Six Numeracy

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Article Info

ISSN (online): 2582-7138
Volume: 06
Issue: 03
May-June 2025
Received: 10-03-2025
Accepted: 12-04-2025
Page No: 193-198

Abstract
This study investigated the effectiveness of Game-Based Strategic Intervention Materials (G-SIMs) in enhancing numeracy skills among students. It aimed to evaluate the impact of G-SIMs on student performance and to determine whether significant differences existed between a control group and an experimental group before and after the intervention.
The study involved two groups - control and experimental - both assessed through pre-tests and post-tests to measure numeracy proficiency. Initially, both groups were at the Developing level, with 95% of students in each group. G-SIMs were integrated into the lessons of the experimental group, and student progress was analyzed using statistical tools, specifically p-values, to assess improvement.
Following the implementation of G-SIMs, the control group reached 100% in the Approaching Proficiency level, while the experimental group achieved 95% in Approaching Proficiency and 5% in the Advanced level. No significant difference was found in the pre-test performances ($p = 0.501$) or post-test performances ($p = 0.131$) between the two groups. However, both groups demonstrated statistically significant improvement: the control group increased from a mean score of 13.20 to 17.20 ($p = 0.000$), and the experimental group from 13.60 to 18.15 ($p = 0.000$).
These findings indicate that both groups began at comparable levels and showed substantial improvement after the intervention, with the experimental group exhibiting slightly greater gains. The study recommended the integration of G-SIMs into the mathematics curriculum, the provision of teacher training, and ongoing evaluation of its effectiveness. Further research is also encouraged to explore the long-term impact of G-SIMs and to develop additional game-based learning materials to enhance student outcomes.

DOI: https://doi.org/10.54660/.IJMRGE.2025.6.3.193-198

Keywords: Control group, Experimental group, Game-Based Learning Materials, Strategic Intervention Materials (SIMs)

1. Introduction

Mathematics plays a crucial role in shaping an individual's problem-solving abilities and analytical thinking, essential skills for navigating real-world challenges. However, despite its significance, Filipino students continue to struggle with mathematical proficiency, as evidenced by the 2022 PISA assessment results. With an average score of 355, far below the OECD average of 472, Filipino students demonstrate persistent difficulties in fundamental mathematical concepts and problem-solving skills. Alarmingly, only 16% of students reached at least Level 2 proficiency, the baseline required to effectively engage in everyday situations, compared to 69% across OECD countries. Furthermore, almost no students in the Philippines attained higher proficiency levels (Levels 5 or 6), reflecting a significant gap between Filipino learners and their international counterparts.
Studies indicate that conventional approaches to teaching mathematics, often characterized by lecture-heavy instruction,

contribute to students' negative attitudes and lack of motivation toward the subject (Balbawang & Felix, 2023). Many perceive mathematics as tedious, complex, and impractical, leading to anxiety, frustration, and disengagement (Mazana *et al*., 2019; Hu *et al*., 2018). In contrast, modern educational strategies emphasize interactive and game-based learning approaches to enhance engagement and comprehension. Game-based learning tools provide dynamic, technology-driven resources that make mathematical concepts more accessible, stimulating, and enjoyable for students (Clements & Wright, 2022).

Recognizing the urgent need for innovative teaching strategies, educators are integrating Game-Based Strategic Intervention Materials (G-SIMs) to address learning gaps and boost student performance. These materials align with scientific research, offering interactive instruction tailored to diverse learning styles, particularly for students struggling with mathematical proficiency.

At Cabilang Baybay Elementary School, the challenges faced by Grade Six students in mathematics reflect broader national trends. Many learners struggle with abstract mathematical concepts, leading to low confidence and declining interest. To tackle this issue, this study, titled "Unlocking Mathematical Mastery: Game-Based Strategic Intervention Materials (G-SIMs) for Grade Six Numeracy," aims to evaluate the effectiveness of G-SIMs in enhancing the numeracy skills of Grade Six students. By fostering active participation, competition, and rewards, G-SIMs offer a structured yet engaging learning environment, ultimately improving student comprehension and motivation in mathematics.

2. Method

The study used a quasi-experimental research design, selecting Grade 6 learners with the lowest pre-test scores. These students were divided into two groups: an experimental group, which received traditional lectures supplemented with Game-Based Strategic Intervention Materials (G-SIMs), and a control group, taught through conventional methods without G-SIMs. After instruction, both groups completed a post-test, and their results were compared to assess the effectiveness of G-SIMs in improving numeracy skills.

2.1 Research Problem

This study aimed to investigate the impact of game-based SIMs on numeracy skills enhancement among Grade six learners. Specifically, the authors sought to answer the following.

1.) The pre-test performances of the two groups group before utilizing the G-SIMs
   1.1 Controlled group
   1.2 Experimental group
2.) The post-test performances of the two groups after utilizing the G-SIMs?
   2.1 Controlled group
   2.2 Experimental group
3.) The significant difference in the pre-test performances of the controlled and experimental group before utilizing the G-SIMs
4.) The significant difference in the post-test performances of the controlled and experimental group after utilizing the G-SIMs
5.) The significant difference in the pre-test and post-test performances of the controlled and experimental group after utilizing the G-SIMs?
6.) The proposed action plan is based on the findings of the study.

2.2 Literature Review

Game-based learning (GBL) is widely recognized for its ability to make learning more engaging and effective, particularly in mathematics education. It has been demonstrated to improve students' motivation, engagement, and academic performance significantly. For example, Ke (2020) revealed that students using GBL tools displayed higher engagement and enhanced problem-solving skills compared to traditional instruction. Similarly, Cheung and Slavin (2021) [7], through a meta-analysis, confirmed GBL's superior effectiveness in boosting mathematics achievement over conventional teaching methods.

On the other hand, the development of game-based strategic intervention materials (G-SIMs) requires aligning game mechanics with learning objectives to optimize educational benefits. Plass, Homer, and Kinzer (2020) [17] underscored the importance of features like immediate feedback, scaffolded challenges, and opportunities for reflection in supporting deep learning. Additionally, Gee (2021) [10] highlighted the value of integrating narrative elements and collaborative tasks to enhance engagement and outcomes.

While GBL has been particularly effective in enhancing numeracy skills. Riconscente (2020) found that game-based interventions improved students' understanding and application of mathematical concepts. Tobias and Fletcher (2021) further illustrated how GBL supports foundational numeracy skills among elementary students, helping to bridge learning gaps.

Despite these benefits, GBL faces implementation challenges. Notable among these are unequal access to technology and the need for teacher training. Huizenga *et al*. (2022) emphasized the necessity of professional development programs to equip educators with the skills and confidence to integrate GBL effectively into their practice.

Empirical evidence supports GBL's effectiveness. Benito (2024) [14] demonstrated the positive impact of G-SIMs on Grade 8 students' performance, noting significant improvements from pretests to posttests. Paglomutan (2024) found game-based strategies effective in maximizing mathematics learning and retention for Grade 10 students. Similarly, Agbozo *et al*. (2023) reported enhanced academic performance in Junior High School students using game-based interventions, noting improved attitudes and outcomes compared to traditional methods.

Lastly, a systematic review by Erşen and Ergul (2022) revealed that the use of digital computer games in mathematics education is prevalent, particularly for secondary school students. These games, often associated with "numbers and operations," yielded predominantly positive results. Research trends indicate a preference for quantitative, experimental designs, and studies aiming to determine GBL's effects have grown in importance.

In conclusion, GBL and G-SIMs represent promising methods for enriching mathematics education by fostering interactive, engaging, and effective learning experiences. Continued exploration of long-term effects and best practices for diverse contexts will further cement its role in modern educational strategies.

3. Results

1. Pre-test Performance of the Two Groups before Utilizing the G-SIMs

Table 1 shows the pre-test performance of the two groups before utilizing the G-SIMs.

Table 1: Pre-test Performance of the Two Groups before Utilizing the G-SIMs

Score	Controlled Group		Experimental Group	
	F	%	F	%
Advance (26-30)	0	0	0	0
Proficient (21-25)	0	0	0	0
Approaching proficiency (16-20)	1	5	1	5
Developing (10-15)	19	95	19	95
Beginning (0-9)	0	0	0	0
Total	20	100	20	100

As reflected in Table 1, none of the learners in either group reached the Advanced or Proficient levels. In the Controlled Group, only one student (5%) fell under the Approaching Proficiency level, while the remaining nineteen students (95%) were at the Developing level. Similarly, in the Experimental Group, one student (5%) reached the Approaching Proficiency level and nineteen students (95%) were categorized as Developing. No students in either group were at the Beginning level.

These results indicated that the students from both groups demonstrated limited mastery of basic numeracy skills prior to the intervention. As cited in the study of Segarino *et al*. (2022), and based on Maruyama and Igei (2022), more than 80% of elementary school students lack proficiency in basic mathematical concepts, underscoring the urgent need for instructional reform. Posamentier and Smith (2020) emphasized that educators must possess strong content knowledge and effective pedagogical skills, particularly in adapting to the technological demands of modern education. Furthermore, Kozuka (2018) suggested that remedial interventions targeting computational skills can enhance students' overall mathematical understanding. The results supported this notion, revealing that students in both groups needed support to strengthen their foundational math skills.

2. Post-test Performance of the Two Groups after Utilizing the G-SIMs

Table 2 shows the post-test performance of the two groups before utilizing the G-SIMs.

Table 2: Post-test Performance of the Two Groups after Utilizing the G-SIMs

Score	Controlled Group		Experimental Group	
	F	%	F	%
Advance (26-30)	0	0	0	0
Proficient (21-25)	0	0	1	5
Approaching proficiency (16-20)	20	100	19	95
Developing (10-15)	0	0	0	0
Beginning (0-9)	0	0	0	0
Total	20	100	20	100

In the Controlled Group, none of the learners reached the Advanced or Proficient levels. All twenty students (100%) performed within the Approaching Proficiency level. No learners were recorded in the Developing or Beginning categories. This improvement may be attributed to the teacher's diligent efforts in thoroughly explaining the lesson using traditional teaching methods.

In contrast, the Experimental Group showed further progress. One learner (5%) achieved the Proficient level, while the remaining nineteen (95%) were categorized under Approaching Proficiency. Similar to the control group, no students fell within the Developing or Beginning levels. The slight edge in performance for the experimental group suggested that the Game-based Strategic Intervention Materials (G-SIMs) supported students' comprehension of mathematical concepts, leading to higher post-test scores.

The results reflected a clear improvement in learners' performance, with most students advancing from the Developing level in the pre-test to Approaching Proficiency or higher in the post-test. This indicates that the strategic intervention materials—composed of games, activities, and worksheets—were effective in addressing the least learned competencies in mathematics. The positive shift supports the idea that learners can attain higher levels of understanding when provided with engaging and well-structured remedial support.

These findings align with Schnepel and Aunio (2022), who emphasized that effective interventions must be well-organized, high in intensity, and adapted to the learners' current achievement level. Furthermore, Sison (2021) noted that strategic intervention materials are among the Department of Education's tools for remediation in subjects like Science, Technology, and Mathematics. As demonstrated in this study, the use of G-SIMs represents a viable and effective approach to enhancing both academic achievement and students' attitudes toward learning.

3. Difference in the Pre-test Performance of the Controlled and Experimental Group before Utilizing the G-SIMs

Table 3 shows the pre-test performance of the Controlled and Experimental Group before Utilizing the G-SIMs

Table 3: Difference in the Pre-test Performance of the Controlled and Experimental Group before Utilizing the G-SIMs

Group	Mean	t-test	p-value	Interpretation
Controlled group	13.20	-0.679	0.501	Not Significant
Experimental group	13.60			

Significance level @ 0.05

As presented in the table, the *p*-value of 0.501 exceeded the 0.05 level of significance, indicating that there was no statistically significant difference in the pre-test performance between the controlled and experimental groups before the intervention. This result suggested that both groups had comparable levels of numeracy skills at the start of the study. The similarity in baseline scores confirmed that any subsequent improvement in post-test scores could be attributed more confidently to the use of Game-based Strategic Intervention Materials (G-SIMs) rather than pre-existing differences between the groups.

Zhang (2022) [25] emphasized that students' anxiety toward mathematics was closely related to the instructional approaches used by their teachers. Similarly, Ismael *et al*. (2021) found that certain teacher behaviors—such as rapid pacing, excessive note-taking, overwhelming numbers of exercises, and punitive measures—contributed to increased levels of math anxiety. These findings highlight the need for

engaging and supportive instructional methods, such as G-SIMs, that foster better understanding and reduce anxiety in mathematics learning.

4. Difference in the Post-test Performance of the Controlled and Experimental Group after Utilizing the G-SIMs

Table 4: Difference in the Post-test Performance of the Controlled and Experimental Group after Utilizing the G-SIMs

Group	Mean	t-test	p-value	Interpretation
Controlled group	17.50	-1.542	0.131	Not Significant
Experimental group	18.15			

Significance level @ 0.05

As shown in the table, the *p*-value of 0.131 was greater than the 0.05 significance level, indicating that the difference in the post-test performances between the controlled and experimental groups was not statistically significant. Although the experimental group had a slightly higher mean score (18.15) compared to the controlled group (17.50), the difference was not large enough to establish a significant effect of the G-SIMs intervention.

This finding suggested that the use of Game-based Strategic Intervention Materials (G-SIMs) did not result in a statistically measurable improvement in the numeracy performance of the experimental group when compared to the group that received traditional instruction.

As cited by Balaba and Dioso (2023), the use of interactive games alone was found to be insufficient for significantly improving student performance. They emphasized that students benefit more when such tools are complemented by traditional lectures, which help them acquire and retain new knowledge. Furthermore, Saputri, Rukayah, and Indriaya (2018) explained that even when learning activities are engaging, students may still struggle to achieve higher performance if they lack adequate comprehension and retention skills. This highlights the importance of integrating varied instructional strategies to address different learning needs.

5. Difference in the Pre-test and Post-test Performance of the Controlled and Experimental Group after Utilizing the G-SIMs

Table 5: Difference in the Pre-test and Post-test Performance of the Controlled and Experimental Group after Utilizing the G-SIMs

A. Controlled group	Mean	t-test	p-value	Interpretation
Pretest	13.20	-11.181	0.000	Significant
Posttest	17.50			
B. Experimental group	**Mean**	**t-test**	**p-value**	**Interpretation**
Pretest	13.60	-17.757	0.000	Significant
Posttest	18.15			

Significant @ 0.05

As shown in the table, there was a significant difference in the pre-test and post-test performances of both the controlled and experimental groups after utilizing the G-SIMs.

Table 5A. The controlled group demonstrated a difference in their pre-test and post-test performances. The mean score for the pre-test was 13.20, while the post-test mean was 17.20. The *p*-value of 0.000 was less than the 0.05 significance level, indicating that the difference was statistically significant. Therefore, the null hypothesis was rejected. This finding proved that there was a significant improvement in the academic achievement of learners taught through traditional teaching methods in Mathematics. Traditional techniques were found to be highly effective. As noted by Castronova (2022), information retention through interactive games was at least comparable to, if not greater than, that achieved through traditional instructional approaches.

Table 5B. The experimental group also showed a notable difference in the academic achievement of learners. The mean pre-test score was 13.60, while the post-test mean rose to 18.15. The resulting *p*-value of 0.000 was likewise less than the 0.05 significance level, which indicated a statistically significant improvement. Thus, the null hypothesis was also rejected for the experimental group. This confirmed that the use of Game-based Strategic Intervention Materials (G-SIMs) significantly improved the learners' academic performance in Mathematics.

Interactive games and instructional materials enhanced self-reliance among learners by enabling educators to develop and customize their own content. This autonomy allowed for greater control over instructional delivery compared to traditional settings and potentially led to improved test outcomes. These findings aligned with the conclusions of Sadsad (2022), who affirmed the effectiveness of Strategic Intervention Materials (SIMs) within the Philippine educational context. SIMs were shown to be valuable tools that helped teachers address students' academic difficulties and promote higher-quality instruction. As emphasized by Kitto *et al*. (2020), the primary objective of SIMs was not only to address immediate academic needs but also to support students in achieving a deeper and more personalized understanding, ultimately fostering lifelong learning.

6. Proposed action plan based on the findings of the study

Rationale

The researcher designed an action plan aimed at improving learners' academic performance in numeracy using game-based strategic intervention materials (G-SIMs). Based on the pre-test and post-test findings, the study variables were confirmed, prompting the researcher to formulate the action plan centered on indicators with the lowest weighted mean. Given that the three identified variables demonstrate moderate correlation, the action plan prioritizes the indicators that received minimal focus, addressing them as key areas of concern.

Action Plan

Mathematics Application Technique in Helping Learners Increase Numeracy Knack (MATHLINK) through G-SIMs

GOAL: Considering the result of the study, this action plan, "Mathematics Application Technique in Helping Learners Increase Numeracy Knack (MATHLINK) through G-SIMs" could enhance learners' numeracy skills by employing innovative teaching techniques and strategies. It aims to bridge gaps in mathematical understanding, improve proficiency in fundamental operations, and foster confidence in applying numeracy skills to real-world scenarios. This approach could also focus on personalized learning methods to cater to diverse learner needs and preferences.

Table 6

Activities	Objectives	Strategies	Persons involved	Time frame	Funds	Success indicator
Inclusion of SIMs in regular Mathematics Class	To strengthen learner's knowledge and skills in mathematics literacy and	Review of the Curriculum for possible integration of SIMs	School Head Teachers Learners	Quarterly SY 2025-2026	School Fund or MOOE	95% of the learners gained knowledge and developed skills in Mathematics literacy.
Organization of Seminar, Workshop and Trainings on game-based SIMs	To refresh the teacher's knowledge strategies and skills on game-based SIMs	Conduct seminars and workshop on game-based SIMs	School Head Mathematics Teachers	Semestral Break SY 2025-2026	School Fund or MOOE	95% of the teachers attended and refreshed on game-based SIMs.
Orientation of Teachers about game-based SIMs evaluation materials	To re-orient teachers on evaluation tools for game-based SIMs.	Conduct refresher lecture or seminar on SIMs evaluation tools	School Head Mathematics Teachers	School-based LAC Session or FGD SY 2025-2026	School Fund or MOOE	95% of the teachers attended the seminar and gained more insights about SIMs assessment tools.
Incorporation of game-based SIMS to regular Math lessons	To sustain the learners' acquisition of knowledge and development of numeracy	Incorporate game-based SIMs in daily lesson plans	School Head Mathematics Teachers Learners	SY 2025-2026	School Fund or MOOE	95% of teachers incorporated g-SIMs in regular Math lessons while learners acquired knowledge and skills.

4. Discussion

The following were the significant and salient findings of the study:

1. The Pre-test Performance of the Two Groups before Utilizing the G-SIMs
   Both groups were high at the Developing level, with a frequency of 19 and a percentage of 95%.
2. The Post-test Performance of the Two Groups after Utilizing the G-SIMs

Both groups were high at the Approaching Proficiency level, with a frequency of 20 and a percentage of 100% in the controlled group. In the experimental group, there was one learner at the Advance level, with a frequency of 1 and a percentage of 5%, while 19 learners (95%) were at the Approaching Proficiency level.

1. Difference in the Pre-test Performance of the Controlled and Experimental Group before Utilizing the G-SIMs

There was no significant difference between the pre-test performances of the controlled and experimental groups before utilizing the G-SIMs. The probability value of 0.501 was greater than the 0.05 significance level.

2. Difference in the Post-test Performance of the Controlled and Experimental Group after Utilizing the G-SIMs

There was no significant difference between the post-test performances of the controlled and experimental groups after utilizing the G-SIMs. The probability value of 0.131 was greater than the 0.05 significance level.

3. Difference in the Pre-test and Post-test Performance of the Controlled and Experimental Groups after Utilizing the G-SIMs

There was a significant difference in the pre-test and post-test performances of both the controlled and experimental groups after utilizing the G-SIMs. For the controlled group, the mean pre-test score was 13.20, and the post-test score was 17.50. As a result, the *p*-value of 0.000, being less than the 0.05 significance level, indicated that the decision was significant.

For the experimental group, the mean pre-test score was 13.60, and the post-test score was 18.15. The *p*-value of 0.000, also less than the 0.05 significance level, indicated that the decision was significant.

4. An action plan was developed to enhance or improve the learners' academic performance in numeracy using game-based strategic intervention materials (G-SIMs).

5. Conclusion

The study concludes that both the controlled and experimental groups had comparable skill levels before utilizing Game-Based Strategic Intervention Materials (G-SIMs). After intervention, both groups showed significant improvement, with the experimental group displaying slightly greater progress. However, the difference in post-test results was not statistically significant, suggesting that G-SIMs and traditional methods had similar effects on student performance. Despite this, G-SIMs were found to be effective in reinforcing numeracy skills, contributing to meaningful learning gains. The study recommends implementing the proposed action plan to further enhance learners' mathematical proficiency.

6. Recommendation

The study recommends integrating game-based SIMs (G-SIMs) into the curriculum to improve students' numeracy skills, with school heads playing a key role in monitoring lesson plans, providing teacher training, and assessing the effectiveness of these interventions. Teachers should actively incorporate and modify G-SIMs to cater to diverse learning styles and needs, ensuring an inclusive and engaging educational experience. Administrators are encouraged to require the implementation of the proposed action plan with continuous evaluation to maximize its impact. Researchers should further explore the long-term effects of G-SIMs, identify the most effective game-based strategies, and develop new intervention materials that integrate with other educational technologies to enhance learning outcomes. These efforts collectively aim to create a more dynamic and effective approach to mathematics education.

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