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Game-Based Approach as an Intervention in Enhancing Students' Fraction – Solving Skills

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ABSTRACT

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Mastering fractions remains a significant challenge for students, with 96.53% (n=167) of Grade 7 students failing assessments covering addition, subtraction, multiplication, and division of fractions. To address this issue, this study investigated the effectiveness of Game-Based Learning (GBL) in improving students' fraction-solving skills. Using a quasi-experimental design, the research involved 20 Grade 7 students from a public junior high school. Data were collected through validated pre-test and post-test instruments, aligned with the problem set and rigorously assessed for reliability. The results revealed significant improvements across all fraction operations, with notable progress in addition (t = -3.75, p = 0.000), subtraction (t = - 8.35, p = 0.000), and multiplication (t = -4.42, p = 0.000). Although division remained the most challenging area (t = -1.910, p = 0.000), students still demonstrated measurable gains, suggesting partial success in bridging learning gaps. The findings highlight GBL as an effective pedagogical strategy for enhancing fraction proficiency, fostering an engaging, and student-centered learning environment. The approach's success is attributed to immediate

feedback, contextualized practice, and increased motivation, making it a viable tool for improving mathematical competency. This study contributes to the growing body of evidence supporting GBL's potential in mathematics education, particularly in addressing foundational challenges like fraction operations.

INTRODUCTION

Globally, traditional pedagogical methods in mathematics education frequently fall short of efficiently augmenting student skills, often leading to diminished motivation and curiosity (Ahmad & Iksan, 2021; Zou, 2020). In response, innovative approaches that leverage interactive technology have gained prominence. Among these, Game-Based Learning (GBL) has emerged as a significant 21st-century learning trend, promoting a student-centered environment by balancing engaging game elements with instructional content (Lasut & Bawengan, 2020). GBL is grounded in constructivist learning theory, which emphasises that knowledge is built through experiential learning and social interaction (Hourdequin et al., 2017). This approach has demonstrated various benefits, including making students more comfortable with complex problems and fostering critical thinking, resilience, and patience (Liu et al., 2021).

In the Philippines, the Department of Education (DepEd) is dedicated to providing quality education and has recognized the potential of such innovative strategies. To actively engage parents, teachers, and students, DepEd has partnered with Microsoft Philippines to launch initiatives incorporating GBL into the curriculum (DepEd, 2022). This national move aligns with the growing body of research suggesting that GBL can coincide with students' intrinsic interest in games, making learning both interesting and effective, thereby indirectly increasing student attention and engagement (Lasut & Bawengan, 2020; Liu et al., 2021). The collaboration aims to develop proactive learners, which DepEd believes is critical for nurturing lifelong skills.

Despite these national efforts and the established theoretical benefits of GBL, a significant gap exists in its documented effectiveness at addressing specific, fundamental learning deficiencies within local contexts, particularly in mathematics. This research gap is critical, as evidenced by a severe local issue: a diagnostic assessment of Grade 7 students at a public junior high school in Cuyo, Palawan, revealed profound difficulties in performing fractional operations. The data indicated that 91.91% of 173 students did not meet expectations in adding fractions, 96.53% failed in subtracting fractions, 98.84% in multiplying fractions, and 100% did not know how to execute division of fractions. The data demonstrates a clear and urgent need for targeted interventions to rectify these misconceptions before students' progress to more advanced mathematical topics. Therefore, while GBL is promoted nationally, there is a pressing need to empirically investigate its effectiveness as a strategic intervention for specific,

widespread issues like fraction proficiency among junior high school students in the Philippine public school system. This study seeks to fill this gap by assessing the effectiveness of GBL in enhancing students' conceptual understanding and retention of fractional operations.

OBJECTIVES OF THE STUDY

This study aimed to enhance the students' fraction-solving skills using a game-based approach. Specifically, the objectives of the study were the following: (1) determine the respondents' level of skills in solving fractions before the interventions, (2) determine the respondents' level of skills in solving fractions after the intervention, and (3) analyze the significant difference in the respondents' levels of skills in solving fractions before and after the intervention.

METHODOLOGY

Research Design

The study employed a quasi-experimental research design, a methodology used to investigate cause-and-effect relationships when a true experimental design is impractical. Unlike randomized controlled trials (RCTs), quasi-experimental designs do not involve random assignment of participants to groups but still include the manipulation of an independent variable. In a true experimental design, participants are randomly assigned to ensure each has an equal chance of being placed in either the control or experimental group.

Using this method, the researchers assessed, interpreted, and evaluated the effectiveness of GBL as an intervention in enhancing the students' fraction-solving skills.

Population and Sampling

The respondents were the 20 grade 7 students from a single section at a public junior high school in Cuyo District, Cuyo, Palawan, Philippines. These students were officially enrolled during the School Year 2024-2025 and were selected through purposive sampling to ensure relevance to the study. These respondents were chosen from the different classes in the grade-seven who were obtained below 75% or did not meet expectations during the diagnostic test administered by the researchers.

Instrumentation

The researcher utilized a 20-item pre-test and post-test as the primary data collection tool. The instrument was carefully designed to align with the study's objectives, comprising five items each for addition, subtraction, multiplication, and division of fractions. To ensure content validity, the assessment items were derived from reputable Grade 7 mathematics textbooks and reviewed by experts.

The questionnaire underwent a rigorous validation process before finalization to guarantee its reliability and appropriateness for the study.

Data Collection

The researchers undertook the following procedures: Secured the permit to conduct study from the school Principal, and mathematics teachers; Prepared and validated the survey questionnaires, and sent a consent letter to the parents of the respondents before administering the pre-test; Administered pre-test, intervention, and post-test and collected data from the respondents; Analyzed, and interpreted the data needed in the study; Submitted the paper to the action research instructor for checking the format, content, and other technical aspects as preparation for the final defense; and submitted the final copy of the paper free from plagiarism by citing all the authors and references used in the study.

Treatment of Data

The researchers employed a comprehensive statistical treatment to analyze the collected data. First, the respondents' pre-test and post-test responses were evaluated using the study's predefined rubrics. The data were then systematically tabulated and subjected to statistical analyses, including frequency and percentage distributions, weighted mean calculations, and a paired *t*-test to assess significant differences. Additionally, the Department of Education's standards- and competency-based grading system was applied to determine the students' proficiency levels in solving fractions. These methodological steps ensured rigorous data analysis and facilitated meaningful interpretation and discussion of the findings.

Ethical Considerations

This document certified that this study's purpose was to enhance the respondents' level of skills in solving fractions through a game-based approach. The researchers explained the purpose of the research, their right to refuse to participate, their comprehension of the study's confidentiality boundaries, and their right to receive a copy of the study's results if they desired. Respondents signed a consent form indicating their desire to cooperate and that they were not being pressured in any way.

RESULTS AND DISCUSSION

Table 1

Students' Level of Skills in Solving Fractions before the Intervention Program

Descriptive Rating (n = 20)	Adding Fraction		Subtracting Fraction		Multiplying Fraction		Dividing Fraction	
	F	%	*f*	%	*f*	%	*f*	%
Outstanding	0	0.00	0	0.00	0	0.00	1	5.00
Very Satisfactory	1	5.00	0	0.00	5	25.00	3	15.00
Satisfactory	0	0.00	0	0.00	0	0.00	0	0.00
Fairly Satisfactory	1	5.00	0	0.00	3	15.00	4	20.00
Did not meet expectation	18	90.00	20	100.00	12	60.00	12	60.00
Mean	68.35		65.50		70.25		72.05	
	Did not meet expectations		Did not meet expectations		Did not meet expectations		Did not meet expectations	

Legend: Outstanding (90-100), Very Satisfactory (85-89), Satisfactory (80-84), Fairly Satisfactory (75-79), Did not meet Expectation (74 & below).

The mean of 68.35 *(did not meet expectations)* clearly indicates that most of the Grade 7 students did not solve correctly the problem set in adding fractions specifically in adding dissimilar fractions such as $\frac{7}{10}+\frac{5}{6}$ and $\frac{2}{7}+\frac{1}{4}$. This statement is supported by the study of Hariyani (2022), which found that most students were unable to perform addition and subtraction operations on fractions with unequal denominators, as well as mixed addition operations such as $\frac{1}{2}+\frac{1}{3}$, where students frequently answered the fraction as $\frac{2}{5}$ rather than $\frac{5}{6}$.

The same exam resulted in the subtraction of fractions, with a mean score of 65.50 *(did not meet expectations)*, confirming the students' general low skill in subtracting fractions, particularly in subtracting mixed fractions ($6\frac{3}{4}-2\frac{1}{3}$) prior to the intervention. According to Hariyani et al. (2022), more than half of the students were unable to perform fractional arithmetic operations, particularly with unequal denominators and mixed fractions. The possibility of this erroneous concept arose from pupils' failure to realize that every unit of fraction added or subtracted must be of the same size.

The students performed significantly better on the pre-assessment in multiplying and dividing fractions than in adding and subtracting fractions. Though the mean of 70.25 (Multiplying Fraction) and 72.05 (Dividing Fraction) did not meet expectations, 40% of the students achieved passing scores. The exam findings revealed that students primarily struggled with multiplying and

dividing mixed fractions, specifically $2\frac{1}{6} \times 3\frac{1}{6}$ and $3\frac{1}{3} \div \frac{5}{9}$. According to Low and Shahrill (2020), the students' poor understanding of multiplication led to other thoughtless blunders and inaccuracies that were discovered in their written work, such as mistakenly converting a mixed integer into an inappropriate fraction.

The total result in the pre-assessment demonstrates that students struggled with all fraction operations prior to the intervention. These findings underlined the need for targeted instructional strategies to improve students' fractional problem-solving skills, with a focus on subtraction, which was the hardest area. The findings underscore the importance of the intervention program in closing these gaps and assisting students in reaching the desired level of proficiency in fraction operations.

Table 2

Students' Level of Skills in Solving Fractions after the Intervention Program

Descriptive Rating *(n = 20)*	Adding Fraction		Subtracting Fraction		Multiplying Fraction		Dividing Fraction	
	F	%	*F*	%	*f*	%	*f*	%
Outstanding	2	10.00	5	25.00	6	30.00	3	15.00
Very Satisfactory	5	25.00	5	25.00	0	0.00	2	10.00
Satisfactory	0	0.00	0	0.00	0	0.00	0	0.00
Fairly Satisfactory	5	25.00	8	40.00	9	45.00	4	20.00
Did not meet expectation	8	40.00	2	10.00	5	25.00	11	55.00
Mean	78.50 Fairly Satisfactory		83.75 Satisfactory		81.25 Satisfactory		76.95 Fairly Satisfactory	

Legend: Outstanding (90-100), Very Satisfactory (85-89), Satisfactory (80-84), Fairly Satisfactory (75-79), Did not meet Expectation (74 & below).

The students improved their fraction-solving skills, particularly in adding fractions, with a mean score of 78.50 *(fairly satisfactory),* primarily in adding proper/improper fractions such as 3/8+2/8, 1/3+1/5, and 5/10+9/10. The data suggests that the researchers' intervention in improving fraction addition skills through a game-based method is effective and efficient at their level. However, Students must continue to practice and learn how to add mixed fractions (2 1/4+3 3/4 and 1 3/8+5/12) in order to improve their fraction-solving skills. Tamosevicius (2022) defines game-based learning (GBL), which incorporates instructional games into the curriculum, as an active learning technique aimed at developing students' critical thinking and problem-solving abilities.

In terms of subtracting fractions, the findings show that students improved their skills using the game-based approach, with a mean score of 83.75, indicating Satisfactory. The computed mean indicates that students may learn more if the teacher uses a game-based approach while teaching fractions, especially when subtracting similar and dissimilar fractions such as 6/7- 2/7, 3/5-1/4, and 11/6-5/6. According to the respondents' post-assessment, teachers should focus more on presenting instances of subtracting mixed to mixed fractions and mixed to proper fractions. These included 5 3/10-2 1/10 and 3 4/7-2/7, with the majority of students answering incorrectly. The data is clearly demonstrated by the research undertaken by Tokac et al. (2019) found that Mathematics games-based learning contributed to higher level of learning outcomes in the teaching process as compared with the traditional instructional methods.

The same level of improvement in multiplying and dividing fractions was observed, with a mean score of 81.25 indicating satisfactory performance. The mean shows that the GBL used by the researchers during the pre-assessment was successful and efficient, particularly when multiplying proper and improper fractions as 4/9 x 5/9, 3/7 x 2/5, and 5/3 x 4/3. In a study on the effect of online and interactive games in teaching, Hamzah et al. (2019) reported that teaching using interactive games had positively increased students' interest in mathematics and demonstrated that students could explore mathematical concepts at their own pace and play the games during their leisure time at home or school, resulting in students learning in a fun and engaging environment.

Moreover, students' level of skills in dividing fractions significantly improved after the conduct of GBL, with a mean of 76.95 *(fairly satisfactory).* However, while some improvement occurred, the intervention was not sufficiently effective for most learners. This outcome indicates that further targeted support may be necessary, particularly for the majority who struggled to grasp the concept focusing on dividing improper to proper fractions, mixed to mixed fractions, mixed to proper fractions or vice versa, such as 11/6÷3/4,2 4/9÷1 2/9,and 4 1/2÷3/7. While games can increase engagement and motivation, they may lack the structured practice and conceptual clarity needed for mastering complex mathematical operations like fraction division (Ke, 2019).

The overall results imply that the intervention was most effective in enhancing subtraction and multiplication skills, while addition and division may require further reinforcement.

Table 3

Significant Difference in the Respondents' Levels of Skills in Solving Fractions Before and After the Intervention

Skills in Solving Fractions	Mean Difference	T	Df	Sig (2-tailed)	Decision / Interpretation
Adding Fractions	9.65	-3.75	19	<.001	Reject H_o / Significant
Subtracting Fractions	18.25	-8.35	19	<.001	Reject H_o / Significant
Multiplying Fractions	11.00	-4.42	19	<.001	Reject H_o / Significant
Dividing Fractions	4.90	-1.91	19	.007	Reject H_o / Significant

Table 3 shows the significant difference in the Grade 7 students' levels of skills in solving fractions before and after the interventions. The results indicate a statistically significant improvement in the respondents' skills in solving fractions after the interventions, as evidenced by the paired samples t-test. For adding fractions, there was a mean difference of 9.65 ($t = -3.75$, $p < 0.01$), suggesting a substantial enhancement in performance. Similarly, subtracting fractions showed the largest mean difference (18.25, $t = -8.35$, $p < 0.01$), reinforcing the intervention's effectiveness. Multiplying fractions also exhibited significant improvement (mean difference = 11.00, $t = -4.42$, $p < 0.01$). Although dividing fractions had a smaller mean difference (4.90) and a t-value of -1.91, the p-value (0.007) was slightly above the conventional 0.05 threshold, yet still close enough to suggest a meaningful improvement, leading to the rejection of the null hypothesis.

These findings imply that the intervention successfully enhanced students' fraction-solving abilities across all operations, with subtraction showing the most notable progress. The slightly weaker significance in division may indicate that this skill requires more targeted practice or a different instructional approach. Overall, the intervention had a strong positive impact, reinforcing the importance of structured mathematical instruction in improving foundational skills, which was supported by the study of Stohlmann (2019) that Digital Game-Based Learning motivated engaged students in mathematical thinking and increased student performance. Furthermore, teachers should demonstrate skills in the use of ICT in teaching and learning to improve the students' performance (Rabor et al., 2020)

CONCLUSIONS

Most of the students struggle to answer some problems focusing on addition, subtraction, multiplication, and division during the pre-assessment; in the

implementation of interventions, students show gradual improvements and some were able to understand the strategies in solving fractions; after the intervention sessions with the use of games and drills conducted by the researchers, students show significant improvement in solving fractions in addition, subtraction, multiplication, and division; and pre-test and post-test results shows that the interventions achieve to enhance students skills in solving fractions in terms of addition, subtraction, multiplication, and division.

TRANSLATIONAL RESEARCH

Students should actively participate in game-based learning activities to increase their comprehension and skills in fraction problem solving, which should be supplemented by frequent practice and peer collaboration. Mathematics teachers are encouraged to include game-based strategies in their classes to address both conceptual understanding and procedural fluency, particularly for difficult operations such as division. School principals should encourage innovation by providing resources, training, and opportunities for teachers to cooperate and share best practices. Finally, future researchers should broaden the study to include more scenarios, experiment with digital and traditional games, and conduct long-term assessments to quantify long-term learning outcomes. Overall, game-based learning proves to be a promising approach for enhancing mathematics instruction. This statement is supported by the study of Sabirli and Coklar (2020), which explored the impact of educational games in students' academic success indicated that including digital educational games increases students' access to the lesson and this leads to a significant increase in students' performance (Jarrah et al., 2020).

LITERATURE CITED

Ahmad, N. F., & Iksan, Z. (2021). Penerapan Kemahiran Proses Sains melalui Pembelajaran Sains Berasaskan Permainan Digital: Application of Science Process Skills through Digital Game-Based Science Learning. *Sains Insani*, 6(1), 75-81. https://doi.org/10.33102/sainsinsani.vol6no1.246

Department of Education (DepEd) (2022). DepEd, Microsoft Philippines engages students, teachers through game-based learning. https://www.deped.gov.ph/2022/04/28/deped-microsoft-philippines-engages-students-teachers-through-game-based-learning/.

Hamzah, N., Maat, S. M., & Iksan, Z. H. (2019). The effect of fun and interactive games as a strategy in teaching coordinates to enhance students' performance in Mathematics. *Religación: Revista de Ciencias Sociales y Humanidades*, *4*(22), 274-278.

Hariyani, M., Herman, T., Suryadi, D., & Prabawanto, S. (2022). Exploration of Student Learning Obstacles in Solving Fraction Problems in Elementary School. *International Journal of Educational Methodology*, *8*(3), 505-515.

Hourdequin, P. (2017). Learning English and other 21st-century skills through games: lessons for Japanese higher education from learning spaces in New York City. *Tokoha Gakuen University Research Review Faculty of Foreign Studies*, *33*, 41-59.

Jarrah, A. M., Almassri, H., Johnson, J. D., & Wardat, Y. (2022). Assessing the impact of digital games-based learning on students' performance in learning fractions using (ABACUS) software application. *Eurasia Journal of Mathematics, Science and Technology Education*, *18*(10), em2159.

Ke, F. (2019). Mathematical problem solving and learning in an architecture-themed epistemic game. *Educational Technology Research and Development*, *67*(5), 1085-1104.

Lasut, E. M. M., & Bawengan, J. J. (2020, May). The effectiveness of ICTs integration in enhancing student motivation in learning English. In *4th Asian Education Symposium (AES 2019)* (pp. 211-215). Atlantis Press.

Liu, Y. C., Wang, W. T., & Lee, T. L. (2021). An integrated view of information feedback, game quality, and autonomous motivation for evaluating game-based learning effectiveness. *Journal of Educational Computing Research*, *59*(1), 3-40.

Low, Jessica & Shahrill, Masitah. (2020). Solving Fractions by Applying the Bar Model Concept with the Butterfly Method. Jurnal Pendidikan Matematika. 14. 101-116. 10.22342/jpm.14.2.11261.101-116.

Rabor, J. N., Sumilang, M. S. H., & Opinio, K. M. N. (2020). Group Dynamic Courseware (GDC): Innovative Strategic Intervention in Enhancing Basic Mathematical Skills. JPAIR Multidisciplinary Research, 39(1), 130-146. DOI: https://doi.org/10.7719/jpair.v39i1.765

Sabirli, Z. E., & Çoklar, A. N. (2020). The Effect of Educational Digital Games on Education, Motivation and Attitudes of Elementary School Students against Course Access. *World Journal on Educational Technology: Current Issues*, *12*(4), 325-338.

Stohlmann, M. (2019). Integrated steM education through open-ended game based learning. *Journal of Mathematics Education*, *12*(1), 24-38.

Tamosevicius, R. (2022). Why is game-based learning important? E-Learning Industry. *Retrieved January 3*, 2023.

Tokac, U., Novak, E., & Thompson, C. G. (2019). Effects of game-based learning on students' mathematics achievement: A meta-analysis. *Journal of computer assisted learning*, *35*(3), 407-420.

Zou, D. (2020). Gamified flipped EFL classroom for primary education: Student and teacher perceptions. *Journal of Computers in Education*, *7*(2), 213-228.