

Enhancing Grade 5 Learners' Performance in Division Through Computer- Based Games: An Explanatory Sequential Study

¹Rinalyn G. Ventura, ²Arnel A. Agustin

¹Dupax del Norte Central School, ²Nueva Vizcaya State University
rinalyn.ventura@deped.gov.ph

Article Details:

Received: 21 April 2026
Revised: 30 April 2026
Accepted: 6 May 2026
Published: 12 May 2026
Corresponding Email:
rinalyn.ventura@deped.gov.ph

Recommended Citation:

Ventura, R. G., Agustin, A. A. (2026). Enhancing Grade 5 Learners' Performance in Division Through Computer- Based Games: An Explanatory Sequential Study. *The International Review of Multidisciplinary Research*. 1 (5), 423-429. <https://doi.org/10.5281/zenodo.20143487>

Index Terms:

computer- based games, division skills, game- based learning, learner engagement, Mathematics performance

Abstract. This study investigated the effectiveness of computer-based games in improving the mathematics performance of Grade 5 learners in dividing whole numbers, including money with and without remainder (M5NS-Ie-f-11), and in solving routine and non-routine problems involving division using appropriate strategies at Dupax del Norte Central School during the School Year 2025–2026. Employing a mixed methods explanatory sequential design, the study combined quantitative and qualitative approaches to obtain a comprehensive understanding of learners' academic performance and learning experiences. A total of 89 Grade 5 learners were selected through purposive sampling. The quantitative data from pretest and post- test were analyzed using descriptive statistics of frequency, percentage, mean, standard deviation, paired t-test, while the qualitative data from the answer of open-ended items were analyzed using thematic analysis. Findings revealed that learners initially demonstrated low and inconsistent performance in division, as reflected in the pretest mean score of 64.54 and the high variability of scores. Following the implementation of computer-based games, learners' performance improved significantly, with the posttest mean increasing to 80.80 and score distribution becoming more consistent. Statistical analysis further confirmed a significant difference between the pretest and posttest results, indicating the effectiveness of the intervention. Qualitative findings also showed that learners became more engaged, motivated, and interested in mathematics activities through the use of interactive games. Some learners, however, had problems with cognitive difficulty, technical problems, and instructions during the game. The study findings indicated that computer games can be used effectively in developing the division ability, involvement, and conceptual understanding of learners, provided they are used in conjunction with suitable learning aids and proper teaching.

Introduction

Mathematics has been considered to be the basic building block of elementary learners since mastery of the four fundamental operations is the basic building block of elementary learners. Division is the only unique and complex among these as it demands learners to combine multiplication facts, place value understanding and procedural accuracy. However, lack of competence in this area typically feeds into a vicious circle of frustrated and frustrated effort in higher order matters like fractions and algebra. Challenges in learning simple operations at the elementary level are cumulative as Bernardo (2019) argues that learners will continue to lag to the higher levels of mathematics.

On a larger scale, Filipino students have a high- performance gap as indicated by international tests. The 2022 results of PISA indicated that Philippines scored an average of 355 points, which is very low compared to the OECD average of 472. Although there have been several reforms in education, the traditional forms of educating the learners such as rote memorization no longer seem to capture the attention of the modern learners. As pointed out by Aguhayon et al. (2023), these traditional methods are no longer entirely applicable to the requirements of digital-native learners, and Delgado and Kassim (2019) reported that Filipino learners experience moderate levels of mathematics anxiety. While the study did not

directly examine instructional factors, previous research suggests that highly repetitive exercises and an emphasis on correctness over exploration may contribute to increased anxiety among learners.

In dealing with such problems, teachers are resorting to technology-enhanced learning. Kiili et al. (2018) mention that active learning in a game-based environment involves immediate feedback and adaptive challenges. Similarly, Lashley (2017) discovered that the computer-aided instruction (CAI) technique was proven to be the best technique for enhancing the students' mathematical performance than the traditional method. Computer based games are also known to stimulate intrinsic motivation, as well as performance. Using rewards and challenges, gamification has the ability to keep people engaged and increase their confidence to address complex problems (Hamari et al., 2016; Su and Cheng, 2015).

Digital tools are also used to improve social and individualized learning. According to Moon and Ke (2020) digital games can encourage peer interaction and participation of students in the classroom. Furthermore, as mentioned by Papastergiou (2019) and Tokac et al. (2019), the tools are designed to meet the differentiated learning needs because the student works at his/her own speed. Furthermore, this approach can change the student attitudes so that mathematics no longer feels so scary and so unpleasant.

On the local level, educators at Dupax del Norte Central School have been complaining of an ongoing battle with the facts of division among Grade 5 students. Recent findings by Esguerra et al. (2025) confirmed that division is a major academic challenge, which is often characterized by conceptual and procedural errors. Although international literature enhances gamified learning, there is lack of localized, intervention-based, evidence on Filipino learners. This paper seeks to fill this gap by examining the effect of computer- based games on learning division to give empirical data that will enhance both classroom practice and educational policy.

Research Questions

This study sought to answer the following questions:

1. What is the level of performance of the respondents in division of whole numbers before the use of computer-based games?
2. What is the level of performance of the respondents in division of whole numbers after the use of computer-based games?
3. Is there a significant difference in the performance of the respondents in division of whole numbers before and after exposure to computer-based games?
4. How do learners describe their challenges while utilizing computer- based games to learn division of whole numbers as a basis for enhancement of the intervention?

Null Hypothesis of the Study

There is no significant difference in the performance of the respondents in division of whole numbers before and after exposure to computer-based games.

Theoretical / Conceptual Framework

This research is fundamentally based on the Constructivist Theory of learning as developed by Jean Piaget (1970) and Lev Vygotsky (1978), which argues that learners actively construct knowledge in meaningful experiences and not through passive absorption. The digital environment, in the context of computer-based games is a microworld where a learner can manipulate mathematical concepts, test hypotheses and construct conceptual understanding of division through trial and error. The concept of the Zone of Proximal Development (ZPD) by Vygotsky is particularly applicable, as educational games offer the needed scaffolding, or hints, gradual difficulty, and interactive tools which allow Grade 5 students to bridge the gap between what they can do independently and what they can achieve with the help of digital resources.

In line with this is the Behaviorist Theory by B.F. Skinner (1953), which highlights the importance of reinforcement and immediate feedback in the shaping of the learning outcome. The computer-based games employ these concepts by offering instantaneous results, scores, and rewards that serve as positive reinforcement to the correct procedural use of division. This instant feedback mechanism is vital in the process of correcting misconceptions in real-time before the errors are solidified in the form of fossilization and entrenched errors.

Moreover, the paper combines Cognitive Load Theory and Self-Determination Theory to deal with the psychological impediments to numeracy. Computer-based games can minimize the extraneous cognitive load that can easily result in math anxiety. At the same time, the elements of the gamification as described by Su and Cheng (2015) such as the level of

autonomy in the choice of the levels and the competence that it will provide through the high scores would contribute to the intrinsic motivation. These theories make sure that the digital play will make an otherwise intimidating subject engaging and cognitively accessible.

In this study, an Input-Process-Output (IPO) paradigm was used to offer a systematic flow of the intervention. Input phase: the computer-based games and certain learning competencies in division, namely, dividing whole numbers and solving routine and non-routine problems. The Process entails the systematic use of the pretests, the use of the computer-based games, posttests and analysis of the quantitative data and qualitative interviews on the experience of the pupils. Finally, the Output is the improved performance of Grade 5 students in division competencies and development of a refined computer-based game intervention to teach division.

Methodology

The study employed a mixed-methods explanatory sequential design, combining both quantitative and qualitative methods to thoroughly assess the intervention. The initial phase utilized a quasi- experimental pretest-posttest design to measure the effect of computer-based games on Grade 5 learners to divide whole numbers and money (specifically the ability to solve routine/non-routine problems involving whole numbers and money). The second stage followed and applied the qualitative method based on the interviews to investigate the challenges respondents' face while using the intervention. The design offers to present a balanced view of the impact of the digital intervention by first measuring academic gains, and then detailing the findings based on pupil challenges.

Research Environment

The research was conducted at Dupax del Norte Central School a state-run school in Nueva Vizcaya that serves diverse student population with diverse socio-economic backgrounds. Being one of the high-performing schools in its district, it balances the traditional instruction with an increased integration of the digital tools in accordance with the Department of Education requirements. The existing school mathematical excellence and the availability of the computer facilities were a perfect setting in which the researcher could implement and observe the computer-based game intervention.

Respondents

Table 1 showed the frequency and percentage distribution of the respondents in terms of gender.

Section	Male	Female	Total
Masikap	14	16	30
Masunurin	13	17	30
Mapitagan	15	14	29
Total	42	47	89

Table 1. Frequency Distribution of Pupil Respondents by Section and Gender

Sampling Procedure

To achieve a comprehensive representation, all 89 Grade 5 learners at Dupax del Norte Central School during the 2025-2026 school year, the study utilized purposive sampling in the quantitative phase. After the quantitative analysis, a sub-group of 15 learners who had received the lowest pre-test scores were purposely chosen to participate in the qualitative phase. The selection enabled a focused exploration of the particular difficulties experienced by the struggling learner, thus increasing the depth of the statistical results, according to the explanatory sequential design.

Research Instrument

The study utilized two instruments aligned with the research objectives. The quantitative phase involved 20 item pre- and post-tests, which were aligned to the Grade 5 Mathematics MELCs, to ensure conceptual alignment. Student performance was categorized using the DepEd scale: Outstanding (90–100%), Very Satisfactory (85–89%), Satisfactory (80–84%), Fairly Satisfactory (75–79%), and Did Not Meet Expectations (Below 75%). The qualitative phase involved a semi-structured interview guide that was given to 15 purposively selected learners who showed low scores in the pre-test in order to explore specific learning difficulties.

Data Gathering Procedure

The 20-item Mathematics tests and interview guides were developed and were subjected to expert validation and reliability testing. After getting the required confirmation of the school principal, the pre-test was done on 89 Grade 5 learners, as a performance baseline. The interactive computer-based games provided the respondents with plenty of time to play the game, and finally complete the post-test to determine their division skills. The ethical considerations were strictly adhered to: the participation was facilitated with the help of the purposive selection, and the qualitative data collection among the bottom 15 performers was carried out through face-to-face interviews until the data saturation was achieved to ensure the credibility and dependability of the findings.

Statistical Treatment of Data

The data were analyzed by descriptive and inferential statistics to determine the effect of the computer-based games. Mean and standard deviation was used to describe the level of performance of the Grade 5 learners in the pre-test and post-test. The significant difference between the scores that were obtained on the test before the intervention and after the intervention was determined using a Paired t-test, with all inferences being tested at a significant level of 0.05. Moreover, thematic analysis was used to define and classify trends based on the qualitative interviews on the difficulties faced by the learners.

Results and Discussion

Problem 1. Level of performance of the respondents in division of whole numbers before the use of computer-based games.

Performance Level	Frequency	Percentage
Outstanding	19	21.84
Very Satisfactory	7	8.05
Satisfactory	7	8.05
Fairly Satisfactory	8	9.20
Did Not Meet Expectations	46	52.87
Mean		64.54
Standard Deviation		26.97
Qualitative Description		Did not Meet Expectation

Table 2. Frequency, Percentage, Mean, Standard Deviation and Qualitative Description of the Respondents' Level of Performance in Division of Whole Numbers Before the Use of Computer- based Games

Table 2 showed that most of Grade 5 learners had difficulty with division before the intervention with 52.87% not performing to expectations. Only 21.84% performed outstandingly, which contributes to an overall mean score of 64.54, which is lower than the expected performance at the grade level. The large standard deviation of 26.97 indicates that there was a wide gap in the performance of the students, meaning that although a few students had high skills, majority of the students struggled with the basic concepts. This low and heterogeneous performance is consistent with the existing literature and theories, including Cognitive Load Theory, that traditional instructional patterns may not adequately support the various conceptual and procedural requirements of learners in learning complex division operations.

Problem 2. Level of performance of the respondents in division of whole numbers after the use of computer-based games.

Performance Level	Frequency	Percentage
Outstanding	35	40.23
Very Satisfactory	8	9.20
Satisfactory	11	12.64
Fairly Satisfactory	12	13.79
Did Not Meet Expectations	21	24.14
Mean		80.80
Standard Deviation		16.33
Qualitative Description		Satisfactory

Table 3. Frequency, Percentage, Mean, Standard Deviation and Qualitative Description of the Respondents' Level of Performance in Division of Whole Numbers After the Use of Computer- based Games

Table 3 showed a significant improvement in achievement following the intervention, with the “Outstanding” category becoming the largest group at 40.23% (35 pupils). The qualitative level of the posttest mean score was rated as “Satisfactory” at 80.80 and the standard deviation reduced to 16.33, showing a more even performance pattern and a tighter achievement difference. Although 24.14% of learners still did not meet expectations, the data reflect an overall positive outcome, suggesting that the interactive and scaffolded nature of the computer-based games effectively enhanced individual mastery.

Problem 3. Significant difference in the performance of the respondents in division of whole numbers before and after exposure to computer-based games.

Test	Mean	Std Deviation	Mean Diff	t	p-value	Remarks
Pretest	64.54	26.97	-16.26	-9.52	<.001	Significant
Posttest	80.80	16.33				

Table 4. Analysis of Difference in the Performance of the Respondents in Division of Whole Numbers Before and After Exposure to Computer-based Games

Table 4 indicated that there was a statistically significant difference for division with the mean score increasing from 64.54 to 80.80, thereby giving a statistically significant gain of 16.26. A t-value of -9.52 and a p-value of <.001 justified the rejection of the null hypothesis, thus demonstrating a meaningful impact of the intervention. Furthermore, the decrease in standard deviation from 26.97 to 16.33 indicates that learners’ performances became more consistent and the achievement gap narrowed. The findings suggested that the use of computer-based games in teaching is effective for strengthening the competence of procedural fluency and conceptual understanding, as the students will get instant feedback and it will also make the process less cognitively demanding, so that even the trickiest mathematical operations can be mastered by the students by using computer-based games that are well structured.

Problem 4. Respondents’ challenges in utilizing the intervention

The qualitative data was thematically analyzed and four main challenges were highlighted that affected the learners’ experience of the computer-based games. Despite an overall performance increase to a mean of 80.80, 24.14% of learners still struggled due to cognitive difficulties involving multi-step procedures, remainders, and word problems. Technical and interface difficulties, such as unfamiliarity with the mouse and keyboard, further contributed to performance variations by shifting the learners’ focus from mathematics to technology. Moreover, the time pressure of quick timers caused frustration and guesswork, and there was confusion when the instruction was not clear enough and it was disappearing too quickly. Based on results, timers should be made flexible, interfaces should be streamlined, and instructions should be made more explicit and scaffolded to meet the needs of different learners for future interventions.

Conclusion and Recommendations

Based on the findings, the following conclusions were derived: (1) Prior to the intervention, learners demonstrated below-standard and highly varied performance in division of whole numbers. This indicated weak conceptual understanding and suggested that traditional teaching methods were not fully addressing learners’ diverse needs, highlighting the need for more engaging and learner-centered strategies. (2) The use of computer-based games was effective in improving learners’ division skills, as shown by increased performance and a more consistent distribution of scores. The intervention demonstrated that computer- based game learning enhanced both achievement and engagement, supporting meaningful learning in mathematics. (3) The results proved that both conceptual and procedural skills could be reinforced by the use of technology-based and interactive approaches. (4) Computer-based games improved learners’ engagement and performance but did not guarantee full mastery of division concepts. Learners still struggled with complex tasks such as remainders, large numbers, and word problems, and were also affected by technical issues and unclear instructions. The results implied that the success of the intervention relies on the appropriate guidance, pacing, and instruction support.

Recommendations

1. Teachers are encouraged to integrate computer-based games in Mathematics lessons to enhance learners’ interest and improve their understanding of division. These should be combined with explicit instruction, scaffolding, guided practice, and repeated exercises on multi-step and word problems to strengthen both procedural and conceptual skills.

2. Administrators are encouraged to ensure the implementation of game-based learning by ensuring sufficient digital equipment, software, and reliable internet access. They may also conduct training programs for teachers and collaborate with curriculum developers and game designers to ensure that educational games are user-friendly, have adjustable timers, and include clear instructions suited to diverse learners.
3. Learners are encouraged to actively participate in computer-based games as an additional tool for learning division, maximizing features such as immediate feedback and repetitive practice. They ought to utilize them wisely with the guidance of teachers or parents with emphasis on learning concepts and not in rushing to accomplish tasks.
4. The intervention may be further improved by refining the computer-based games based on learner feedback and observed challenges. Enhancements may include clearer instructions, a simpler interface, adjustable timers, and increased scaffolding for complex division tasks to improve accessibility, engagement, and learning outcomes.
5. Future researchers are encouraged to investigate the long-term efficacy of computer-based interventions by different topics and grade levels, and the integration of digital tools within collaborative learning and teacher-guided strategies to further enrich the process of learner knowledge and engagement.

Acknowledgement

The researcher expresses sincere gratitude to Nueva Vizcaya State University College of Teacher Education (NVSU-CTE) for its research agenda support, to the Schools Division Office of Nueva Vizcaya, to the administrators and teachers of Dupax del Norte Central School, and to all respondents who generously participated in the data collection and implementation phases of this explanatory sequential research.

Funding

This research received no external funding from any public, commercial, or not-for-profit funding agency, and no organization provided financial support for the conduct of the study, authorship, or publication of this article.

Competing Interests Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study; all data used were obtained from previously published sources as cited in the reference list.

References

- Aguhayon, H. G., Tingson, R. D., & Pentang, J. T. (2023). Addressing students' learning gaps in mathematics through differentiated instruction. *International Journal of Educational Management and Development Studies*, 4(1), 69–87. <https://doi.org/10.53378/352967>
- Bernardo, A. B. I. (2020). Socioeconomic status moderates the relationship between growth mindset and learning in mathematics and science: Evidence from PISA 2018 Philippine data. *International Journal of School & Educational Psychology*, 9(2), 208–222. <https://doi.org/10.1080/21683603.2020.1832635>
- Delgado, K. D. D., & Kassim, S. R. (2019). Mathematics anxiety among young Filipino learners: Investigating the influence of gender and socio-economic status. *Science International (Lahore)*, 31(3), 575–579. [ERIC Record](https://eric.ed.gov/?id=EJ1200000)
- Esguerra, M. M., Labadan, C. B., & Comon, J. D. (2025). Barriers on mathematics performance among learners in West districts of Cagayan de Oro City Division. *American Journal of Arts and Human Science*, 4(2), 115–129. <https://doi.org/10.54536/ajahs.v4i2.4253>
- Hamari, J., Shernoff, D., Rowe, E., Coller, B., & Edwards, T. (2016). Challenging games help learners learn: An empirical study on engagement, flow, and immersion in game-based learning. *Computers in Human Behavior*, 54, 170–179. <https://doi.org/10.1016/j.chb.2015.07.045>
- Kiili, K., Moeller, K., & Ninaus, M. (2018). Evaluating the effectiveness of a game-based rational number training: In-game metrics as learning indicators. *Computers & Education*, 120, 13–28. <https://doi.org/10.1016/j.compedu.2018.01.012>
- Lashley, L. (2017). The effects of computer-aided instruction in mathematics on the performance of Grade 4 pupils. *SAGE Open*, 7(3). <https://doi.org/10.1177/2158244017712775>

- Moon, J., & Ke, F. (2020). *Exploring the relationships among middle school students' peer interactions, task efficiency, and learning engagement in game-based learning*. *Simulation & Gaming*. <https://doi.org/10.1177/1046878120907940>
- Papastergiou, M. (2019). Exploring the potential of computer and video games for health and physical education: A literature review. *Computers & Education*, 53(3), 603–622. <https://doi.org/10.1016/j.compedu.2009.04.001>
- Piaget, J. (1970). *Genetic epistemology*. Columbia University Press.
- Programme for International Student Assessment. (2018). *PISA 2018 results (Volume I): What students know and can do*. OECD Publishing. <https://doi.org/10.1787/5f07c754-en>
- Skinner, B. F. (1953). *Science and human behavior*. Macmillan.
- Su, C. H., & Cheng, C. H. (2015). A mobile gamification learning system for improving learning motivation and achievement. *Journal of Computer Assisted Learning*, 31(3), 268–286. <https://doi.org/10.1111/jcal.12088>
- 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. <https://doi.org/10.1111/jcal.12347>
- Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Appendices

No appendices are attached to this study.