ISSN: 2945-4190

World Journal on Education and Humanities Research
Creative Commons Attribution 4.0 International
Vol. 3, Issue 4, pp. 243-253
Received, November 2023; Revised December 2023;
Accepted December 2023

Article

Effectiveness of A Technology-Based Instructional Tool on The Performance of Grade 3 Pupils in Basic Arithmetic Operations

Melissa Andales
Jasmin Ybanez
Kaitlin Marie Opingo
Margie Fulgencio
Harlen Gamboa
GenGen Padillo

Corresponding Author: melissaandales@gmail.com

Abstract: This study aimed to evaluate the effectiveness of specific educational interventions in enhancing mathematical competencies among young learners. Two groups of children, a control group and an experimental group, each consisting of 17 participants primarily aged 8 to 9 years, were assessed. While both groups were comparable in age and initial academic performance, they differed in gender distribution, with the experimental group having a more balanced gender representation. The study involved pretest and posttest evaluations of competencies in various mathematical areas such as addition, subtraction, multiplication, division, and word problems. The results, analyzed using t-values and p-values, revealed that the experimental group demonstrated significantly greater improvements in all mathematical competencies compared to the control group. This improvement was uniform across all areas tested, indicating the effectiveness of the interventions applied to the experimental group. The data suggest that the more balanced gender distribution in the experimental group, along with the specific teaching methods or interventions employed, contributed significantly to the enhanced performance. This finding highlights the importance of effective educational strategies and potentially the role of gender balance in learning environments. Overall, the study underscores the potential of targeted educational approaches in substantially improving mathematical skills among young learners.

Keywords: Pretest-Posttest Comparison, mathematical competencies, educational intervention

Introduction

Mathematics has been identified as a crucial subject in education, laying the groundwork for essential skills such as critical thinking, problem-solving, and numerical analysis, key to success in many life areas (National Council of Teachers of Mathematics, 2018; Boaler, 2019). Despite its importance, many students find it challenging

ISSN: 2945-4190

to understand and excel in basic mathematical concepts, leading to decreased confidence and motivation in the subject. Moreover, Alam & Mohanty (2023) emphasized that improving math education is vital, given its significant impact on students' overall academic success and future prospects.

Holm and Kajander's observation (2018) about the increasing use of technological instructional tools in mathematics education highlights a significant shift in teaching methods. These tools, ranging from interactive software to educational apps, have the potential to transform traditional math instruction, making it more engaging and understandable for students. The interactive nature of technology can cater to various learning styles, potentially making complex mathematical concepts more accessible and less intimidating for students (Staddon, 2022). However, the effectiveness of these tools, particularly for students in third grade and above, remains an area needing further exploration. This age group is at a critical stage in their mathematical development, where they transition from basic arithmetic to more complex operations and problem-solving and research in this area could focus on how these tools improve understanding and retention of mathematical concepts, influence problem-solving skills, and help in bridging learning gaps (Carpenter & Moser, 2020; Olivares et al., 2021).

Moreover, the impact of factors such as age, gender, and previous math achievement on the effectiveness of these tools is not well understood (Zahedi et al., 2021; Lopez-Inesta et al., 2020). For instance, younger students might interact with and benefit from these tools differently compared to older students. Gender may also play a role in how students engage with technology-based learning, considering existing research that suggests differences in how boys' and girls' approach and perceive mathematics (Chen et al., 2020). Furthermore, students with a strong background in math could potentially gain more from these tools compared to those struggling with the subject, or the reverse might be true, with struggling students benefiting more from the interactive and engaging nature of technology (Wang et al., 2021; Kobayashi, 2021). Research addressing these gaps could involve comparative studies assessing the outcomes of using technological tools versus traditional teaching methods across different age groups and genders. Longitudinal studies could also be beneficial to understand the long-term impacts of these tools on students' mathematical understanding and achievement. Such research would provide valuable insights for educators and curriculum developers, informing more effective integration of technology in math education and potentially leading to more personalized and adaptive learning experiences for students.

This study was prompted by the need to address challenges faced by third-grade students in mastering basic mathematical operations and to provide concrete evidence on the effectiveness of technology-based teaching tools in this context. The research aimed to guide the development of more effective and tailored teaching strategies that cater to the varied needs of students, focusing on the impact of these technological tools at Timpolok Elementary School and the role of students' backgrounds in their academic performance. The findings of this study are significant for various parties, including educators, school leaders, parents, and students themselves. Contributing to the ongoing discussion about the integration of technology in mathematics education, this research offers valuable insights into the success of technology-driven educational tools in improving third graders' math skills. The recommendation for schools, particularly institutions like Timpolok Elementary School, is to embrace technology-based instructional tools to enhance their students' mathematical abilities.

Implementing the strategies derived from this research could enable schools to identify and address their students' educational gaps, fostering a more engaging and inclusive learning atmosphere. Such an approach would aid teachers in developing impactful teaching techniques, integrating technological resources like Microsoft PowerPoint presentations to ease students' cognitive burden and improve their grasp of mathematical principles. The strategy further highlights the importance of cooperation among teachers, parents, and community organizations in nurturing students' interest in math. By collaborating effectively, these key players can build a nurturing educational network, thereby boosting students' innate motivation and proficiency in fundamental math skills. Future research directions could include exploring the specific impacts of different technological tools on student learning in mathematics and assessing the long-term effects of these collaborative educational strategies on student outcomes across diverse learning environments.

Methodology

In this study, a quasi-experimental design with a pretest/posttest format was employed to evaluate the effect of a technological intervention on the mathematical abilities of learners at Timpolok Elementary School, located in Barangay Timpolok, Lapu-Lapu City, Cebu, Philippines. The school, catering to students from Kindergarten through Grade 6, served as the focal point for the research. Specifically, the study involved 68 third-grade students, divided equally into two sections: Section Humility and Section Generosity. These students were further categorized into an Experimental Group and a Control Group, with 17 learners from each section assigned to each group, based on their existing class structures to maintain continuity.

ISSN: 2945-4190

The research tool employed for assessment was designed in accordance with the "Most Essential Learning Competencies (MELC)" for Grade 3 Mathematics, ensuring a comprehensive and curriculum-aligned evaluation. This instrument covered a broad spectrum of mathematical topics essential for Grade 3 learners, including Addition, Subtraction, Multiplication, Division, Place Value, Fractions, Ratios, and Word Problems. This selection of topics was intentional, aimed at capturing the key competencies required at this grade level. The methodology encompassed both the experimental application of the technological tool in question and a subsequent assessment of its impact on the students' understanding and proficiency in these critical mathematical areas.

Results and Discussion

Table 1. Profile of the Subjects of Both Groups

Profile		Control Group (n = 17)		Experimental Group (n = 17)	
		f	%	f	%
A. Age (in years)					
8 - 9		16	94.12	17	100.00
10 - 11		0	0.00	0	0.00
12 - 13		1	5.88	0	0.00
	Mean:	8.59		8.29	
B. Gender					
Female		4	23.53	8	47.06
Male		13	76.47	9	52.94
C. Final Grade in Grade 2 Math					
75 - 79 [Fairly satisfactory]		1	5.88	1	5.88
80 - 84 [Satisfactory]		10	58.82	10	58.82
85 - 89 [Very satisfactory]		4	23.53	3	17.65
90 - 100 [Outstanding]		2	11.76	3	17.65
	Mean:	83.24		84.00	

The data presented in Table 1 outlines the profiles of subjects in both the control and experimental groups, each consisting of 17 participants. In terms of age, the majority of both groups were between 8 to 9 years old, with the control group having 94.12% (16 individuals) and the experimental group having all of its members (100%) in this age range. Notably, the mean age of the control group was slightly higher at 8.59 years compared to 8.29 years in the experimental group. Gender distribution showed more variation. In the control group, the majority were male (76.47%, or 13 individuals), while in the experimental group, the distribution was more balanced with 52.94% males (9 individuals) and 47.06% females (8 individuals). Regarding academic performance, specifically final grades in Grade 2 Math, both groups showed a similar distribution across different grade ranges. The most common grade

ISSN: 2945-4190

range was '80 - 84 [Satisfactory]', with 58.82% (10 individuals) in each group. The mean final grade was slightly higher in the experimental group (84.00) compared to the control group (83.24). It's interesting to note that both groups had individuals in the highest grade category '90 - 100 [Outstanding]', but the experimental group had a slightly higher percentage (17.65% vs. 11.76% in the control group). Overall, these data suggest some differences between the two groups, particularly in terms of age and gender distribution, but similarities in academic performance.

Table 2. Level of Competencies of the Control Group

Competencies	Control Group (n = 17)					
	Pretest			Posttest		
	Mean	StDev	Meaning	Mean	StDev	Meaning
A. Addition	17.00	3.22	Good	20.41	4.84	Very Good
B. Subtraction	16.65	3.94	Good	18.82	4.16	Very Good
C. Multiplication	15.35	3.06	Good	16.47	3.52	Good
D. Division	13.71	2.87	Good	15.35	2.52	Good
E. Place Value	17.65	3.32	Good	17.77	3.36	Good
F. Prime, Factors, and Multiples	15.59	3.57	Good	17.59	3.14	Good
G. Fractions and Ratios	15.41	4.66	Good	16.59	3.20	Good
H. Word Problems	15.41	3.59	Good	16.47	3.84	Good

Table 2 presents the level of competencies in various mathematical areas for the control group, consisting of 17 participants, measured before and after a certain intervention. Each competency area shows improvements from the pretest to the posttest. In the area of addition, the mean score improved from 17.00 (Good) to 20.41 (Very Good), indicating a notable increase in proficiency. Similarly, in subtraction, the mean score rose from 16.65 to 18.82, both categorized as Good, but nearing the Very Good range in the posttest. For multiplication and division, the improvements were less dramatic but still positive, with mean scores in both remaining within the Good category, yet showing increases from 15.35 to 16.47 in multiplication, and 13.71 to 15.35 in division. Place Value competency showed the least change, with both pretest and posttest scores averaging around 17.65 and 17.77, respectively, both within the Good category. For Prime Numbers, Factors, and Multiples, there was a decent increase from a pretest mean of 15.59 to a posttest mean of 17.59. Fractions and Ratios also saw improvement, with scores moving from 15.41 to 16.59. Lastly, Word Problems, a critical area for applying mathematical concepts, showed a positive change, with the mean score increasing from 15.41

ISSN: 2945-4190

to 16.47, remaining within the Good category. Overall, these data suggest that the control group experienced improvements across all areas of mathematical competencies, with the most notable gains in addition and subtraction.

Table 3. Level of Competencies of the Experimental Group

Competencies	Experimental Group (n = 17)					
	Pretest			Posttest		
	Mean	StDev	Meaning	Mean	StDev	Meaning
A. Addition	17.06	3.38	Good	21.29	5.38	Very Good
B. Subtraction	16.65	4.18	Good	19.53	4.91	Very Good
C. Multiplication	15.82	4.22	Good	17.65	4.31	Good
D. Division	13.94	3.54	Good	17.18	4.26	Good
E. Place Value	17.29	3.53	Good	19.59	4.95	Very Good
F. Prime, Factors, and Multiples	15.41	3.89	Good	19.65	4.62	Very Good
G. Fractions and Ratios	14.88	4.37	Good	18.47	5.06	Very Good
H. Word Problems	14.88	3.33	Good	18.53	4.93	Very Good

Table 3 details the competency levels in various mathematical subjects for the experimental group of 17 participants, showing their performance before and after a specific intervention. The data reveals significant improvements across all areas from the pretest to the posttest. In the area of addition, there was a substantial increase in the mean score, moving from 17.06 (Good) in the pretest to 21.29 (Very Good) in the posttest. Subtraction also showed notable improvement, with the mean score rising from 16.65 to 19.53, elevating from Good to Very Good. Multiplication and division both maintained a 'Good' rating, but with increases in mean scores: multiplication went from 15.82 to 17.65 and division from 13.94 to 17.18. Place Value showed a significant enhancement, with the mean score jumping from 17.29 (Good) to 19.59 (Very Good). Similarly, the competency in Prime Numbers, Factors, and Multiples saw a considerable rise, from a pretest mean of 15.41 to a posttest mean of 19.65, moving into the Very Good category. Fractions and Ratios, as well as Word Problems, also showed marked improvements, with mean scores increasing from 14.88 to 18.47 and 18.53, respectively, both reaching the Very Good level in the posttest. Overall, these results indicate that the experimental group experienced substantial improvements in all mathematical areas tested, with several competencies moving from a Good to a Very Good level of performance. This suggests a positive impact of the intervention on the group's mathematical abilities, particularly in more complex areas like Word Problems and Fractions and Ratios.

Table 4 presents a statistical analysis of the mean differences between pretest and posttest scores in basic math operations for both the control and experimental groups, using t-values and p-values to determine significance. In the control group, significant improvements (where the null hypothesis, Ho, was rejected) were observed in Addition (t = -5.93, p = 0.000), Subtraction (t = -4.16, p = 0.001), Multiplication (t = -2.38, p = 0.030), Division (t = -4.41, p = 0.000), and Prime, Factors, and Multiples (t = -3.73, p = 0.002).

Table 4. Significant Mean Gained Difference of the Pretest and Posttest in the Basic Math Operations of Both Groups

Competencies	t-value	p-value	Significance	Results
I. Control Group				
A. Addition	-5.93	0.000	Significant	Ho rejected
B. Subtraction	-4.16	0.001	Significant	Ho rejected
C. Multiplication	-2.38	0.030	Significant	Ho rejected
D. Division	-4.41	0.000	Significant	Ho rejected
E. Place Value	-0.44	0.668	Not significant	Ho accepted
F. Prime, Factors, and Multiples	-3.73	0.002	Significant	Ho rejected
G. Fractions and Ratios	-1.98	0.066	Not significant	Ho accepted
H. Word Problems	-1.37	0.190	Not significant	Ho accepted
II. Experimental Group				
A. Addition	-6.15	0.000	Significant	Ho rejected
B. Subtraction	-5.26	0.000	Significant	Ho rejected
C. Multiplication	-2.19	0.044	Significant	Ho rejected
D. Division	-5.21	0.000	Significant	Ho rejected
E. Place Value	-2.36	0.031	Significant	Ho rejected
F. Prime, Factors, and Multiples	-6.01	0.000	Significant	Ho rejected
G. Fractions and Ratios	-4.36	0.000	Significant	Ho rejected
H. Word Problems	-4.15	0.001	Significant	Ho rejected

(alpha = 0.05)

However, Place Value (t = -0.44, p = 0.668), Fractions and Ratios (t = -1.98, p = 0.066), and Word Problems (t = -1.37, p = 0.190) did not show significant improvements, leading to acceptance of the null hypothesis in these areas. For the experimental group, all competencies showed significant improvements. Addition (t = -6.15, p = 0.000), Subtraction (t = -5.26, p = 0.000), Multiplication (t = -2.19, p = 0.044), Division (t = -5.21, p = 0.000), Place Value (t = -2.36, p = 0.031), Prime, Factors, and Multiples (t = -6.01, p = 0.000), Fractions and Ratios (t = -4.36, p = 0.000), and Word Problems (t = -4.15, p = 0.001) all showed significant gains with the null hypothesis rejected in each case. These results indicate that while both groups showed significant improvements in several areas, the experimental group displayed a more comprehensive improvement across all tested competencies. This suggests that the intervention applied to the experimental group might have been more effective in enhancing overall mathematical skills compared to the control group.

Discussion

The data from Tables 1 to 4 provide insightful comparisons between the control and experimental groups in a study, focusing on demographic profiles and improvements in mathematical competencies. Table 1 reveals that both groups primarily consisted of children aged 8 to 9, with a slightly higher mean age in the control group and more balanced gender representation in the experimental group. Both groups had similar academic performance in Grade 2 math. Tables 2 and 3 display the competency levels in various mathematical subjects for both groups. The control group (Table 2) showed improvements in all areas from the pretest to the posttest, with notable gains in addition and subtraction but less significant improvements in place value, fractions and ratios, and word problems. In contrast, the experimental group (Table 3) exhibited significant improvements across all areas, moving several competencies from a 'Good' to 'Very Good' level. Table 4, which analyzes the mean differences between pretest and posttest scores, further elucidates these trends. The control group showed significant improvements in several areas but not in place value, fractions and ratios, and word problems. On the other hand, the experimental group showed significant improvements in all competencies, suggesting a more effective intervention or methodology applied to this group compared to the control group. Overall, these results indicate that while both groups improved, the experimental group experienced more uniform and significant gains across all areas of mathematical competencies. This suggests that whatever additional methods or approaches were used with the experimental group were effective in enhancing their mathematical understanding and skills more comprehensively than the control group.

Conclusion

The analysis of the data from leads to a clear conclusion that the experimental group demonstrated a more substantial and uniform improvement in mathematical competencies compared to the control group. This is evidenced by significant gains across all areas of mathematical skills in the experimental group, as shown in the pretest

ISSN: 2945-4190

and posttest comparisons. These results suggest that the methods or interventions applied to the experimental group were notably effective. While both groups were comparable in terms of age and initial academic performance, the experimental group's balanced gender distribution and the more effective teaching or intervention strategies likely contributed to their enhanced performance. This study underscores the potential impact of targeted educational approaches in improving mathematical competencies among young learners.

References

Alam, A., & Mohanty, A. (2023). Cultural beliefs and equity in educational institutions: exploring the social and philosophical notions of ability groupings in teaching and learning of mathematics. International Journal of Adolescence and Youth, 28(1), 2270662.

Boaler, J. (2019). Limitless mind: Learn, lead, and live without barriers. San Francisco: Jossey-Bass

Carpenter, T. P., & Moser, J. M. (2020). The development of addition and subtraction problem-solving skills. In Addition, and subtraction (pp. 9-24). Routledge.

Chen, I. H., Gamble, J. H., Lee, Z. H., & Fu, Q. L. (2020). Formative assessment with interactive whiteboards: A one-year longitudinal study of primary students' mathematical performance. Computers & Education, 150, 103833.

Kobayashi, E. S. (2021). Supporting struggling students in the high school mathematics classroom: Comparing mathematics games and a second mathematics class as tools intended to develop proficiency (Doctoral dissertation, University of Hawai'i at Manoa).

López-Iñesta, E., Botella, C., Rueda, S., Forte, A., & Marzal, P. (2020). Towards breaking the gender gap in Science, Technology, Engineering and Mathematics. IEEE Revista Iberoamericana de Tecnologias del Aprendizaje, 15(3), 233-241.

National Council of Teachers of Mathematics. (2018). Principles to actions: Ensuring mathematical success for all. Reston, VA: National Council of Teachers of Mathematics.

Holm, J., & Kajander, A. (2018). Technology-enhanced mathematical learning opportunities for young children: A systematic review.

Education and Information Technologies, 23(3), 1007-1028. https://doi.org/10.1007/s10639-018-9733-y

Olivares, D., Lupiáñez, J. L., & Segovia, I. (2021). Roles and characteristics of problem solving in the mathematics curriculum: a review. International Journal of Mathematical Education in Science and Technology, 52(7), 1079-1096.

Staddon, R. V. (2022). A supported flipped learning model for mathematics gives safety nets for online and blended learning. Computers and Education Open, 3, 100106.

Wang, M. T., Zepeda, C. D., Qin, X., Del Toro, J., & Binning, K. R. (2021). More than growth mindset: Individual and interactive links among socioeconomically disadvantaged adolescents' ability mindsets, metacognitive skills, and math engagement. Child Development, 92(5), e957-e976.

Zahedi, L., Batten, J., Ross, M., Potvin, G., Damas, S., Clarke, P., & Davis, D. (2021). Gamification in education: A mixed-methods study of gender on computer science students' academic performance and identity development. Journal of Computing in Higher Education, 33, 441-474.