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Technological Pedagogical Strategies in the Improvement of Basic Functions and Management of Mathematical Operations

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Abstract

This study aimed to analyze the contribution of techno-pedagogical strategies in strengthening mastery in mathematical multiplication with students at the basic elementary level in Ecuador. The post-positivist paradigm, quantitative approach, quasi-experimental and comparative design was used, with pre-test and post-test to 4 groups (A, N, B and G) of 30 students each. The first A was the control and the remaining three N, B and G, the experimental ones. During the pre-test, the groups received training through demonstration strategies in the classroom, exercises and teamwork, evaluated with a knowledge test of ten exercises with true and false options. The following week (post-test), group A received reinforcement with the same strategies, while the others received it simultaneously in separate classrooms, with different teachers, using technological strategies based on the tools Nearpod, Blooket and Genially, to be evaluated again using the same strategy. The results indicate that for group A, there were no significant differences between the median scores ($p \geq 0.05$) while, in the remaining groups, a significant improvement was observed ($p = 0.000$), where group B, using the Blooket resource, reflected a greater increase in the median score. It is concluded that these resources can be integrated as pedagogical strategies and significantly favor the mastery of the basic mathematical function in multiplication and specifically with the use of Blooket, highlighting the importance of technological innovation in educational training.

Keywords: *Techno-Pedagogical Strategy, Reinforcement, Mathematical Multiplication, Teaching, Educational Training.*

Introduction

Currently, the education system faces a significant challenge due to students' academic performance, which continues to be affected by the global pandemic's impact, especially with the return to in-person classes (Cortés-Albornoz et al., 2023). This situation led to a limited development of cognitive skills in mathematics, where effective interaction between teachers and students was constrained by the application of emerging methods (Alban Conto et al., 2021). In this sense, the lack of widely applied strategies and somewhat improvised academic reinforcement activities proved to be minimally effective (Holik et al., 2023). In the context of educational processes, the challenges for learning demanded more committed support from both the home and the school foundations.

In this regard, educational challenges are addressed with the goal of improving academic performance by adopting a focus on educational and technological innovation. Consequently, there is a recognized need to incorporate technological resources as a key strategy to enhance and reform the educational process, with a particular focus on solving mathematical exercises intended for basic elementary level students. This approach is grounded in the principles of equity and the aspiration to promote quality education.

This technological progression is not limited to the virtual sphere but is also significantly integrated into specific areas such as mathematics, even from an early age. The provision of tools is seen as a means to facilitate and provide feedback on students' skills and abilities in this specific area. The recognition of the increasing application of technology from an early age in the field of mathematics highlights the importance of emphasizing that technological resources play a crucial role in strengthening teaching and learning processes (Ainul Maulid bin Ahmad et al., 2023).

The convergence of technological evolution and early mathematics education has suggested a promising approach to enrich the educational experience and improve academic outcomes. However, the implementation of digital environments in education has presented substantial challenges, particularly in

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terms of equity and technological accessibility. In this context, technology played a crucial role in maintaining the teaching and learning process during the pandemic, facilitating a significant shift towards virtual education (Molnar et al., 2022).

This transition has required adaptation from both teachers and students to a new mode of study, which involves designing learning strategies and methodologies based on various digital platforms, tools, and resources. These had been used, albeit optionally, in some institutions that were moving towards a growing digital education approach for nearly a decade (Núñez-Naranjo & Chancusig-Toapanta, 2022).

Despite the efforts made, the pandemic caused a significant disruption in the academic training process in Latin America for the vast majority of educational institutions. By November 2021, approximately 71 million children and adolescents in the region were affected by school closures. The government efforts to implement distance learning modalities were, at that time, insufficient (Cortés-Albornoz et al., 2023).

In the Ecuadorian context, this reality was no less concerning; the health crisis and social distancing led to an unprecedented emergency marked by a period of mandatory confinement. In response, the Ministry of Education of Ecuador chose to transition to virtual teaching, creating a substantial impact on the educational system (Beck, 2023; Montalvan-Chamba et al., 2022). However, this adaptation proved to be a considerable challenge, as the vast majority of educators were not adequately prepared to handle this modality in a non-presential environment (Ibda et al., 2023).

To address the educational disruption at the national level, the educational plan named "Aprendamos Juntos en Casa" was implemented, a crucial initiative by the Ministry of Education of Ecuador (Ministerio de Educación del Ecuador, 2020). As part of this strategy, weekly educational worksheets were distributed as study guides, using widely accessible communication channels such as WhatsApp or email to reach students. Simultaneously, teachers turned to virtual platforms like Zoom, Classroom, and Meet to conduct online classes.

In this direction, Cifuentes et al. (2021) and Abdullah et al. (2022) pointed out that applying strategies based on the use of ICT in educational processes provides interconnection between teachers and students through methodological strategies supported by digital tools. From this perspective, it is established that technological resources allow students to have fun and learn in a playful manner, helping to improve the educational process in subjects related to mathematics.

Despite these efforts, a significant limitation in the use of audiovisual material and didactic strategies was evident. This was primarily attributed to the lack of familiarity among educators with the available technologies (Buda & Czékman, 2021). Therefore, the restrictions in managing technological strategies not only highlight the challenges associated with the abrupt transition to virtual teaching but also imply the need for ongoing training for educators in the effective use of technological tools (Manou-abi, 2023).

In light of the unfolding scenario, the lack of experience with these platforms sharply affected the quality and variety of the educational methodologies employed, influencing the effectiveness of the teaching and learning process during this period of virtual modality implementation. In this sense, the implementation of the "Aprendamos Juntos en Casa" Educational Plan in Ecuador, according to the (Ministerio de Educación del Ecuador, 2020), became a crucial point in mitigating the negative impacts of the pandemic on education.

From this perspective, it is essential to address technological barriers and provide ongoing, specific training in educational technology to ensure effective integration of these resources into the educational process. This finding highlights the importance of closing the gap between educational theory and practice, ensuring that educators are properly equipped to face emerging technological challenges.

In a specific context, the Educational Unit under study located in Ambato, Ecuador, presents technological resources and teaching dynamics that still maintain a traditional approach, even after the return to in-person teaching. Additionally, a specific issue was identified in the area of mathematics concerning the mastery of

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basic functions, specifically multiplication, among students at the basic elementary level. This was evident in the averages of the third quarter of the second semester for the 2022-2023 period, where around 30% of students did not achieve the expected minimum grades.

For this reason, there is a need to conduct research to address and mitigate this specific issue in the area of mathematics, practically demonstrating the application of technological resources to reinforce mastery of multiplication operations in the educational training process. The feasibility of this study is supported by the possibility of reducing the observable difficulties in students.

In this regard, a quasi-experimental study has been chosen, employing techno-educational strategies, considering instructions and methods used at the time of teaching, which provide the basis for formal training within a programmed time horizon and the effective achievement of the expected educational training objectives. Thus, this study starts with the following question: What are the contributions of techno-pedagogical strategies to reinforcing the mastery of mathematical multiplication among basic elementary level students in Ecuador?

Background

Pedagogy and Technological Tools

Considering pedagogical strategies and technological tools, it is imperative to note that technological advancement encompasses various social aspects, and for the context of remote or semi-remote education, it is the most demanded option, especially those based on gamification (Karamert & Kuyunku Vadar, 2021; Núñez-Naranjo & Chancusig-Toapanta, 2022). Consequently, Cabrera-Solano, (2022) highlights that among the notable resources is the digital tool Genially, an application that allows for the creation of interactive digital structures. This medium enables the use of templates and resources to design innovative content with various appealing features, although it is not specifically aimed at teaching mathematics.

In the same context, (Wild et al., 2019) point out that another relevant tool is Blooket, a gamification resource that facilitates the creation of quizzes with various answers, whether correct or incorrect, allowing participants to advance as they answer correctly, thus promoting a competitive level. Similarly, the proposed activities can be developed solo, live with everyone in the classroom, or even set as assignments.

Naumoska et al. (2022) state that in current teaching processes, there is the interactive software Nearpod, which is a web-based application that does not require installation but needs an Internet connection. Due to screen properties, it is preferable to use a fixed computer for designing resources, but students or participants can use mobile devices to view educational activities in real-time.

In association, Mites Vilela et al. (2022) emphasizes that student motivation for learning lies in the combination of pedagogy with technology. The versatility of the Genially platform is highlighted, where interactive content can be created using gamified templates, allowing students to interact through audios, texts, videos, or images by sharing a link and accessing educational material of interest for free. Palomeque-Serrano & Guevara-Vizcaíno (2021) present an interesting view on the use of teaching strategies based on technological resources. They assert that the use of the Genially platform, among others, has contributed to developing skills in both teachers and students, motivating them to delve into its applications and leverage its versatility to carry out an interactive process that fosters critical thinking development.

Phuc Luong Huynh (2024) verified that the Blooket tool is a motivating didactic strategy for students who struggle with learning subjects like English or mathematics. The results indicate that incorporating extrinsic motivational elements, such as points or badges, enhances general motivation and increases the likelihood of success in educational planning. Therefore, the interactive nature of Blooket, along with its ability to create a supportive learning environment, fosters a sense of learning and self-awareness among students. This, in turn, allows students to understand their strengths and weaknesses and take ownership of their learning process.

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Regarding the interactive tool Nearpod, (Ríos-Zaruma et al., 2019) notes that it is part of the agile methodology for educational innovation that promotes the comprehensive development of students. As a collaborative and interactive learning platform, it allows students to improve their concentration and participation, providing an opportunity to complement the learning provided by the teacher.

In relation to the application of technological pedagogical strategies, Susanto et al., (2023) have noted that the Technological and Pedagogical Model is today a factor and measure of collaborative learning achievements in education, driving the development of special competencies in both teachers and students at school and secondary levels. They also mention that with the rapid progress in technological development and self-efficacy regarding digital devices, understood as self-efficacy in information and communication technologies, it is important for helping students face and self-manage their ongoing learning processes.

Teaching Mathematics and Technopedagogy

Referring to technopedagogical strategies in mathematics education, Marbán and Sintema, (2024) highlight that the effective integration of Information and Communication Technologies (ICT) into mathematics education has become a challenge for professionals and researchers. In this regard, the TPACK framework (Technological Pedagogical Content Knowledge) has been employed in many studies related to the use of ICT in classrooms. However, reports on the development of TPACK by future teachers in mathematics teaching and learning environments appear insufficient to provide a solid understanding of these aspects, particularly concerning their perceptions of technology use after their university training in mathematics education.

In another perspective, Gómez-García et al. (2020) explain that the incorporation of ICT by mathematics teachers has been challenging, as it requires improvement in their knowledge of new technologies. They note that teachers generally prefer to choose from a variety of software rather than selecting different hardware devices. Teachers who already have precise expertise in ICT are combining technology management with educational platforms to enhance student learning in mathematics.

Materials y Method

Objective of the Study

The general objective of this research is to analyze the contribution of technopedagogical strategies in enhancing the mastery of mathematical multiplication among elementary level students in Ecuador.

Population and Sample

The population directly involved in the research consists of 250 elementary level students. A non-probabilistic sample was extracted, comprising 4 groups of 30 children each (120 in total), equally divided by gender and aged between 6 and 7 years. The first group is identified as the control group (not receiving the intervention), while the remaining three groups are experimental groups identified as N, B, and G, which underwent the intervention (post-test) using the strategies with Nearpod (N), Blooket (B), and Genially (G). It is noteworthy that all selected students have their own mobile devices and Wi-Fi connection at home, enabling the use of technological resources for asynchronous activities.

In collaboration, five teachers participate, two specialized in mathematics and ICT management, and the other three in basic education with training in technological resources and ICT, with an average accumulated experience of 7 years in the area and elementary level. These teachers are aged between 30 and 34 years. They have been in charge of the fourth year of basic education and have actively participated in the research, directly involved in the collection and classification of documentation and information, as they are part of the teaching staff of the educational unit.

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Instrument

The instrument applied consists of 10 items based on five phases and aspects to be examined regarding classroom knowledge on multiplication operations, adapted with dichotomous response propositions V ( ) or F ( ), where a correct answer scores 3 points and an incorrect answer scores 0 points. The phases are detailed as follows:

Phase 1: Understanding Terms. Identify the numbers or terms to be multiplied. For example, if we have the numbers 23 and 5, identify which is the multiplicand and which is the multiplier.

Phase 2: Placement of Numbers. Write the numbers one below the other, aligning units, tens, hundreds, etc., accordingly.

Phase 3: Multiplication of Numbers. Start by multiplying the units of the multiplier by each digit of the multiplicand, beginning from right to left. For example, multiply first by the units of the multiplier, then by the tens, and so on.

Phase 4: Summing Results. Add the partial results obtained in the previous step, considering the correct positions according to the multiplication (units, tens, hundreds, etc.).

Phase 5: Verification of Results. Check the result obtained to ensure there were no errors in the multiplication process. This may include verification using alternative methods like column multiplication or calculators.

Subsequently, internal consistency was verified by calculating the Kr20 coefficient, proposed by Kuder and Richardson in 1937 (Durán Pérez & Lara Abad, 2021). The result of this calculation was 0.814, representing an acceptable condition for the study.

Data Collection and Analysis Procedure

This study is framed within the post-positivist paradigm (Giraldo, 2020). It denotes an applied methodology using a quantitative approach within a quasi-experimental design, aiming to present the evolution described by the study groups at two times: before (pre-test) and after (post-test) the academic intervention, considering the study of Albarracín-Villamizar et al., (2020).

Similarly, the hypothetical-deductive method is used, starting from an intentional non-probabilistic sampling (Van Heerden & Naicker, 2023). This study also relies on a literature review, characterized by consulting and obtaining relevant bibliographic references for the research objectives. The information processing was carried out using the SPSS statistical program, facilitating the analysis of the relationship between variables. After analyzing the pre-test results, an academic intervention was reinforced through the use of technopedagogical strategies applying open-access resources over a period of two weeks. This intervention was designed using digital didactic aspects, incorporating both synchronous and asynchronous activities with Nearpod, Blooket, and Genially resources.

Resultados

After analyzing the pre-test results, an intervention was implemented to enhance learning through the use of pedagogical technological strategies. This intervention was designed using gamification principles to improve the identified skills, incorporating activities supported by the following resources:

Genially Tool: This platform was used for students to access and interact with the "Game of the Goose," an online game designed for a playful review of multiplication tables. The game was created using this template and is accessible from any mobile device.

Blooket Tool: This platform was used to develop multiple-choice questionnaires that, as they were answered,

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turned into competitive games to promote learning.

Nearpod Interactive Software: This was used to create an interactive presentation with scientific content, drawings, and gamification elements.

Regarding the execution of the pre-test and post-test, given that the applied instrument contained 10 items, each valued at 3 points for a correct response, there were 2 questions per dimension, with an ideal total of 6 points per dimension and a maximum total of 30 points. This is in accordance with the sample size defined for the study. The pre-test results were divided into two parts: the first for the control group and the second detailing the intervention group. Table 1 presents the pre-test results for the control group.

Table 1 Descriptive Findings in Pre-Test and Post-Test for the Control Group

Student	Pre-Test Score	Post-Test Score*	Difference
1	12.00	9.00	3.000
2	18.00	21.00	-3.000
3	12.00	12.00	0.000
4	15.00	12.00	3.000
5	6.00	12.00	-6.000
6	9.00	12.00	-3.000
7	12.00	9.00	3.000
8	12.00	15.00	-3.000
9	15.00	15.00	0.000
10	15.00	15.00	0.000
11	12.00	15.00	-3.000
12	9.00	12.00	-3.000
13	3.00	9.00	-6.000
14	9.00	12.00	-3.000
15	12.00	9.00	3.000
16	18.00	15.00	3.000
17	21.00	21.00	0.000
18	18.00	18.00	0.000
19	21.00	18.00	3.000
20	9.00	21.00	-12.000
21	18.00	21.00	-3.000
22	9.00	12.00	-3.000
23	6.00	12.00	-6.000
24	24.00	24.00	0.000
25	18.00	21.00	-3.000
26	12.00	9.00	3.000
27	15.00	15.00	0.000
28	12.00	15.00	-3.000
29	21.00	18.00	3.000
30	15.00	15.00	0.000
Average	13.6	14.8	-1.20
Median	**12.00**	**15.00**	**0.00**

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Std. Dev	5.028	4.310	3.576

Note: The negative variation indicates that the result in the post-test decreased compared to the pre-test.

In the Table 1 shows a slight improvement in the average scores from the pre-test to the post-test. It is also noted that 50% of the students passed the pre-test with an average score of 13.6, while in the post-test, the percentage increased to 63.33% with an average score of 14.8. These findings suggest that the students in the control group collectively improved their performance, although the average score remains below 15 points, which is the minimum passing score for the evaluation.

Table 2 Descriptive Findings from Pre-Test and Post-Test for Experimental Group N.

Student	Pre-Test Score	Post-Test Score*	Difference
1	15.00	24.00	-9.000
2	18.00	21.00	-3.000
3	12.00	21.00	-9.000
4	15.00	18.00	-3.000
5	9.00	18.00	-9.000
6	9.00	18.00	-9.000
7	12.00	18.00	-6.000
8	9.00	21.00	-12.000
9	15.00	15.00	0.000
10	15.00	18.00	-3.000
11	12.00	21.00	-9.000
12	9.00	15.00	-6.000
13	12.00	21.00	-9.000
14	9.00	18.00	-9.000
15	12.00	21.00	-9.000
16	21.00	24.00	-3.000
17	21.00	21.00	0.000
18	18.00	18.00	0.000
19	12.00	18.00	-6.000
20	9.00	21.00	-12.000
21	18.00	21.00	-3.000
22	12.00	24.00	-12.000
23	9.00	12.00	-3.000
24	8.00	24.00	-16.000
25	9.00	21.00	-12.000
26	12.00	24.00	-12.000
27	15.00	15.00	0.000
28	12.00	15.00	-3.000
29	21.00	18.00	3.000
30	9.00	18.00	-9.000
Average	12.97	19.40	-6.43
Median	**12.00**	**19.50**	**7.50**
Std. Dev	4.004	3.125	4.710

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Note: The intervention was based on the use of the Nearpod resource. Negative variation in the scores indicates a decrease in the score from the pre-test to the post-test.

As shown in Table 2, there was a significant improvement in the average scores from the pre-test to the post-test. Additionally, only 40% of the students passed the pre-test, with an average score of 12.97, whereas in the post-test, the passing percentage increased to 96.67%, with an average score of 19.40. Only one student did not achieve a score above 15 points. These findings suggest that students in Group N benefited from the Nearpod intervention, leading to a notable improvement in their performance. Similarly, Table 3 will present the comparative results between the pre-test and post-test for Group B, following the reinforcement with the Blooket technological resource.

Table 3 Descriptive Findings during the Pre-Test and Post-Test for the Experimental Group B

Student	Pre-Test Score	Post-Test Score*	Difference
1	9.00	21.00	-12.000
2	12.00	24.00	-12.000
3	15.00	21.00	-6.000
4	12.00	27.00	-15.000
5	9.00	18.00	-9.000
6	12.00	21.00	-9.000
7	15.00	24.00	-9.000
8	9.00	24.00	-15.000
9	12.00	27.00	-15.000
10	12.00	21.00	-9.000
11	9.00	18.00	-9.000
12	6.00	21.00	-15.000
13	9.00	24.00	-15.000
14	12.00	24.00	-12.000
15	12.00	27.00	-15.000
16	9.00	21.00	-12.000
17	18.00	27.00	-9.000
18	15.00	21.00	-6.000
19	9.00	18.00	-9.000
20	9.00	21.00	-12.000
21	12.00	24.00	-12.000
22	15.00	27.00	-12.000
23	15.00	27.00	-12.000
24	18.00	24.00	-6.000
25	21.00	24.00	-3.000
26	24.00	21.00	3.000
27	18.00	27.00	-9.000
28	18.00	27.00	-9.000
29	12.00	21.00	-9.000
30	21.00	24.00	-3.000
Average	13.30	23.20	-9.90
Median	**12.00**	**24.00**	**9.00**

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Std. Dev	4.364	2.941	4.180

Note: *The intervention was based on the use of the Blooket resource. Negative variation in the scores indicates that the student's score decreased from the pre-test to the post-test.

Table 3 shows a significant improvement in average scores from the pre-test to the post-test. Initially, the average score in the pre-test was 13.30, while in the post-test, it rose to 23.20. The percentage of students passing the evaluation increased markedly, indicating a successful application of the Blooket resource. The median score also improved substantially, reflecting a general enhancement in performance among the students in Group B.

Table 4. Descriptive Findings during the Pre-Test and Post-Test for the Experimental Group G

Student	Pre-Test Score	Post-Test Score*	Difference
1	12.00	21.00	-9.000
2	18.00	18.00	0.000
3	12.00	18.00	-6.000
4	15.00	21.00	-6.000
5	12.00	21.00	-9.000
6	12.00	24.00	-12.000
7	12.00	18.00	-6.000
8	12.00	21.00	-9.000
9	15.00	21.00	-6.000
10	15.00	15.00	0.000
11	12.00	18.00	-6.000
12	12.00	18.00	-6.000
13	15.00	21.00	-6.000
14	12.00	24.00	-12.000
15	12.00	24.00	-12.000
16	9.00	21.00	-12.000
17	12.00	27.00	-15.000
18	15.00	27.00	-12.000
19	12.00	21.00	-9.000
20	18.00	18.00	0.000
21	21.00	21.00	0.000
22	12.00	24.00	-12.000
23	12.00	21.00	-9.000
24	12.00	27.00	-15.000
25	24.00	21.00	3.000
26	21.00	18.00	3.000
27	18.00	24.00	-6.000
28	12.00	21.00	-9.000
29	15.00	27.00	-12.000
30	18.00	21.00	-3.000
Average	14.30	21.40	-7.10
Median	**12.00**	**21.00**	**7.50**

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Std. Dev	3.495	3.125	5.074

Note: *The intervention was based on the use of the Genially resource. Negative variation in the scores indicates that the student's score decreased from the pre-test to the post-test.

Table 4 demonstrates a significant improvement in average scores from the pre-test to the post-test. The average score increased from 14.30 in the pre-test to 21.40 in the post-test. The percentage of students passing the evaluation improved markedly, showing that the Genially resource had a positive impact on student performance. The median score also improved, indicating a general enhancement in performance among the students in Group G.En resumen, se puede aportar que, al igual que en los grupos experimentales tuvieron un mejor desempeño según las calificaciones logradas en el post test, en comparación con el grupo control, sin embargo, los estudiantes del grupo G, lograron una mejoría significativa la cual se asocia con la aplicación de estrategia de enseñanza bajo la herramienta Genially incluso con mejor desempeño que el grupo N y B.

Inferential Analysis

To inferentially validate the hypothesis that the application of techno-pedagogical strategies enhances the mastery of basic multiplication operations in elementary-level students, the following steps were undertaken:

Normality Test: First, a normality test was performed using SPSS to analyze the mean values obtained from the pre-test and post-test for each defined group. The focus was on the differences observed.

Control Group Analysis: The normality test was conducted for the control group, applying the Shapiro-Wilk test to the differences between pre-test and post-test scores. For N=30N = 30N=30, the significance value was 0.0020.0020.002, which is less than 0.050.050.05. This result indicates that the data do not follow a normal distribution. As a result, a non-parametric test was used, specifically the Wilcoxon test. The results of this test are presented in Table 5.

Table 5: Wilcoxon Test Results for the Control Group

Null Hypothesis	Test	Sig.[a,b]	Decision
The median difference between the control group students' pre-test and post-test scores is equal to 0.	Wilcoxon Signed-Rank Test for Related Samples	0.079	Fail to reject the null hypothesis

Note: The significance value of 0.079 is greater than 0.050. There is no significant difference between the means of the pre-test and post-test scores.

For the experimental groups, a normality test was conducted to determine the appropriate statistical test for each case. For Experimental Group N, the significance value was found to be 0.002, which is less than 0.05. For Experimental Group B, the significance value was 0.001, also less than 0.05, and for Group G, the significance value was 0.014, which is also less than 0.05. Therefore, the Wilcoxon Signed-Rank Test was applied to each case. Table 6 summarizes the results of each test applied.

Table 6: Wilcoxon Test Results for Experimental Group

Group	Null Hypothesis	Test	Sig. (a,b)	Decision

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Experimental N	The median difference between pre-test and post-test scores for group N is equal to 0.	Wilcoxon Signed-Rank Test for Related Samples	0.002	Reject the null hypothesis.
Experimental B	The median difference between pre-test and post-test scores for group B is equal to 0.	Wilcoxon Signed-Rank Test for Related Samples	0.001	Reject the null hypothesis.
Experimental G	The median difference between pre-test and post-test scores for group G is equal to 0.	Wilcoxon Signed-Rank Test for Related Samples	0.014	Reject the null hypothe|sis.

Note: For all experimental groups, the significance values are less than 0.05, indicating significant differences between the pre-test and post-test scores.

Discussion

In the contextual analysis of the issues addressed in this study, significant challenges faced by the current educational system are highlighted, especially those related to the situation caused by the COVID-19 pandemic. This situation, marked by weak interactions between teachers and students and a lack of academic reinforcement strategies, has affected students' mastery of basic functions and mathematical operations (Cortés-Albornoz et al., 2023; Holik et al., 2023). There remains a noticeable deficiency due to the forced transition to virtual education during the pandemic, leading to the use of technological didactic strategies amidst socioeconomic disparities, impacting many students (Alban Conto et al., 2021). Resistance to change and educators' lack of preparation for virtual teaching are also emphasized as additional challenges.

The pre-test results for both the control group and experimental groups show significant deficiencies in mastering mathematical multiplication operations, underscoring the need to innovate with new and novel digital teaching and learning strategies (Núñez-Naranjo & Chancusig-Toapanta, 2022). The implementation of technological resources during academic reinforcement led to notable improvements, as evidenced by post-test results where the use of Nearpod, Blooket, and Genially resources allowed for clear differences in descriptive results, both in percentages and in the mean data, reflecting a positive change in mastering basic functions and managing multiplication operations, an important factor highlighted by Ainul Maulid bin Ahmad et al. (2023).

Significant improvement in students' mastery and performance was observed after implementing techno-pedagogical strategies supported by the use of digital tools such as Blooket (Phuc Luong Huynh, 2024; Wild et al., 2019), Genially (Cabrera-Solano, 2022; Karamert & Kuyunku Vadar, 2021; Palomeque-Serrano & Guevara-Vizcaíno, 2021), and the interactive software Nearpod (Naumoska et al., 2022). These are important technological resources that benefit both in-person and remote education (Abdullah et al., 2022). The positive change is reflected in an overall improved average in aspects related to a solid understanding of multiplication phases. The detailed discussion of post-test results and comparison with pre-test results provides clear evidence of the positive impact of techno-pedagogical strategies on the teaching and learning process for mastering multiplication. This aligns with the contributions of Susanto et al. (2020) who studied the application of technological tools and strategies in children's learning processes.

The positive post-test results reflect the favorable impact achieved through the planning and execution of

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this implementation, particularly the use of the Blooket platform, which proved to be the most effective and well-received by students as a collaborative learning platform. This finding is associated with the studies of (Palomeque-Serrano & Guevara-Vizcaíno, 2021), (Phuc Luong Huynh, 2024), and Ríos-Zaruma et al. (2019), whose research supports that the use of these technologies within teaching strategies positively impacts the improvement of children's skills in handling functions and operations included in their curriculum subjects.

Similarly, the methodological design of pre-tests and post-tests is ideal for studies aiming to evaluate the progress achieved by a particular group through an intervention proposal. This was observed in this study with the group of students initially assessed with a diagnostic test, followed by intervention through technological tools, and finally, a verification assessment to determine the achieved trend (Albarracín-Villamizar et al., 2020).

This aspect is directly related to the contributions of Mites Vilela et al. (2022) Mites-Vilela (2022), who emphasizes the importance of combining pedagogy with technology through the planned and directed use of digital platforms. These platforms support efficient content communication, stimulate student participation, and encourage their creativity. This perspective is supported by the work of Marbán & Sintema (2024) and Gómez-García et al., (2020), who demonstrated the weaknesses, strengths, and perspectives of using ICT in developing technological pedagogical strategies.

Conclusions

The use of platforms such as Genially, Nearpod, and Blooket emerges as technological resources that contribute to achieving and strengthening the objectives of the teaching and learning process. These tools are key in addressing both evident and potential difficulties in learning mathematical multiplication. In conclusion, the implementation of techno-pedagogical strategies by educators enhances the fundamental skills for handling mathematical multiplication, motivating students in an efficient, engaging, and enjoyable manner. This fosters learning and understanding through interaction and communication with both the teacher and classmates. This highlights the importance of integrating digital media and technology for more reliable reinforcement, ensuring continuous learning. Among these tools, Blooket stands out by providing quizzes with both correct and incorrect answers, helping students to learn more fluently and improve their performance in mathematical operations. Additionally, it can be utilized for other educational disciplines.

Limitations

One notable aspect is the fact that a fully experimental design was not applied, which may condition the inferential analysis of the study. This leaves an open research gap for future researchers to expand the scope and provide more robust results. Although the instrument was reviewed, validated, and its reliability estimated, the lack of a standardized scale to measure the performance of the applied intervention encourages the execution of new studies that include the design of a scale, which can be evaluated using the principles of structural equation modeling.

Data Availability Statement

All data is available in this manuscript.

Autor Contributions

ANN: Conceptualization, Writing – original draft, Writing – review & editing, Project administration, Funding acquisition, Supervision, Conceptualization, Investigation. **JMR**: Conceptualization, Methodology, Data curation.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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