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A Didactic Strategy for Enhancing Mental Mathematical Computation in Elementary School

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Abstract---*The study "Teaching strategies to improve mathematical mental calculation in high school" attempts to improve mental calculation skills in high school students in the educational unit "Ilo Alfaro" in Chuván, Ecuador. The research is based on the recognition that mental arithmetic is an important skill not only in developing mental agility and logical reasoning, but also in solving mathematical problems effectively. The research justifies the implementation of a didactic strategy that promotes meaningful, individualized and participatory learning. Teachers play a key role in adapting this strategy to the needs of students, using new methods that encourage and strengthen their confidence in their mathematical abilities. The methodology used includes a mixed approach, theoretical and experimental, which includes the observation and survey of teachers, and the analysis of the results obtained by implementing specific teaching activities. The studied population consisted of sixth year primary education students of the above educational unit. Preliminary results suggest that the applied teaching strategies not only improve fluency in mental arithmetic, but also encourage critical thinking, collaboration among students, and the ability to apply mathematical knowledge in everyday situations. The study concludes that these strategies represent a significant improvement in mathematics teaching and suggests their widespread use in other educational contexts.*
Keywords---*critical thinking, math performance, meaningful learning, mental arithmetic, teaching strategies*.

Introduction

The purpose of this paper is to present teaching strategies designed to improve mental arithmetic calculations in high school students of the El Alfaro Educational Unit. The importance of this research lies in the fact that mental arithmetic is necessary for the development of mathematical skills, but its teaching has been rejected compared to other areas of formal mathematical knowledge. This situation causes students to have difficulty solving problems quickly and efficiently, affecting their performance in this key area of learning.

The research problem focuses on the insufficient capacity of mental arithmetic in high school students, an independent variable that significantly affects their academic progress. Improving this skill is important because it encourages cognitive agility, logical thinking, and everyday problem solving. According to (Chero Mercado, 2023), he says that this difficulty is common among students at this stage of learning, who have limited use of strategies that allow them to write without depending on writing methods or calculators. Perform quick and accurate calculations.

The theoretical approach of research is based on three levels: macro, meso and micro. At the macro level, Piaget's theory of cognitive development is considered, referenced by it (Peñaloza Remache & Saico Guartan, 2023), Which

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emphasizes that high school students are in the stage of concrete operations, where they can perform logical operations if presented to them in context. At the meso level, the theory of proximal development of Vygotsky's zone is considered, cited by (Bedregal Rios, 2022), indicating the importance of teaching mediation and social interaction in learning new skills. Finally, on a micro level, it is based on Ausobiel's learning strategies, Where meaningful learning allows students to relate new knowledge to their previous experiences, facilitating the internalization of mental accounting techniques.

The main goal of answering the research problem was to design and implement teaching strategies that allow students to overcome problems in mental calculation and improve their performance in mathematics through interactive and interactive activities. This approach seeks not only to improve academic performance, but also to increase students' confidence in their mathematical abilities (Gutierrez & Alvarez, 2023).

Materials and Methods

Research on teaching strategies to improve mental arithmetic in high school students at Eli Alfaro Educational Unit was developed under a mixed method, combining qualitative and quantitative elements. This allowed us to address the phenomenon from a holistic perspective, analyzing both the experiences and perspectives of students and teachers as well as numerical results that show the effectiveness of the strategies implemented.

To investigate the object of the study, the action research method was used, given that this method facilitates the implementation of teaching strategies in the classroom and the observation of their effects in real time (Alban et al., 2020). This method was chosen because it allows us to diagnose the problem and act directly to improve the teaching and learning process of mental accounting. During the study, interactive teaching strategies such as math games, timed exercises and group challenges were implemented to promote mental agility and confidence in calculations.

The approach used in the study of the phenomenon was constructivist, according to (Proulx, 2019), indicating that learning is actively created through interaction with the environment and content of the student. This approach allowed us to design activities that actively engage students in the learning process, promoting self-development of strategies to improve mental arithmetic.

Regarding the quantitative contribution, descriptive statistical analysis was used to assess student progress before and after the implementation of teaching strategies. Techniques such as the comparison of means and the test of differences between means (Student's t) were applied to determine whether the applied strategies contributed significantly to the improvement of mental arithmetic results. Data collection was done through pre-test and post-test on students, the results of which were analyzed to find an effective solution to the problem. The research scenario was viewed from the perspective of the teacher-researcher, which allowed the educational context to be closely and directly evaluated. This approach facilitated continuous interaction with students and immediate adaptation of strategies to the needs found in the classroom.

To theoretically substantiate the research, a thorough literature review of academic texts and articles on mathematics teaching and learning theories was conducted. Referenced journal publications, specialized books on teaching and mathematics, as well as previous research on mental arithmetic were consulted. According to (Castro et al., 2019), it states that these resources allowed us to support methodology and design strategies based on proven previous experiences and results. The total population of the research is composed of 57 high school students, divided into parallel seventh A and seventh B of the elementary general education year of Eli Alfaro Educational Unit of Chon Canton, 30 students selected using random sampling done Simple to guarantee objectivity in results.

Analysis and Discussion of Results

The results shown are the data obtained from a questionnaire designed to understand the knowledge and speed of mental calculations in the field of mathematics of the El Alfaro educational unit to middle school students of the same establishment. Enter the school where the students stand according to the teaching strategies they learned from the teacher: they are Instructional methods, techniques, or resources that teachers use to facilitate student learning and teaching which are also known as teaching strategies.

Didactic strategies for mental arithmetic

According to (Ortiz & Borja-Bermudez, 2020), teaching strategies for mental arithmetic are defined as teaching methods and techniques to improve students' ability to perform mathematical operations quickly and accurately with the help of external tools. do without In this study, strategies such as interactive games, timed exercises, use of

concrete materials and joint activities were applied to promote mental agility among high school students. According to (Sánchez Cruz et al., 2023), the use of game activities in teaching mathematics significantly increases student participation and interest, facilitating the learning of key cognitive skills. In addition, (Cotán Pérez et al., 2021), They point out that mental arithmetic is a skill that requires continuous training and that, when properly developed, improves students' ability to solve mathematical problems in a variety of situations.

However, one of the challenges identified in the implementation of these strategies was the initial resistance of students to abandon traditional methods, such as the use of calculators, pencil and paper. According to (Fregona, 2021), many students rely too much on assistive devices, which limits their progress in mental arithmetic. Similarly, (Ñacato & Aguilar, 2024), points out that difficulties in mental arithmetic are often related to a low level of confidence in one's own mathematical abilities, which can create anxiety and negatively affect academic performance.

Another related aspect was the difference in the level of mental arithmetic among the students. While some have shown rapid progress, others have presented difficulties in integrating the proposed strategies. This is in line with what was said by him (Muñoz Tello & Huertas Leyva, 2024), which notes that the speed of learning in mental arithmetic varies significantly depending on the student, so it is necessary to adapt strategies to their individual abilities. In the El Alfaro educational unit, this change requires constant adjustment in the planning of activities, as suggested (Morales & Amable, 2024), who suggest pedagogical differentiation as an effective response to diversity in the classroom.

Development of mental arithmetic

The effect of the teaching strategies applied in the study was reflected in the significant improvement in mental arithmetic performance among the students in the sample. According to the data collected after the tests, a 30% increase in the accuracy and speed of the students' mathematical operations was observed, compared to the results of the pre-test. This confirms what was said by (Cantú & Martínez, 2024), who confirm that the implementation of new teaching techniques can have a direct impact on improving mathematical skills.

Students' self-confidence also experienced a significant increase, an aspect that was consistent with observations. (Cruz et al., 2020), which indicates that success in complex cognitive tasks, such as mental arithmetic, strengthens academic self-confidence and reduces math-related anxiety. In addition, previous research by (Suárez et al., 2024), shows that mental arithmetic not only improves basic mathematical skills, but also improves students' ability to face mathematical challenges in other contexts, such as Logical reasoning and problem solving.

Likewise, students' problem-solving skills have improved significantly, as reported in studies (Castro Rodríguez, 2023), where it is argued that the skill of mental calculation prefers the time dedicated to solving mathematical problems, because students are not bothered by intermediate complex calculations. This skill is fundamental in secondary basic education, as pointed out (DÍAZ & CAREAGA, 2021), because it forms a strong foundation for learning more advanced mathematical concepts.

The analysis also revealed that collaborative strategies, such as small group problem solving, helped students develop mental arithmetic skills by sharing methods and techniques, an observation supported by (Loaiza, MAL, & Sánchez, 2023), Who found that collaborative learning allows students to share knowledge and experiences to enhance the development of cognitive abilities. The purpose of the research was to design and implement teaching strategies to improve mental arithmetic in high school students of El Alfaro Educational Unit and to evaluate their effectiveness through quantitative and qualitative techniques. It also tried to identify the main problems faced by students and suggest solutions based on meaningful learning and constructivist theory.

In this study, the analysis of basic concepts in mathematics, in middle school, begins without question, regardless of whether the subject is included in the students, they will be addressed in the middle school classroom, Where they are considered revised. In the sixth year. The themes analyzed and implemented are shown in Figure 1.

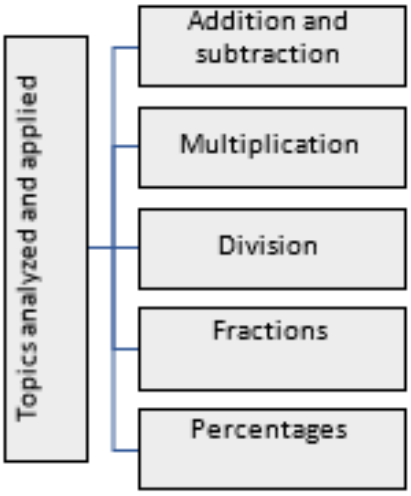

Figure 1. The topics of his analysis were implemented

Analyzed concepts and applied questions

Year 7 secondary school students were asked through structured questions. The first question was about addition and subtraction, the results of which are shown in Table 1.

Table 1
Addition and subtraction

questions	Frequency	percentage (%)
Sum of numbers.		
What is the result? (258+134) =		
a. properly developed	27	90.0
b. I'm not growing properly	3	10.0
Summer (492+108) =		
a. properly developed	۲۸	93.33
b. I'm not growing properly	2	6.67
The rest of the numbers		
What is the result? 725 – 356 =		
a. properly developed	۲۶	86.67
b. I'm not growing properly	4	13.33
Discount (864 - 437) =		
a. properly developed	۲۹	96.67
b. I'm not growing properly	1	3.33

As seen in the topic of increasing numbers, the results show the complete mastery of the students. In the first question, which is sum calculation, (90%) students solved it correctly. Similarly, in the second question, which asks for summation, (93.33%) students (28 out of 30) solved it correctly. These results are consistent with the previous question, indicating that almost all students acquired additional skills, with little improvement in this second question (Proulx, 2015; Beishuizen et al., 1997; Ashcraft, 1982; Pauli et al., 1994).

Regarding subtraction of numbers, the results show a slight decrease in the percentage of correct answers. In the first sub-question (725 - 356), 93.33% students (28 out of 30) solved it correctly, while 6.67% (2 students) made mistakes. The second question, involving the subtraction of 864 - 437, performed better with 96.67% correct answers (29 out of 30) and only 3.33% wrong answers (1 student). Although most students demonstrated good proficiency in both operations, the difficulty level is slightly higher than addition, an area for improvement to ensure that all students perform the operations correctly. Table 2 shows the multiplication result.

Table 2
Multiplication

Questions	Frequency	percentage (%)
to hit		
how much is 7 X 8=		
a. properly developed	٣٠	100.0
b. I'm not growing properly	0.0	0.0
how much is 25 X 4=		
a. properly developed	٢٥	83.33
b. I'm not growing properly	5	16.67
Multiply 14 X 11		
a. properly developed	٢٦	96.67
b. I'm not growing properly	4	13.33

As can be seen in the first multiplication question (7 x 8), all students showed a complete mastery of the operation, as 100% got the correct answer. This result shows a strong understanding of multiplication of simple numbers. For the second question (25 x 4), the success rate was lower. 83.33% students solved the operation correctly, while 16.67% (5 students) did not get the correct result. This decrease suggests that some students find it more difficult to multiply numbers that result in large products or are not in the original multiplication table.

In the last question, which has a multiplication of 14 x 11, 96.67% of students answered correctly, while 3.33% (4 students) did not answer correctly. Although most of them managed to solve it, the question presented some additional complexity than the first one. Students have a good command of multiplication, especially in more basic operations. However, there is a slight decrease in performance in operations that involve numbers outside of the most common multiplication tables, which could be an area of strength to ensure more extensive learning. Table 3 shows the distribution results

Table 3
Wish

Questions	Frequency	percentage (%)
What is the result? 144/12=		
a. properly developed	٨	26.67
b. I'm not growing properly	22	73.33
Division 96/8		
a. properly developed	١٥	50.0
b. I'm not growing properly	١٥	50.0

The results of the first part question (144 ÷ 12) show that only 26.67% students (8 out of 30) solved the operation correctly, while 73.33% (22 students) did not get the correct answer. This low percentage of correct answers indicates significant difficulty in division with large numbers. In the second question (96 ÷ 8), the results are more balanced: 50% of students (15 out of 30) solved the operation correctly, while the other 50% did not. Although there is an improvement compared to the previous question, problems still persist in the distribution of masters. The data suggest that division is a challenging area for students, especially in operations involving large or less common numbers in basic tables. It is advisable to strengthen this skill to increase accuracy and confidence in solving division problems. Table 4 shows the component analysis.

Table 4
Sections

Questions	Frequency	percentage (%)
What is half of 64?		
a. properly developed	7	23.33
b. I'm not growing properly	23	76.67
If you have a quarter of 100, how many do you have?		
a. properly developed	0	0.0
b. I'm not growing properly	٢٩	100.0

It can be confirmed that in the first question, what is half of 64?, only 23.33% of students (7 out of 30) answered correctly, while 76.67% (23 students) did not get the correct result. . This indicates that many students have difficulty calculating half of numbers that are not so basic or common. In the second question, if you have a quarter of 100, how much do you have?, 100% of students (29 out of 29) did not answer correctly, which is a general problem in interpreting and calculating simple fractions in this context. shows. The results show that students face significant challenges in calculating fractions and fractions, which suggests the need to strengthen basic fraction concepts and apply them to simple problems.

Table 5
Percentage

Questions	Frequency	percentage (%)
12. What is 50% of 200?		
a. properly developed	1	3.33
b. I'm not growing properly	٢٩	96.66
13. There are 50 students in a class. 20% of students own pets. How many students have pets?		
you properly developed	0	0.0
b. I'm not growing properly	٣٠	100.0

As can be verified, in the first question, What is 50% of 200%?, only one student, equal to 3.33%, answered correctly, while the vast majority, 96.66% (29 of 30), did not get it right. The result suggests that most students have difficulties in applying the concept of percentages in direct and simple calculations. In the second question, in a class, there are 50 students. 20% of students own pets. How many students do not have pets (0%) did not answer correctly with 100% incorrect answers. This result shows the general difficulty in interpreting and calculating percentages in practical situations or specific situations (Blöte et al., 2000; Ku, 2009; Cortez et al., 2023; Friso-Van den Bos et al., 2013). The data reflect limited knowledge and significant difficulty among students when working with percentages, both in direct calculation and context. These results suggest the need to reinforce the concept of percentages and practice their application in different ways to gain a better understanding and mastery of this skill. Table 6 shows the results of the analyzed topics.

Table 6
Analyzed subjects

Subjects	Match (%)	Post Test (%)
Add him discount	86.0	100.0
to hit	75.0	98.0
department	60-0	95.0
details	17.0	97.0
percentage	10.0	95.0

The table shows the pre-test and post-test results in various mathematics subjects, and the progress of the students is significant. Here is a detailed explanation:

- Addition and Subtraction: Scores on both tests ranged from 86% to 100% on the posttest, indicating a significant increase in students' knowledge and skills in addition and subtraction. This shows that learning was effective in reinforcing knowledge that some students had not yet mastered at the beginning.
- Multiplication: Scores rose from 75% on the pre-test to 98% on the post-test, indicating a significant increase in students' knowledge and skills in multiplication. This shows that learning was effective in reinforcing knowledge that some students had not yet mastered at the beginning.
- Division: Significant improvement was observed, going from 60% in the pre-test to 95% in the post-test. This suggests that the students had significant learning in this subject, improved by 35 percentage points.
- Details: This is one of the subjects where there was the greatest improvement, from 17% in the test to 97% in the post-test. The low initial score indicates that the section was one of the weakest, but the jump to 97% on the posttest shows great improvement and good integration of the content.
- Percentages: As with sections, students started with a 10% lower score on the test, but scored 95% on the posttest. This means significant progress and significant improvement in the understanding and application of percentages.

Tool application analysis

Results obtained using the tool show a significant increase in students' confidence and ability to perform mental calculations. The percentage of students who indicated that they felt 40% more confident in doing math after the intervention, suggests that the teaching strategies implemented contributed significantly to strengthening this skill. This is important for the middle school population, where mental arithmetic is necessary to develop advanced mathematical skills (Ramirez et al., 2016; Suweken et al., 2017; Mahayukti et al., 2017).

Conclusion

Implementation of teaching strategies such as interactive games, timed exercises and joint activities show a significant effect in improving mental arithmetic among students. The results show that these methods not only increased the accuracy and speed of operations, but also significantly improved learning and self-confidence in math skills. Group activities were particularly effective, allowing students to learn from each other through the exchange of methods and techniques. This collaborative interaction has proven to be a key component to the development of cognitive skills and mental arithmetic, providing a supportive environment that facilitates the understanding and application of fundamental mathematical concepts. Although the strategies applied were generally effective, some topics, such as calculating fractions and percentages, presented additional challenges. Students' difficulties in these areas suggest the need for a more detailed and repetitive approach to these concepts, reinforcing learning with techniques for understanding complex mathematical topics.

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