

Didactic strategy to strengthen logical-mathematical reasoning in seventh grade students

María Genoveva Avilés Martínez^{1*} <https://orcid.org/0009-0003-4994-2189>

Ricardo Sánchez Casanova² <https://orcid.org/0000-0001-5354-6873>

Roger Martínez Isaac³ <https://orcid.org/0000-0001-5354-6873>

¹Escuela Bella Primavera. Cuba

²Universidad de La Habana. Cuba

³Universidad Bolivariana de Ecuador

*Autor para la correspondencia: genoaviles22@gmail.com

ABSTRACT

This study analyzes the lack of effective didactic strategies to develop logical-mathematical reasoning in seventh grade students, especially in contexts with limited resources and traditional methods. Despite the relevance of this skill, there are few contextualized proposals to strengthen it. In response, a didactic strategy based on interactive activities, problem solving and technology was designed and implemented. With a mixed approach, the results showed significant improvements in the ability to analyze and solve problems. This work proposes a replicable model that seeks to transform mathematics teaching and strengthen essential competencies for learning.

Keywords: Strategy; Didactics; Didactics; Reasoning; Logical; Mathematical; Education; Mathematics

Introduction

Mathematics education constitutes a fundamental pillar in the development of students' cognitive skills, especially in a world where problem solving and logical reasoning are essential competencies for academic and professional life (Astudillo, 2023). Within this field, logical-mathematical reasoning stands out as a transversal skill that transcends the boundaries of the classroom, allowing students to interpret, analyze and address complex problems in various contexts (Barbosa & Angarita, 2022). However, several studies point out that, in basic education classrooms, the development of this competence has not reached the expected levels, largely due to the prevalence of traditional and non-interactive teaching methods (Celi *et al.*, 2021). This scenario calls for the implementation of innovative teaching strategies to meet the learning needs of the 21st century.

Historically, mathematics teaching has been characterized by a transmissive approach, focused on memorization and repetition of procedures (Chillan, 2022). Although this model has produced acceptable results in terms of calculation and basic operations, it has significantly limited the development of more complex skills, such as logical-mathematical reasoning. In recent decades, advances in pedagogy and technology have opened new possibilities for reconfiguring educational approaches, promoting active and student-centered methodologies. In the Ecuadorian context, institutions such as Medardo Ángel Silva face the challenge of adapting these innovations to realities marked by resource limitations and high dropout rates (Fernández, 2021).

The central problem of this research lies in the lack of didactic strategies specifically designed to promote logical-mathematical reasoning in seventh grade students, a crucial stage in educational formation. How can pedagogical strategies be adapted to strengthen this competency in a context characterized by limited resources and high cultural diversity? This question underscores the need to develop concrete proposals that integrate participatory approaches and affordable technological tools, addressing both the structural limitations and the potentialities of the educational environment. Existing literature has explored the importance of incorporating active strategies, such as problem-based learning and the use of digital tools, in the teaching of mathematics (Garcia, 2022). However, there is a significant gap in research applied to specific contexts, where socioeconomic and cultural conditions demand customized adaptations. This article aims to fill this gap by designing and implementing a didactic strategy that not only responds to local needs, but also serves as a replicable model in similar contexts.

In addition, the formation of logical-mathematical reasoning has a direct impact on the integral development of students, contributing to strengthen their ability to make informed decisions and solve problems in diverse contexts (Guadamud, Solorzano & Zambrano, 2023). In this way, the strengthening of this skill transcends the academic environment, promoting competencies necessary for daily life and future employment. It is, therefore, imperative that educational institutions adopt didactic approaches that not only comply with curricular standards, but also stimulate creativity and critical thinking. This study is developed in the Medardo Angel Silva institution, located in a context with limited resources, but rich in cultural diversity. This scenario offers a unique opportunity to evaluate the effectiveness of innovative teaching strategies in a challenging environment. The designed strategy combines interactive activities, contextualized problem solving and the use of low-cost technological tools, allowing a practical and sustainable implementation.

In this article, we describe the theoretical and methodological foundations that support this didactic strategy, the results obtained after its implementation and the implications of these results for educational practice. In doing so, we seek to contribute to the existing body of knowledge and provide teachers with concrete tools to enrich their pedagogical practices. The objectives of this research are, first, to design and validate a didactic strategy focused on the development of logical-mathematical reasoning in seventh grade students, and second, to analyze the impact of this strategy on students' academic and attitudinal performance. This integrative approach combines theory and practice to offer concrete solutions to one of the most pressing challenges in mathematics education today.

Development

This study adopted a mixed methodological approach, combining qualitative and quantitative elements to analyze the development of logical-mathematical reasoning in seventh grade students. A quasi-experimental design with pretest and posttest measurements was used, allowing the evaluation of changes without the need for a control group. The didactic strategy included interactive activities, contextualized problem

solving and accessible technological tools, implemented during six weeks with face-to-face and online sessions.

The evaluation combined standardized tests, surveys and interviews to measure progress and perceptions. Quantitative data were analyzed using Student's t-test, while qualitative data were processed with thematic coding. The sample of 30 students from the Medardo Ángel Silva institution was selected intentionally, ensuring diversity of mathematical levels and representativeness of the Ecuadorian educational context.

The study guaranteed methodological rigor through inclusion criteria, confidentiality and ethical protocols. Its findings provide a basis for strengthening mathematics teaching and generating replicable strategies in contexts with technological and pedagogical limitations, promoting innovative and sustainable educational practices.

Results and discussion

Didactic Strategy for the Development of Logical-Mathematical Reasoning

Name of the Strategy:

“Learning to Solve: Contextualized Didactic Strategy for the Formation of Logical-Mathematical Reasoning”.

General Objective:

Strengthen logical-mathematical reasoning in seventh grade students through interactive, contextualized activities and the use of technological tools, promoting the understanding, analysis and resolution of mathematical problems.

Components of the Strategy:

1. Contextualized Approach:

- ✓ Design mathematical problems based on situations in the students' immediate environment (local market, public transportation, family budgets).
- ✓ Relate abstract concepts to concrete examples from everyday life, such as measuring areas of real spaces or analyzing patterns in common objects.

2. Interactive Activities:

- ✓ Integrate group dynamics, such as problem-solving competitions or debates to analyze different mathematical approaches.

- ✓ Incorporate educational games that encourage active and collaborative participation among students.

3. Use of Educational Technology:

- ✓ Implement free educational applications and software, such as GeoGebra or Desmos, to explore geometric and algebraic concepts.
- ✓ Use digital simulations that allow experimenting with mathematical variables in a visual and dynamic way.

4. Problem-Based Learning (PBL):

- ✓ Present a central problem at the beginning of each unit, which students should solve progressively as they acquire and apply new mathematical concepts.
- ✓ Encourage independent research and teacher-guided learning.

5. Formative and Creative Assessment:

- ✓ Conduct ongoing assessment through hands-on activities, such as creating graphs, solving mathematical challenges in teams, and thematic projects.
- ✓ Design clear rubrics that measure the development of logical reasoning, creativity, and students' ability to justify their answers.

6. Implementation Stages:

1. Initial Diagnostic:

- ✓ Apply a diagnostic assessment to identify students' level of logical-mathematical reasoning.
- ✓ Collect data on their interests, socio-economic context and access to technological resources.

2. Activity Planning:

- ✓ Select topics from the official curriculum and adapt them to practical problems related to everyday life.
- ✓ Design interactive activities and choose technological tools compatible with the available resources.

3. Execution of the Strategy:

- ✓ Divide the process into weekly sessions of 90 minutes, distributed in group, individual and technological activities.
- ✓ Begin each session with a central problem and encourage active participation through discussions and collaborations.

4. **Follow-up and Evaluation:**

- ✓ Conduct periodic performance measurements through hands-on testing and direct classroom observations.
- ✓ Discuss results with students and adjust activities according to their needs.

Sample Activities:

1. **Activity: The Family Budget**

- ✓ Context: Students should calculate the weekly budget for a family of four considering local costs for food, transportation and services.
- ✓ Competencies developed: Application of basic operations, handling of percentages, and data analysis.

2. **Activity: Geometric Pattern in Architecture**

- ✓ Context: Analyze geometric patterns in community buildings and calculate areas or perimeters.
- ✓ Competencies developed: Identification of geometric shapes, use of formulas and spatial visualization.

3. **Activity: How to optimize time in transportation?**

- ✓ Context: Solve problems related to optimal routes to get to school considering distances, times and costs.
- ✓ Competencies developed: Logical thinking, handling of proportions and estimations.

Resources Needed:

1. **Physical Materials:**

- ✓ Calculators, grid sheets, rulers, and geometry tools.
- ✓ Posters and cards for group dynamics.

2. **Technological:**

- ✓ Devices with internet access (tablets, laptops, or smart phones).
- ✓ Free educational software such as GeoGebra, Desmos, or Khan Academy.

3. **Trained Teachers:**

- ✓ Training in active teaching strategies and use of technology tools.

Indicators of Success:

1. Increase in logical-mathematical reasoning scores measured by standardized tests.
2. Increased active participation and motivation of students in classes.
3. Successful application of mathematical concepts in practical, everyday problems.
4. Positive feedback from students and teachers about the strategy.

This strategy is designed to be flexible and adaptable to different contexts, allowing teachers to integrate it according to the needs of their classrooms. Its practical and dynamic approach seeks not only to strengthen logical-mathematical reasoning, but also to motivate students to value the relevance of mathematics in their daily lives.

Description of Pretest and Posttest Analysis

To evaluate the impact of the didactic strategy on the development of logical-mathematical reasoning, standardized tests were administered before (pretest) and after (posttest) the intervention. The initial results (pretest) showed an overall average of **62.4 points** (SD = 9.5) on a scale of 100, indicating that most students had a basic performance in this skill. After the implementation of the strategy, the mean score increased to **77.8 points** (SD = 8.6), evidencing a significant improvement in logical-mathematical reasoning skills.

Hypothesis testing using **Student's t test** for paired data confirmed that this difference is statistically significant ($t = -9.87, p < 0.001$), which reinforces the effectiveness of the didactic strategy. The average scores per category evaluated in the tests are presented below.

Table 1. Average scores by category evaluated in the tests.

Category	Pretest Average	Posttest Average	Increase
Troubleshooting	58.7	75.4	+16.7
Logical thinking	63.2	78.6	+15.4
Pattern understanding	65.3	79.5	+14.2
Application of concepts	62.5	77.7	+15.2

Source: Self elaboration

Impact on Academic Performance

Detailed analysis of the results by category reflects significant progress in all areas evaluated. The category with the largest increase was “Problem Solving” (+16.7), suggesting that the contextualized, hands-on activities had a direct impact on students' ability to analyze and solve complex problems. “Understanding patterns” also showed a notable advance (+14.2), possibly due to the use of technological tools that facilitated the visualization of relationships and sequences, as shown in Table 1.

The following bar chart 1 illustrates the average differences between pretest and posttest evaluations by category:

Source: Self elaboration

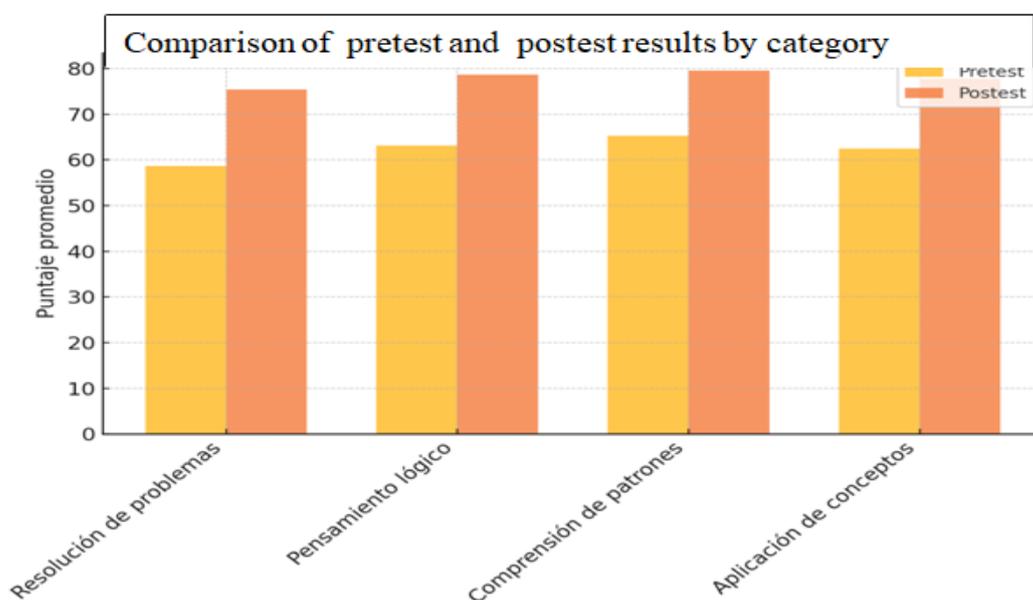


Figure 1: Average differences between Pretest and Posttest evaluations by category

Attitudinal Changes

In addition to academic gains, students' attitudes towards mathematics were assessed through surveys. Before the intervention, only 30% of the participants expressed interest in the subject, while this percentage increased to 70% after the implementation of the strategy.

The following pie chart 2 represents the change in student perceptions:

Source: Self elaboration

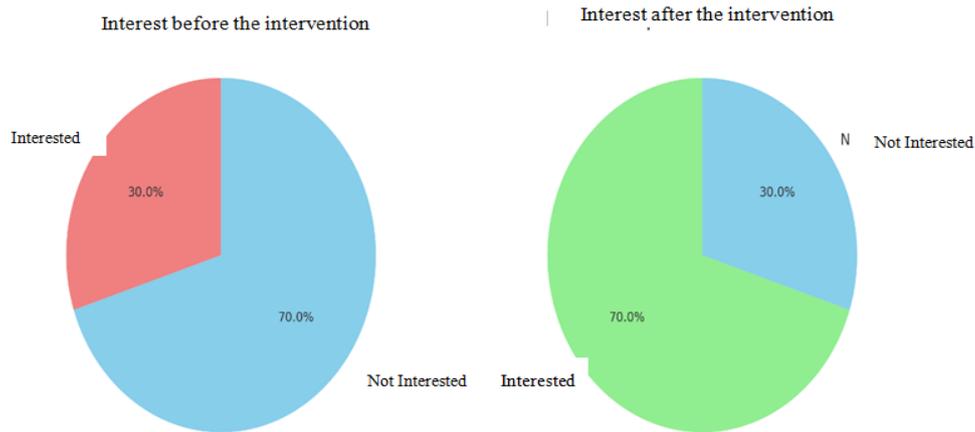


Figure 2: Change in students perceptions

Student and teacher comments provided valuable insight into the intervention. Students highlighted that the practical and contextualized activities helped them to better understand mathematical concepts, while teachers recognized that the strategy promoted more active participation in the classroom. In summary, the quantitative and qualitative results confirm that the didactic strategy implemented had a positive and significant impact on the development of logical-mathematical reasoning, improving both academic performance and motivation towards the subject. These findings reinforce the importance of adopting innovative and contextualized approaches in the teaching of mathematics.

The results of the present study show significant progress in the development of logical-mathematical reasoning in seventh grade students after the implementation of the designed didactic strategy. The increase in the average scores on the post-tests, accompanied by a positive change in attitudes towards mathematics, suggests that the interactive and contextualized activities, supported by the use of technology, played a crucial role in the improvement of these competencies. These findings not only validate the initial hypothesis, but also confirm the effectiveness of the methodological approach adopted. These data indicate that logical-mathematical reasoning can be effectively fostered when strategies that integrate everyday life problems, accessible technological tools and collaborative dynamics are employed. The most salient advances, such as increased problem solving and pattern understanding, reinforce the idea that contextualization of learning is fundamental to achieve a meaningful connection between abstract concepts and students' concrete experiences. This coincides with pedagogical theories that stress the importance of active learning and contextual relevance for

consolidating mathematical knowledge. In comparison with previous research, the results of this study are in line with those that highlight the positive impact of active methodologies on the development of mathematical competencies. For example, recent studies have shown that problem-based learning and the use of technological tools increase motivation and academic performance in mathematics. However, this work goes further by focusing on a challenging socioeconomic context, showing that even in conditions of limited resources; innovative strategies can generate significant improvements. In contrast, research that has employed purely theoretical or traditional approaches has reported less encouraging results, highlighting the need to renew pedagogical practices. Nevertheless, this study has limitations that should be considered when interpreting the results. First, the absence of a control group prevents us from attributing with complete certainty the progress observed exclusively to the strategy implemented. In addition, the small sample size limits the generalizability of the findings to other populations. Finally, although accessible technological tools were used, reliance on digital resources may not be feasible in contexts with limited access to technology.

Despite these limitations, the implications of the findings are significant for both teaching practice and future research. This study demonstrates that the contextualization of learning and the use of interactive resources are effective approaches for the development of essential mathematical competencies. Future research could focus on replicating this strategy in rural contexts or with larger populations, as well as exploring its long-term impact on students' academic formation. It would also be interesting to investigate combining this strategy with other methodologies, such as project-based learning, to further enhance the results. An unexpected aspect of the study was the marginally lower increase in the “application of concepts” category compared to other areas. This could be related to the intrinsic difficulty of translating abstract concepts to specific contexts, an issue that deserves further exploration. Although the impact on this category was positive, its relative low magnitude could reflect the need to reinforce activities designed for this particular skill. In conclusion, the results of this study underscore the relevance of adopting innovative pedagogical approaches to strengthen logical-mathematical reasoning in basic education students. Although challenges remain, such as expanding the sample and integrating a control group, this work provides solid evidence on the effectiveness of strategies that combine theory, practice and technology. This advance in mathematics education has the potential to significantly influence curriculum design and

teacher training, promoting a more inclusive, relevant and effective mathematics education.

Conclusions

The findings of this study show that the implementation of an interactive and contextualized didactic strategy significantly favors the development of logical-mathematical reasoning in seventh grade students. Improvements were observed in problem solving, logical thinking and pattern identification, which demonstrate the effectiveness of a dynamic pedagogical approach adapted to the realities of the student environment. In addition, the positive changes in students' perceptions of mathematics highlight the importance of interventions that not only strengthen conceptual learning, but also stimulate intrinsic motivation.

From a practical perspective, these results have relevant implications for curriculum design and teacher training. The incorporation of hands-on activities and affordable technological tools can transform mathematics teaching, making it more accessible and connected to everyday life.

By linking mathematical learning with concrete experiences, this strategy not only improves academic performance, but also develops essential problem-solving skills in different contexts. This study contributes to the educational field by proposing a replicable and adaptable model that combines theory and practice, offering concrete solutions to pedagogical challenges in mathematics teaching. However, the study has certain limitations. The absence of a control group makes it difficult to attribute the results exclusively to the strategy implemented, and the small sample size, concentrated in a single institution, restricts the generalization of the findings to other educational contexts. Even so, these results constitute a significant advance and suggest the need to expand future research. It is recommended that this strategy be replicated in diverse settings, including rural areas and communities with different characteristics and those longitudinal evaluation methods be employed to measure long-term impact.

Finally, combining this strategy with approaches such as project-based learning or gamification could generate new perspectives in mathematics education. In conclusion,

this study highlights the importance of adopting innovative and contextualized pedagogical approaches to improve mathematics learning. Although questions remain to be explored, the results obtained represent a key step towards an educational model that is more inclusive, dynamic and adapted to the challenges of the 21st century.