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OBMEP COMO INSTRUMENTO DE PROMOÇÃO DA APRENDIZAGEM MATEMÁTICA: EVIDÊNCIAS DE UM CURSO PREPARATÓRIO

OBMEP AS AN INSTRUMENT FOR PROMOTING MATHEMATICS LEARNING: EVIDENCE FROM A PREPARATORY COURSE

OBMEP COMO INSTRUMENTO PARA PROMOVER EL APRENDIZAJE DE LAS MATEMÁTICAS: EVIDENCIA DE UN CURSO PREPARATORIO

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Resumo

Este estudo teve como objetivo investigar as contribuições de um curso preparatório para a Olimpíada Brasileira de Matemática das Escolas Públicas e Privadas (OBMEP) na formação matemática de estudantes do Ensino Fundamental II da rede pública municipal de São Raimundo Nonato – PI. A pesquisa adotou abordagem de natureza mista, com predominância qualitativa, desenvolvida sob a perspectiva da pesquisa-ação. Participaram 30 alunos classificados para a segunda fase da OBMEP, sendo 15 do nível 1 (6.º e 7.º anos) e 15 do nível 2 (8.º e 9.º anos). Os instrumentos de recolha de dados incluíram cinco simulados discursivos, um questionário de percepção e observações sistemáticas ao longo do curso. Os resultados evidenciaram melhoria gradual no desempenho dos estudantes, observada nas médias percentuais de acertos nos simulados. A análise por áreas indicou melhor rendimento em aritmética e raciocínio lógico, enquanto persistiram dificuldades em geometria e contagem/probabilidade. Além dos avanços quantitativos, os dados qualitativos revelaram aumento do interesse, da motivação e da autoconfiança em relação à Matemática. A metodologia adotada — baseada na resolução de problemas, aulas dialogadas, acompanhamento individualizado e utilização de materiais

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Pages: 1-30

organizados — foi apontada pelos estudantes como fator determinante para a aprendizagem. Conclui-se que o curso preparatório se configurou como uma estratégia pedagógica, contribuindo para o fortalecimento das competências matemáticas e para a construção de uma relação mais positiva com a disciplina, reforçando o papel da OBMEP.

Palavras clave: Preparatório OBMEP. Aprendizagem Matemática. Estratégia de Ensino. Educação Pública.

Abstract

This study aimed to investigate the contributions of a preparatory course for the Brazilian Mathematics Olympiad for Public and Private Schools (OBMEP) to the mathematical education of middle school students in the public school system of São Raimundo Nonato – PI. The research adopted a mixed-methods approach, predominantly qualitative, developed from an action-research perspective. Thirty students qualified for the second phase of the OBMEP participated, 15 from level 1 (6th and 7th grades) and 15 from level 2 (8th and 9th grades). Data collection instruments included five discursive essay-based mock exams, a perception questionnaire, and systematic observations throughout the course. The results showed a gradual improvement in student performance, observed in the average percentage of correct answers in the mock exams. The analysis by subject area indicated better performance in arithmetic and logical reasoning, while difficulties persisted in geometry and counting/probability. Beyond the quantitative advances, the qualitative data revealed an increase in interest, motivation, and self-confidence in relation to mathematics. The methodology adopted—based on problem-solving, dialogic classes, individualized monitoring, and the use of organized materials—was identified by students as a determining factor in learning. It is concluded that the preparatory course proved to be a pedagogical strategy, contributing to the strengthening of mathematical skills and the construction of a more positive relationship with the subject, reinforcing the role of OBMEP (Brazilian Mathematical Olympiad for Public Schools).

Keywords: OBMEP Preparatory Course; Mathematics Learning; Teaching Strategy; Public Education.

Resumen

Este estudio tuvo como objetivo investigar las contribuciones de un curso preparatorio para la Olimpíada Brasileña de Matemáticas para Escuelas Públicas y Privadas (OBMEP) a la educación matemática de estudiantes de secundaria en la red escolar pública de São Raimundo Nonato – PI. La investigación adoptó un enfoque de métodos mixtos, predominantemente cualitativo, desarrollado desde una perspectiva de investigación-acción. Treinta estudiantes calificados para la segunda fase de la OBMEP participaron, 15 de nivel 1 (6.º y 7.º grados) y 15 de nivel 2 (8.º y 9.º grados). Los instrumentos de recolección de datos incluyeron cinco simulaciones discursivas, un cuestionario de percepción y observaciones sistemáticas a lo largo del curso. Los resultados mostraron una mejora gradual en el rendimiento de los estudiantes, observada en el porcentaje promedio de respuestas correctas en las simulaciones. El análisis por área temática indicó un mejor rendimiento en aritmética y razonamiento lógico, mientras que persistieron las dificultades en geometría y conteo/probabilidad. Más allá de los avances cuantitativos, los datos cualitativos revelaron un aumento en el interés, la motivación y la autoconfianza en relación con las matemáticas. La metodología adoptada, basada en la resolución de problemas, clases dialógicas, seguimiento individualizado y el uso de materiales organizados, fue identificada por los estudiantes como un factor determinante en el aprendizaje. Se concluye que el curso preparatorio resultó ser una estrategia pedagógica que contribuyó al fortalecimiento de las habilidades matemáticas y a la construcción de una relación más positiva con la asignatura, reforzando así el papel de la OBMEP (Olimpiada Brasileña de Matemáticas para Escuelas Públicas).

Palabras clave: Curso Preparatorio OBMEP. Aprendizaje Matemático. Estrategia Didáctica. Educación Pública

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Pages: 1-30

1 Introduction

In Brazil, the provision of quality public education faces structural and social challenges. The precarious state of schools, the scarcity of teaching resources, the limited continuing education of teachers, and the devaluation of the profession, coupled with social inequality, lead many students, facing family economic difficulties and low levels of education at home, to drop out of school prematurely to enter the workforce.

This reality is evidenced by data from the 2022 Census, released by the Brazilian Institute of Geography and Statistics (IBGE), which indicate a reduction in the illiteracy rate over the last 12 years. Despite the progress, the rate remains higher among Black or mixed-race people, the elderly, and residents of the Northeast region, where the rate (14.2%) is double the national average (7.0%).

Among the challenges of public policies aimed at basic education is the development of concrete actions that promote quality teaching and contribute to the improvement of educational indicators, which are measured based on indicators such as student performance on standardized tests and school pass rates.

Among the areas assessed, mathematics is considered by many students to be the most complex, presenting difficulties even in elementary content, such as basic operations. These gaps compromise learning progress and hinder advancement in content essential for the student's educational development.

The Inep report on PISA 2022 shows that only 27% of Brazilian students reach the minimum level of proficiency in mathematics necessary for the full exercise of citizenship. Several factors contribute to this scenario, including the way content is taught in the classroom, often presented in a decontextualized manner and without connection to the reality experienced by students.

Faced with the challenges of Brazilian public education, the Ministry of Education (MEC) has developed, over the past few years, various policies aimed at improving the quality of education. Of particular note are investments in teacher training, expanding access to educational resources, and strengthening essential learning outcomes.

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Pages: 1-30

Initiatives such as the More Teachers for Brazil program (2025–2026) and the National Commitment to All Mathematics demonstrate this effort, prioritizing teacher appreciation, continuing education, and specific actions for mathematics teaching, seeking to ensure more meaningful learning and better results in basic education.

In this context of strengthening educational policies and encouraging mathematics learning, the Brazilian Mathematics Olympiad for Public and Private Schools (OBMEP) emerged in 2005 as an important initiative. It is a national project aimed at Brazilian public and private schools, which seeks to stimulate and promote the study of mathematics in Brazil.

Participating in OBMEP may constitute a meaningful educational experience, regardless of the results obtained. The Olympiad helps to spark students' interest in mathematics, demonstrating that this area of knowledge can be stimulating and even enjoyable.

In this context, the central question that the research sought to answer is: what is the contribution of a preparatory course for the Brazilian Mathematics Olympiad for Public and Private Schools (OBMEP) to the teaching of mathematics to middle school students in the public municipal school system of São Raimundo Nonato – PI?

Seeking to answer this question, the main objective of this research was to investigate the contributions of a preparatory course for the OBMEP (Brazilian Mathematical Olympiad for Public Schools) to the teaching of mathematics to middle school students in the public school system of São Raimundo Nonato, Piauí.

To achieve the overall objective, the following specific objectives were defined: to investigate the level of knowledge and mathematical skills of middle school students in the public school system of São Raimundo Nonato – PI; to analyze the effectiveness of preparatory courses for the OBMEP (Brazilian Mathematical Olympiad for Public Schools) in the mathematical education of these students; to identify the main difficulties faced in learning mathematics; and to propose strategies to improve mathematical education based on the results obtained.

REMUNOM
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Pages: 1-30

Thus, this study seeks to objectively demonstrate how a preparatory course for the OBMEP (Brazilian Mathematical Olympiad for Public Schools) can contribute to the mathematical education of middle school students in the public school system of São Raimundo Nonato – PI, offering reflections and insights that strengthen mathematics teaching and expand learning opportunities for these students.

This article is organized into six sections. Initially, the teaching of mathematics in basic education is discussed; then, the educational role of OBMEP (Brazilian Mathematical Olympiad for Public Schools) in the school context is addressed. Subsequently, the methodological procedures are presented, including the characterization of the participants and the description of the data analysis. Following this, the analysis and discussion of the results are developed, encompassing performance in the mock exams, analysis by subject area, and students' perceptions of the preparatory course. Finally, the concluding remarks are presented, with reflections and observations arising from the study.

2. Teaching Mathematics in Basic Education

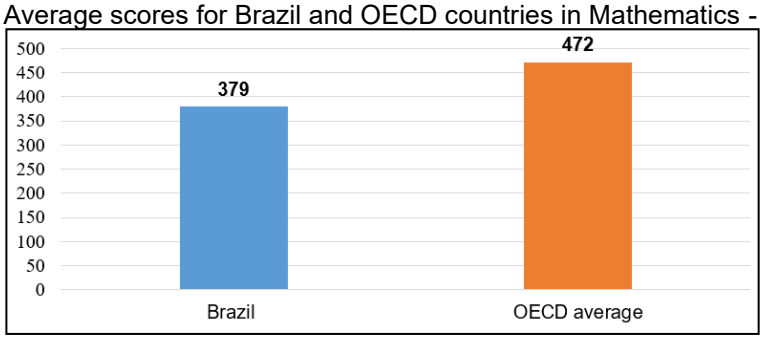
Regarding mathematics education in basic education, data provided by PISA (2022) reveals that 27% of Brazilian students reach the basic level of proficiency in mathematics, considered the minimum for the full exercise of citizenship. While only 10% reach the adequate level, the data is even more critical when looking at students from the most vulnerable classes, reaching only 3% of this group.

Analyzing the PISA (2022) data, a study conducted by Interdisciplinarity and Evidence in the Educational Debate (IEDE), in partnership with the Institute of Pure and Applied Mathematics (IMPA) and the Laboratory for Studies and Research in Social Education of FEA – PR/USP (Lepes), and with the support of B3 Social, published in 2024, provides a diagnosis of the situation of Brazilian students in mathematics. It highlights that Brazil is far behind the average scores obtained by students from developed countries that make up the OECD. Graph 1 indicates that the difference between the average scores obtained by Brazilian students and those from OECD countries is 93 points, representing a 3-year delay in learning.

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Graph 1 – Average scores for Brazil and OECD countries in Mathematics - PISA 2022

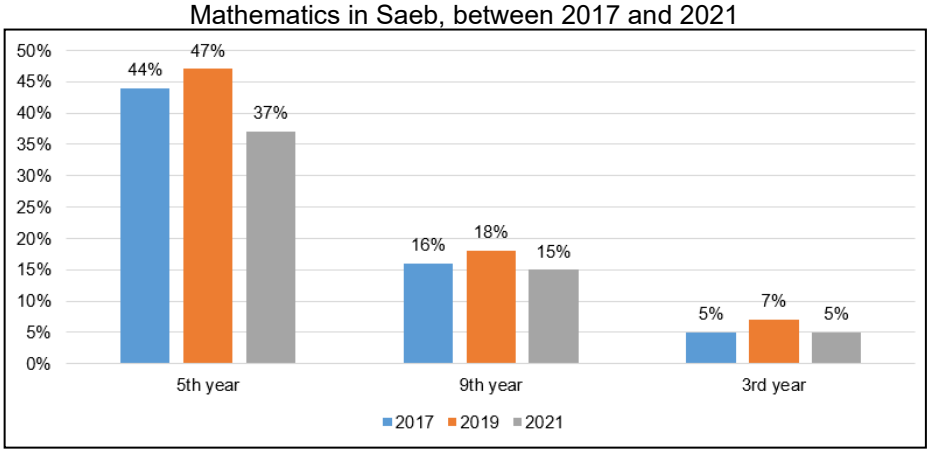


Source: IEDE (2024)

According to the IEDE study (2024), the shortcomings in mathematics education are evident in the Saeb assessments, which analyze data from Saeb conducted between 2017 and 2021. According to data from Saeb (2019), the last one conducted before the Covid-19 pandemic, only 47% of 5th-grade elementary school students had the appropriate level.

In the 2021 Saeb (National Assessment of Basic Education), already impacted by the pandemic, with the suspension of classes, remote learning, and little or no support for students and their families, there was a 10% drop, with only 37% of students in the 5th grade having an adequate level. This situation worsened in subsequent years, as shown in Graph 2: in 2019, only 19% of 9th-grade students had an adequate level, while only 7% of 3rd-grade students did.

Graph 2 – Evolution in the percentage of public school students with adequate learning in Mathematics in Saeb, between 2017 and 2021



Source: IEDE (2024)

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Based on the data presented above in graphs 1 and 2, it is clear that the teaching and learning of mathematics in basic education in Brazil is leaving much to be desired. The shortcomings occur in all years evaluated, but the situation is more critical in the final years of elementary school and in high school. The level of learning is declining year after year, which should be the opposite; there is no progress.

In this scenario, it is necessary to study the reasons that cause this decline in learning levels, especially when the student enters the final years of elementary school, and the following questions can be asked: what is being done in the early years so that less than half reach the adequate level? and what is being done in the final years and high school so that the percentage of students with an adequate level falls, instead of increasing? These are questions worth reflecting on, in order to understand the reasons that cause such a gap in relation to developed countries.

In light of this, the United Nations Educational, Scientific and Cultural Organization (UNESCO) highlights the need to rethink mathematical literacy in the face of social, technological, and cultural changes:

> Nowadays, mastering basic knowledge of numbers and magnitudes, which for a long time constituted the mathematical condition for social integration, is not enough. The culture of numbers – or digital culture – in which current societies are increasingly immersed, the new responsibilities that individuals must assume, as citizens or as people, the growing uncertainties that mark the world in which we live, demand a revision of the idea of mathematical literacy (UNESCO, 2016, p. 14).

This reflection reinforces the need for a broader and more meaningful approach to mathematics education. Therefore, concern for the quality of mathematics education is legitimate and requires integrated efforts from governments, educational institutions, teachers, and society as a whole.

With the goal of improving the quality of mathematics learning in Brazilian public basic education, several actions have been implemented over the last few decades, in which the federal government, in partnership with state and municipal governments, has been developing various programs and initiatives aimed at improving the country's educational indicators.

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Pages: 1-30

Among the projects and actions conceived as means to improve the quality of basic education, one can highlight OBMEP, which, according to Maranhão (2011, p. 13), "is a globally recognized public policy, one of the largest governmental initiatives focused on the teaching-learning process in mathematics, aiming to improve the motivation, interest, and performance of students in Brazilian public schools."

Furthermore, the objectives of OBMEP, found on the official website of the Olympiad, highlight its importance in the educational landscape by encompassing different dimensions of teaching and learning, which it seeks to:

> To stimulate and promote the study of Mathematics; to contribute to improving the quality of basic education, enabling a greater number of Brazilian students to have access to quality teaching materials; to identify young talents and encourage their entry into universities in scientific and technological fields; to encourage the professional development of public school teachers, contributing to their professional recognition; to contribute to the integration of Brazilian schools with public universities, research institutes and scientific societies; to promote social inclusion through the dissemination of knowledge (OBMEP, 2023).

These objectives confirm the relevance of the initiative, which goes beyond simply holding a competition, seeking to positively transform the landscape of mathematics education in the country, which is still in a critical state, even with the efforts made to change this reality.

3. OBMEP and its Educational Role

The Brazilian Mathematics Olympiad for Public and Private Schools – OBMEP is an initiative of the Institute of Pure and Applied Mathematics – IMPA, with support from the Ministry of Education – MEC and the Ministry of Science, Technology and Innovation – MCTI. Created in 2005, it has established itself as one of the largest olympiads in the country, reaching, in its 20th edition (2025), 99.93% of Brazilian municipalities and approximately 18.6 million students.

The main mission of OBMEP is to encourage students' interest in mathematics, providing a challenging and favorable learning environment. The competition is divided into three levels: level 1 for students in the 6th and 7th grades

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Pages: 1-30

of elementary school, level 2 for students in the 8th and 9th grades, and level 3 for high school students.

In addition to individual benefits, the initiative has also produced concrete results in the performance of Brazilian public schools. According to Biondi, Vasconcellos and Filho (2009), OBMEP has a positive and statistically significant effect on the average mathematics scores of schools in the 2007 Prova Brasil exam. The authors highlight that this impact intensifies as the number of participants in the annual editions of the Olympiad increases, contributing to improving the quality of public education.

A study evaluating the impact of OBMEP (Brazilian Mathematical Olympiad for Public Schools) on public schools, conducted in 2011 by the Center for Management and Strategic Studies (CGEE), shows that:

> The teaching materials distributed to schools by OBMEP – the Question Bank from previous years' exams and the booklets from the Scientific Initiation Program – are points of agreement between schools that have been successful in OBMEP and those that have not been successful: in both groups, both students and teachers agree on the importance of this material, not only for preparing for the Olympiad, but mainly for its use in the classroom, which is perceived as innovative, challenging, and demanding logical reasoning from students – only 3% of managers stated that teachers do not use the material. (CGEE, 2011, p. 9-10).

This data reinforces the fact that OBMEP transforms daily school life; students and teachers recognize the value of material that stimulates logical reasoning and promotes challenges, creating a more motivating environment for learning mathematics.

This work carried out in public schools has produced positive effects on students' academic performance. Proof of this can be seen in a recent study conducted by Agência Brasil (2024), which highlights that:

> Students from schools with high participation rates in the Brazilian Public School Mathematics Olympiad (OBMEP) have obtained better results in the National High School Exam (ENEM). This is shown by research conducted by Interdisciplinarity and Evidence in the Educational Debate (IEDE), an organization dedicated to studies in education. (AGÊNCIA BRASIL, 2024).

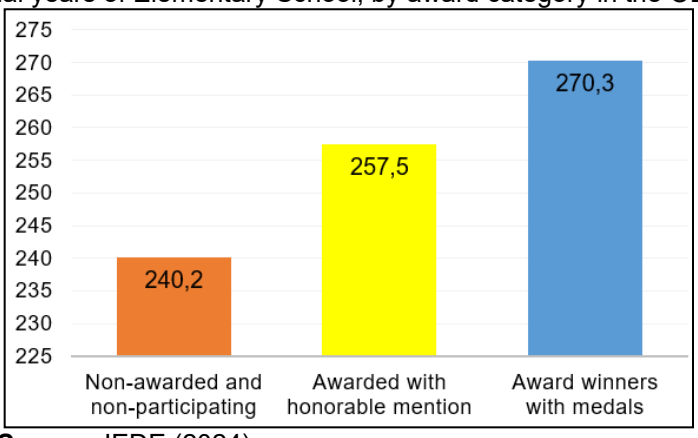
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Pages: 1-30

The study conducted by IEDE (2024), analyzing several schools that were part of the research, correlates student results in OBMEP with performance in educational indicators, analyzing performance in assessments such as SAEB and ENEM. It was found that award-winning schools achieve better results compared to non-awarded and non-participating schools. The same occurs in relation to ENEM; the average scores of award-winning schools are considerably better.

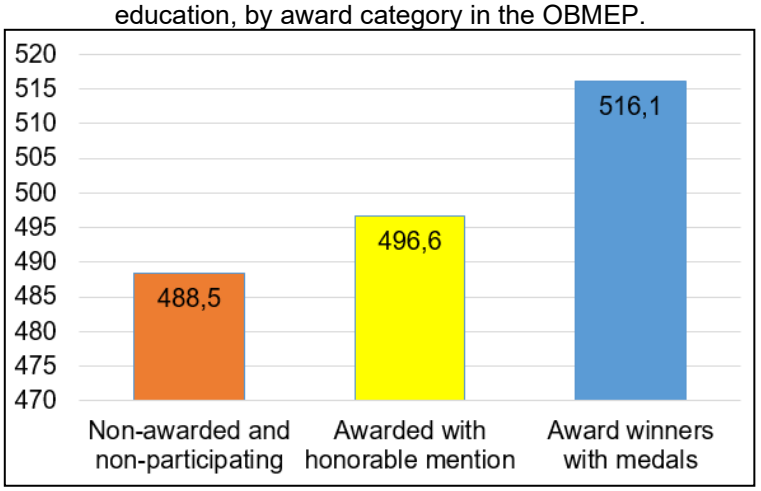
Graphs 3 and 4 show the average differences in performance on the Saeb and Enem exams, correlating them with the results on the OBMEP, respectively.

Graph 3 - Average Mathematics score for 9th grade students in the 2019 Saeb for schools offering the final years of Elementary School, by award category in the OBMEP



Source: IEDE (2024)

Graph 4 – Average Mathematics score in the 2019 ENEM exam for schools offering High School education, by award category in the OBMEP.



Source: IEDE (2024)

These data reinforce the importance of initiatives like OBMEP, which, in

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Pages: 1-30

addition to stimulating interest in mathematics, contributes to strengthening education in public schools. By valuing students' potential and offering new perspectives, these actions show that quality education is a possible path for everyone, regardless of the difficulties faced in daily life.

4. Problem Solving as a Theoretical Foundation for Preparing for the OBMEP

OBMEP goes beyond a strictly competitive character and can be understood as a pedagogical instrument that demands differentiated strategies in relation to traditional teaching. Its problems, marked by non-routine situations and conceptual challenges, require students to do more than the mechanical application of formulas, calling them to interpretation, argumentation, and the development of their own problem-solving strategies.

In this context, problem-solving is configured as a structuring axis of the teaching and learning process in Mathematics. As argued by Onuchic and Allevato (2011), the problem should assume the role of starting point for the construction of knowledge, favoring the articulation between different mathematical contents and the generation of new concepts. This perspective shifts the focus from the simple execution of algorithms to the understanding of the processes involved in the elaboration of solutions.

Van de Walle (2001, apud Onuchic; Allevato, 2011) complements this understanding by defining a problem as a task for which the student does not have previously memorized rules, requiring them to mobilize their own strategies. This definition is directly related to the nature of the OBMEP questions, which require autonomous and flexible reasoning, as well as the ability to establish connections between different areas of knowledge.

The problem-solving method systematized by Polya (1995) constitutes an important reference for understanding this approach. By proposing four stages: understanding the problem, developing a plan, execution, and reflection, Polya emphasizes that learning mathematics involves facing intellectual challenges and building investigative paths. For the author, teacher mediation should occur in a

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Pages: 1-30

balanced way, allowing the student to take a leading role in the problem-solving process. This conception directly dialogues with practices that value active learning and the development of intellectual autonomy.

From this perspective, problem-solving is not limited to a teaching technique, but operates as a mechanism for cognitive mobilization, involving interpretation, strategic planning, monitoring of actions, and metacognitive reflection. These dimensions are particularly relevant in the context of science olympiads, whose questions demand analytical thinking, creativity, and the ability to argue mathematically.

Beyond the cognitive component, educational literature indicates that challenging environments, when properly mediated, foster a sense of competence and intrinsic motivation in students. Thought-provoking and investigative questions, such as those found in the Brazilian Mathematical Olympiad (OBMEP), can act as catalysts for academic engagement, stimulating persistence, interest, and active involvement with the subject.

Within the scope of this research, the preparatory course was structured in light of these theoretical frameworks, prioritizing the collective discussion of strategies, the collaborative resolution of problems, and systematic reflection on the procedures adopted. The proposal sought to create an active learning environment in which students were encouraged to explain their reasoning, compare solutions, and construct mathematical arguments, approaching the stages described by Polya and the concept of problem-solving advocated by Onuchic and Allevato.

Thus, preparation for the OBMEP was conceived not only as training for a specific test, but as an opportunity to strengthen mathematical thinking, intellectual autonomy, and student engagement in the face of more complex cognitive challenges.

5 Methodological Procedures

This investigation adopted a mixed-methods (qualitative and quantitative) approach, combining statistical analysis of student performance with interpretation

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Pages: 1-30

of perceptions constructed throughout the training process. This integration allowed for the simultaneous examination of measurable aspects of progress in mock exams and qualitative dimensions related to engagement, motivation, and the lived pedagogical experience.

Regarding the objectives, the research is characterized as exploratory, as Gil (2002) points out; this type of investigation seeks to broaden the understanding of preparation for scientific olympiads in the context of Mathematics Education. The study was developed through field research, with direct observation of activities and application of instruments in the formative environment itself.

According to Thiollent (2011), the investigation falls within the perspective of action research, since it articulated pedagogical intervention and systematic reflection on practice. However, for analytical purposes, this article specifically focuses on the evaluative dimension of the implemented intervention, assuming a single-group design with repeated measures over time. This configuration approximates a quasi-experimental design, even without an external control group, which imposes limits on the causal inference of the results.

5.1 Design and Participants

The preparatory course was held between June and October 2023, bringing together 30 middle school students, all previously qualified for the second phase of the OBMEP (Brazilian Mathematical Olympiad for Public Schools). Fifteen students from Level 1 (6th and 7th grades) and fifteen from Level 2 (8th and 9th grades) participated, coming from three schools in the municipal network.

In Level 1, 6 students from the 6th grade and 9 from the 7th grade participated, aged between 11 and 13 years (8 male and 7 female). In Level 2, 10 students from the 8th grade and 5 from the 9th grade participated, aged between 13 and 15 years (4 male and 11 female). Therefore, this is a purposive sample composed of students with above-average prior performance, which should be considered when interpreting the results.

5.2 Instruments and Procedures

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The research instruments included:

- Application of an initial diagnostic mock exam;
- Application of four subsequent mock exams, each consisting of six essay questions from previous editions of the OBMEP;
- Final perception questionnaire with seven questions;
- Systematic observation of classroom dynamics.

The diagnostic mock exams aimed to identify the participants' initial performance. Subsequent the mock exams allowed for monitoring progress throughout the training period. The course was structured around problem-solving, prioritizing collective discussion of strategies, mathematical argumentation, and reflection on the procedures adopted.

The essay questions were graded based on predefined criteria, considering: (i) understanding of the problem; (ii) adequacy of the strategy; (iii) logical development of the solution; and (iv) coherence of the final result. Partial points were awarded when the student demonstrated consistent reasoning, even if they did not fully arrive at the expected answer. The grading was performed by the lead researcher, with no independent double grading, which constitutes a methodological limitation.

5.3 Data Analysis Procedures

The quantitative analysis was conducted using descriptive statistics, in accordance with the guidelines of Morettin and Bussab (2010), including the calculation of the mean percentage of correct answers and the corresponding standard deviations for each mock exam applied. Additionally, the absolute mean gain (Δ%) between the first and the last mock exam was estimated in order to measure the variation in students' performance throughout the course.

To qualify the magnitude of the observed difference, the standardized effect size (Cohen's d) was calculated, as proposed by Cohen (1988), using the combined standard deviation of the initial and final measurements. This procedure makes it

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Pages: 1-30

possible to assess the intensity of the recorded progression based on conventional interpretation criteria (small, medium, and large effects), although without the intention of establishing robust causal inference, due to the lack of a control group.

In relation to the qualitative analysis, the data obtained from classroom observations and records produced during the preparatory course were examined through content analysis, following the proposal of Bardin (2016). The procedure was conducted in three main stages: (i) pre-analysis, involving a preliminary reading of the records and organization of the material; (ii) exploration of the material, through a process of thematic coding, in which significant excerpts were identified and grouped according to recurring meaning units; and (iii) treatment and interpretation of the results, a stage in which the codes were consolidated into analytical categories related to aspects such as student engagement, perception of mathematical difficulty, participation in activities, and motivation to take part in scientific olympiads.

5.4 Limitations of the Study

Several aspects should be considered when interpreting the results. Firstly, the sample consisted exclusively of students who had already qualified for the second phase of the OBMEP, which introduces selection bias and limits the generalizability of the findings.

Additionally, the observed progress may be partially associated with familiarization with the format of the tests (training effect) and the natural maturation of the students throughout the training period. The absence of an external control group prevents a direct causal attribution between the pedagogical intervention and the gains recorded; therefore, the results should be interpreted as evidence of progress associated with participation in the course.

6. Analysis and Discussion of the Data

This section presents an analysis of the data obtained throughout the preparatory course for the OBMEP, integrating quantitative evidence from the mock

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 07/03/2026
Vol: 13.02
DOI: 10.66104/efm1we40
Pages: 1-30

exams with qualitative data from systematic observations and the students' perception questionnaire. This approach allows us to understand not only the evolution of performance, but also the changes related to motivation, self-confidence, and perception of learning.

Considering the quasi-experimental design with a single group and repeated measures, the results should be interpreted as evidence of progression over time. Due to the absence of a control group and the intentional nature of the sample, it is not possible to establish a direct causal relationship between the intervention and the observed gains, but only to identify associations consistent with the formative period analyzed.

6.1 Evolution of Performance in Essay Based Mock Exam

The practice tests administered constituted the main quantitative instrument for monitoring the evolution of student performance. Five essay-based practice tests were applied, the first being diagnostic and the others intended for the progressive monitoring of learning.

As shown in Table 3, the evolution of the average percentage of correct answers and the standard deviation can be observed throughout the exams applied to level 1.

Table 3 – Overall average scores (%) – Level 1

Mock exams	Number of Questions	Average Score (%)	Standard Deviation (%)
Diagnostic test	6	42	12
Mock Exam 1	6	46	10
Mock Exam 2	6	53	9
Mock Exam 3	6	57	8
Mock Exam 4	6	61	8

Source: Research data (2023).

At level 1, the average percentage of correct answers improved from 42% in the diagnostic exam to 61% in the final exam, representing an absolute gain of 19 percentage points. This result corresponds to a relative increase of approximately 45% compared to the initial performance. A reduction in the standard deviation was

REMUNOM
ISSN 2178-6925

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Vol: 13.02
DOI: 10.66104/efm1we40
Pages: 1-30

also observed, from 12% to 8%, indicating a decrease in variability among students and greater homogeneity in performance throughout the period.

To assess the magnitude of the progression observed at Level 1, the effect size was calculated using Cohen's d coefficient, as shown in Equation 1:

$$d = \frac{M_F - M_I}{\sigma} \qquad \text{(Equation 1)}$$

Where M_F represents the average obtained in the last exam, M_I corresponds to the average of the diagnostic exam, and σ refers to the average of the standard deviations of the two applications.

Substituting the observed values, we have:

$$M_F - M_I = 61 - 42 = 19$$

$$\sigma = \frac{12 + 8}{2} = 10$$

therefore, $d = \frac{19}{10} = 1{,}9$.

According to the interpretation criteria proposed by Cohen (1988), d values above 0.8 are already considered large magnitude. Thus, the result obtained (d = 1.9) indicates a very large effect size, suggesting that the implemented pedagogical intervention produced a significant impact on student performance.

The results for level 2, presented in Table 4, allow for the analysis of the progression of average performance and the dispersion of results throughout the exams.

Table 4 – Overall average success rate (%) – Level 2

Mock exams	Number of Questions	Average Score (%)	Standard Deviation (%)
Diagnostic test	6	48	11
Mock Exam 1	6	55	10
Mock Exam 2	6	61	9
Mock Exam 3	6	63	8
Mock Exam 4	6	71	7

Source: Research data (2023).

At level 2, the average percentage of correct answers increased from 48% in the diagnostic exam to 71% in the last exam, corresponding to an absolute gain of

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 07/03/2026
Vol: 13.02
DOI: 10.66104/efm1we40
Pages: 1-30

23 percentage points, equivalent to a relative increase of approximately 48%. The standard deviation decreased from 11% to 7%, indicating distributed progression among the participants.

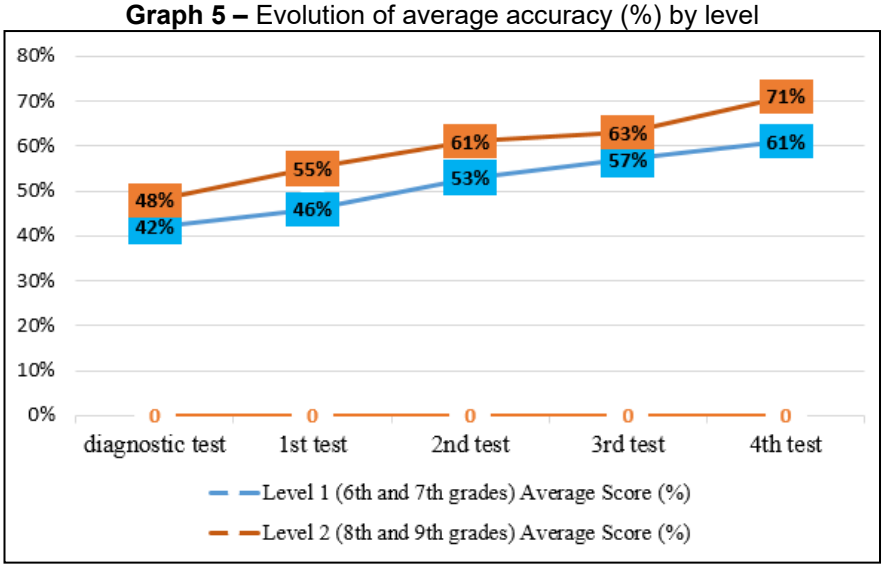
Applying the same methodology to calculate the magnitude of progression at level 2, we have:

$$d = \frac{71 - 48}{\frac{11 + 7}{2}} = \frac{23}{9} = 2{,}56$$

This result also represents a very large effect size, Cohen (1988), indicating a high magnitude of progression observed between the beginning and end of the period analyzed at level 2.

The evolution of average scores in the mock tests for students in levels 1 and 2 can be observed in Graph 5, which shows the percentage progression throughout the tests administered during the preparatory course.

Graph 5 – Evolution of average accuracy (%) by level



Source: Research data (2023)

As shown in Graph 5, there is a growing trend in average performance at both levels, with gradual progression throughout the applications. At level 1, the average improved from 42% in the diagnosis to 61% in the last exam, while at level 2 there was an increase from 48% to 71%. These results show consistent progression throughout the analyzed period, although it is not possible to attribute direct causality to the pedagogical intervention.

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 07/03/2026
Vol: 13.02
DOI: 10.66104/efm1we40
Pages: 1-30

Among the study's limitations, the small number of participants (30 students) and the fact that the investigation only included students who qualified for the second phase stand out, restricting the generalization of the results. However, the findings are consistent with the studies by Biondi, Vasconcellos and Filho (2009) and Soares and Candian (2011), which highlight the positive influence of projects associated with OBMEP on students' motivation, autonomy, and mathematical performance.

In summary, the analysis of the mock exams showed an improvement in mathematical skills and a strengthening of students' interest in the subject throughout the preparatory course, highlighting its relevance in the context of public education.

6.2 Performance Analysis by Content Area.

This section presents the results of the analysis of the number of correct answers by content and level, based on the essay-based mock exams applied throughout the course. The data allows us to observe the students' performance in each content area covered, highlighting aspects related to the understanding of concepts and the problem-solving strategies employed throughout the learning process.

The content assessed in the mock exams was grouped according to the traditional OBMEP classification: arithmetic, algebra, geometry, counting/probability, and logical reasoning. Table 5 presents the number of questions and the average percentage of correct answers per area, considering the results of the level 1 (6th and 7th grades) and level 2 (8th and 9th grades) classes.

It should be noted that each question was classified according to the area that required the greatest expertise for its resolution, although some questions involved knowledge from more than one subject. This categorization allowed for a more precise analysis of the areas in which students demonstrated greater proficiency, as well as those in which they showed greater difficulties.

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 07/03/2026
Vol: 13.02
DOI: 10.66104/efm1we40
Pages: 1-30

The distribution of performance by subject area is presented in Table 5, allowing identification of the areas with the highest and lowest percentage of correct answers at each level.

Table 5 – Average percentage of correct answers by area and level

Thematic area	Number of Questions (Level I)	Percentage of Correct Answers (Level I)	Number of Questions (Level II)	Percentage of Correct Answers (Level II)
Arithmetic	7	63%	6	72%
Algebra	5	55%	5	65%
Geometry	6	49%	7	55%
Counting/Probability	6	42%	6	48%
Logical Reasoning	6	68%	6	71%

Source: Research data (2023).

The results indicated better performance in the areas of logical reasoning and arithmetic, with averages higher than the other areas. At level 1, the average percentages were 68% in logical reasoning and 63% in arithmetic, while at level 2 they were 71% and 72%, respectively.

On the other hand, the lowest averages were observed in the areas of counting/probability and geometry, suggesting a higher level of cognitive complexity associated with these skills, especially with regard to abstraction and organization of reasoning.

In general, students at level 2 showed a higher number of correct answers compared to those at level 1, highlighting differences in performance between the groups analyzed. This result is consistent with data presented by IEDE (2024), which also identifies variations in performance in large-scale educational assessments, such as Saeb and Enem.

At both levels, it was observed that the greatest difficulties were associated with content related to the interpretation of problems involving counting and probability, as well as the application of geometric concepts. This finding is consistent with the results presented by PISA (2022), which highlight limitations in mathematical literacy, especially in situations that demand modeling, spatial visualization, and combinatorial reasoning.

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 07/03/2026
Vol: 13.02
DOI: 10.66104/efm1we40
Pages: 1-30

In the context of the analyzed mock exams, these results highlight relevant aspects of student performance in content that is recurrent in assessments such as the OBMEP (Brazilian Mathematical Olympiad for Public Schools). The analysis allows for the identification of patterns related to the problem-solving strategies employed and the difficulties encountered, contributing to an understanding of student performance throughout the educational process.

6.3 Qualitative Analysis of Students' Perception

In addition to quantitative analyses of performance in the mock exams, the study sought to understand students' perceptions of the preparatory course for the OBMEP (Brazilian Mathematical Olympiad for Public Schools), considering aspects related to interest in mathematics, motivation, perception of learning, and level of satisfaction with the training experience. To this end, a questionnaire was administered at the end of the course and answered by the 30 students participating in the research.

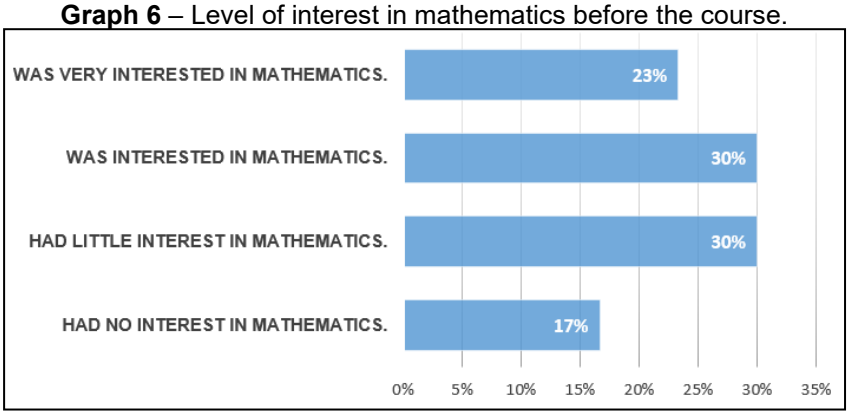
The use of questionnaires as a data collection instrument makes it possible to access perceptions, opinions, and meanings attributed by subjects to their lived experience, contributing to a broader understanding of the phenomenon under investigation, Gil (2008). In this sense, the analysis of these responses allows for the complementation of quantitative data, articulating objective and subjective evidence of the formative process.

Initially, the aim was to identify the students' level of interest in mathematics before participating in the preparatory course. The results are presented in Graph 6.

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 07/03/2026
Vol: 13.02
DOI: 10.66104/efm1we40
Pages: 1-30

Graph 6 – Level of interest in mathematics before the course.



Source: research data (2023)

As shown in Graph 6, it can be observed that 30% of students declared having little interest in the subject and 17% stated they had no interest, totaling 47% of participants with a low level of initial interest. On the other hand, 30% reported having interest and 23% stated they had a lot of interest, totaling 53% with a positive perception of Mathematics.

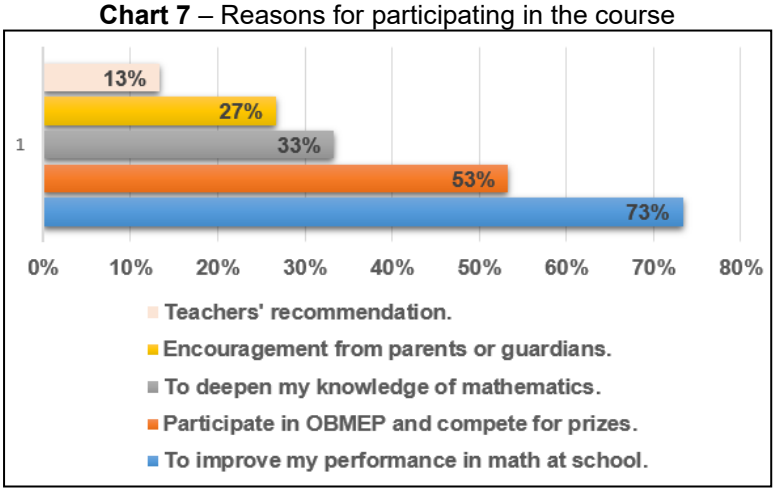
These data show that a significant portion of the students entered the course exhibiting weaknesses in their relationship with the subject, which reinforces the importance of educational initiatives that promote engagement and the development of confidence in learning mathematics. According to Biondi, Vasconcellos, and Filho (2009), participation in activities associated with OBMEP can significantly contribute to increasing students' interest and performance by providing challenging and stimulating experiences.

Next, the main reasons that led students to participate in the preparatory course were investigated. The results are presented in Graph 7.

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 07/03/2026
Vol: 13.02
DOI: 10.66104/efm1we40
Pages: 1-30

Chart 7 – Reasons for participating in the course



Source: Research data (2023).

The data presented in Graph 7 indicate that 73% of students cited the desire to improve their performance in Mathematics at school as their main motivation, while 53% indicated an interest in participating in the OBMEP (Brazilian Mathematical Olympiad for Public Schools) and the possibility of competing for awards. In addition, 33% reported an interest in deepening their mathematical knowledge, 27% mentioned family encouragement, and 13% highlighted teacher recommendations.

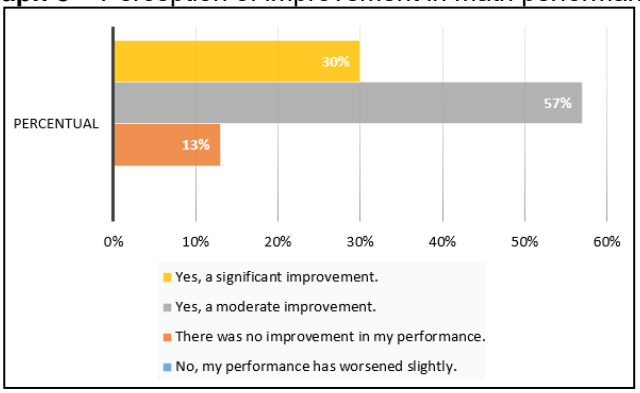
These results show that participation in the course was associated with both personal factors, such as the desire to learn and improve academic performance, and contextual factors, such as encouragement from teachers and family members. As Thiollent (2011) points out, the active involvement of participants in training processes is related to strengthening motivation and commitment to learning, especially when students attribute meaning and relevance to the proposed activities.

The study also sought to analyze the students' perception of their own progress throughout the course. The results are presented in Graph 8.

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 07/03/2026
Vol: 13.02
DOI: 10.66104/efm1we40
Pages: 1-30

Graph 8 – Perception of improvement in math performance



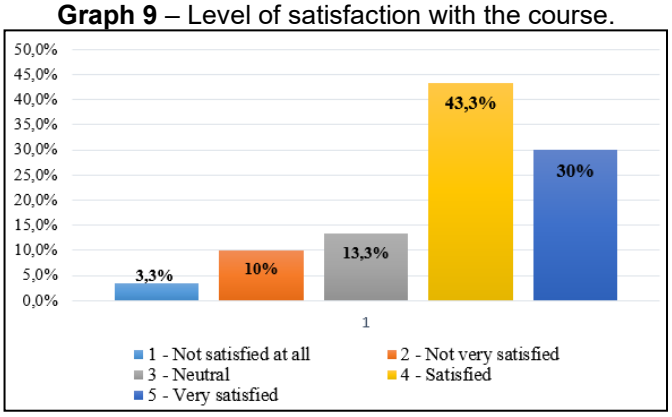
Source: Research data (2023).

As illustrated in Graph 8, 30% of students stated that they had noticed significant progress in their learning, while 57% indicated that they had observed moderate improvement in their performance. Only 13% of participants reported not noticing significant progress.

These data reveal that most students recognized progress in their learning, a result that is consistent with the advances observed in the previously presented mock exams. According to Morettin and Bussab (2010), the joint analysis of quantitative and qualitative data allows for a more consistent understanding of educational phenomena, making it possible to identify not only objective results, but also the perceptions and experiences of the participants.

The students' level of satisfaction with the preparatory course was also investigated, as shown in Graph 9.

Graph 9 – Level of satisfaction with the course.



Source: Research data (2023).

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 07/03/2026
Vol: 13.02
DOI: 10.66104/efm1we40
Pages: 1-30

The data presented in Graph 9 indicate that 43% of students declared themselves satisfied and 30% stated they were very satisfied with the course, totaling 73% positive evaluations. On the other hand, 13.3% expressed a neutral position and only 3.3% indicated dissatisfaction.

This result highlights a predominantly positive evaluation of the course, indicating that the training experience contributed significantly to the academic development of the participants. This type of positive perception is associated, as Biondi, Vasconcellos and Filho (2009) point out, with the impact of educational initiatives that promote the development of logical reasoning and intellectual autonomy in students.

In addition to objective questions, the questionnaire included open-ended questions, allowing students to express their perceptions of the course's contributions. The main findings are presented in Table 1.

Table 1 – Report on the course's contributions to interest in and understanding of mathematics.

Students	Answers
A3	"During the course, I realized that mathematics isn't as difficult as it seems, and I really enjoyed the way we studied the material. The positive aspect is how the teacher explains things."
A4	"The way we studied, sitting around the table and talking about how to solve the problems, made me learn more."
A5	"The way the teacher taught the class, helping with the answers."
A6	"The content seems to have become easier, and the teacher's help with the answers was great. A positive point was the problem sets; every class had a different problem set to answer, without needing to copy the questions."

Source: Research data (2023).

The reports presented in Table 1 show that the students perceived positive changes in their relationship with mathematics, highlighting aspects such as the clarity of the explanations, the teacher's support, and the methodology adopted. Student A3 stated that "in the course I could see that mathematics is not as difficult

REMUNOM
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Received: 13/01/2026 - **Accepted:** 07/03/2026
Vol: 13.02
DOI: 10.66104/efm1we40
Pages: 1-30

as it seems," while student A4 highlighted that the study method based on the discussion of solutions contributed to their learning.

These testimonies indicate that the methodology adopted favored the construction of knowledge in a more meaningful way, promoting greater understanding of the content and developing students' confidence. According to Thiollent (2011), pedagogical approaches that encourage the active participation of students contribute to strengthening learning and critical thinking.

The study also sought to investigate the course's contribution to clarifying doubts and overcoming difficulties in mathematics. The results are presented in Table 2.

Table 2 – Report on the usefulness of the course in resolving doubts and difficulties in mathematics.

Students	Answers
A11	"Yes, it helped me a lot. Every time I had a problem, the teacher explained it to me in an easier way until I understood."
A12	"Yes, I had a lot of difficulty with content that I didn't learn back then, and the teacher is going back to that content that I didn't learn properly in school."
A13	"Yes, the material is good, easy to understand, and the explanations are more direct and to the point than what you get at school."

Source: Research data (2023).

The reports presented in Table 2 show that the course contributed significantly to overcoming difficulties and strengthening learning. Student A11 stated that the teacher explained the content until there was understanding, while student A12 highlighted the importance of reviewing previously misunderstood content.

These results indicate that pedagogical support and the use of appropriate strategies contributed to meeting the individual needs of students, favoring the development of learning. As Gil (2008) points out, systematic support and the use of appropriate pedagogical strategies are essential factors for the success of educational processes.

REMUNOM
ISSN 2178-6925

Received: 13/01/2026 - **Accepted:** 07/03/2026
Vol: 13.02
DOI: 10.66104/efm1we40
Pages: 1-30

Overall, the analysis of the questionnaire responses shows that the preparatory course contributed not only to the development of mathematical performance, but also to strengthening students' motivation, self-confidence, and interest in the subject. These results complement the quantitative evidence presented earlier, reinforcing the importance of educational initiatives that promote the development of mathematical reasoning and student engagement.

The combination of quantitative and qualitative data allows for a more comprehensive understanding of the course's impact, demonstrating that the training experience contributed to the academic and personal development of the participating students.

7. Final Considerations

This research aimed to investigate the contributions of a preparatory course for the Brazilian Mathematics Olympiad for Public and Private Schools (OBMEP) to the mathematical education of middle school students in the public school system of São Raimundo Nonato – PI. Through the integrated analysis of quantitative data obtained from mock exam and qualitative data from perception questionnaires and systematic observations, it was possible to identify consistent evidence of improved performance and positive changes in students' relationship with mathematics throughout the training period.

Regarding academic performance, the results showed a progressive increase in average scores on the mock exam, both at level 1 and level 2, indicating improved performance throughout the course. Analysis by content area revealed better performance in arithmetic and logical reasoning, while greater difficulties persisted in geometry and counting/probability. These results allow us to identify areas that require greater pedagogical attention, especially regarding the development of mathematical interpretation, abstraction, and argumentation skills—essential competencies for problem-solving.

From a qualitative perspective, the students' responses indicated relevant changes in their perception of mathematics, including increased interest,

REMUNOM
ISSN 2178-6925

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Vol: 13.02
DOI: 10.66104/efm1we40
Pages: 1-30

strengthened self-confidence, and greater security in problem-solving. Participants highlighted the methodology adopted as positive aspects, characterized by problem-solving, individualized support, encouragement of dialogue, and the use of organized materials—elements that fostered a more participatory and meaningful learning environment.

The integrated analysis of the results suggests that the preparatory course constituted a formative environment conducive to the development of mathematical reasoning and the strengthening of students' engagement with the subject. However, considering the methodological design adopted, with a single group and a purposive sample composed of students already qualified for the second phase of the OBMEP (Brazilian Mathematical Olympiad for Public Schools), the results should be interpreted as evidence of an association between the formative period and the observed progress, and it is not possible to establish a direct causal relationship between the intervention and the identified gains.

Among the study's limitations, the small number of participants, the geographical scope restricted to a single municipal school network, and the absence of a control group stand out, factors that limit the generalizability of the results. Furthermore, the possibility of influence from external factors, such as the students' natural maturation and their progressive familiarization with the assessment format, should be considered.

Despite these limitations, the results contribute to the debate on mathematics education in basic education, highlighting the potential of formative initiatives associated with OBMEP (Brazilian Mathematical Olympiad for Public Schools) to promote the development of mathematical reasoning, motivation, and confidence in students. The findings reinforce the importance of adopting pedagogical strategies that prioritize problem-solving, student protagonism, and systematic monitoring of learning.

Finally, it is recommended that future research expand the number of participants, include different educational contexts, and adopt comparative designs, including control groups, in order to deepen the understanding of the impacts of

REMUNOM
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Vol: 13.02
DOI: 10.66104/efm1we40
Pages: 1-30

preparatory courses and similar initiatives on the development of mathematics learning over time.

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