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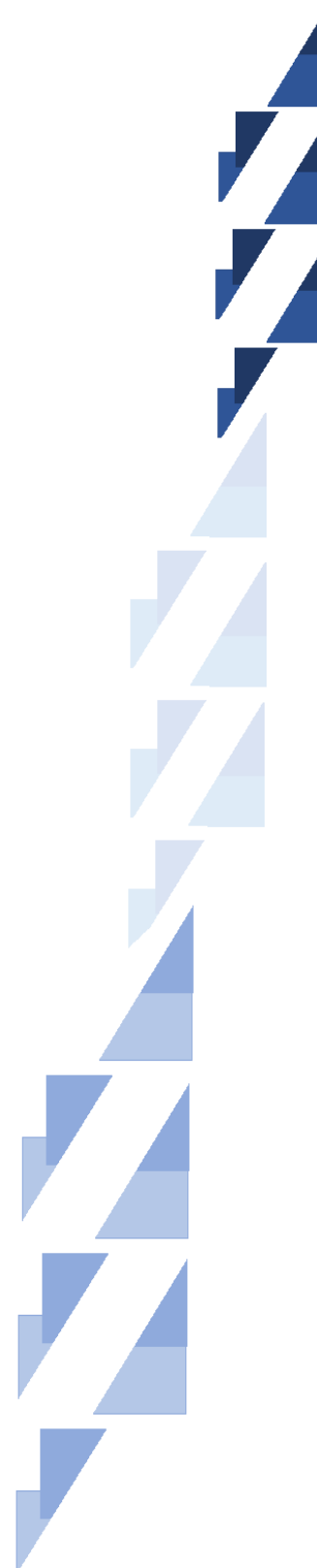
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Articles

Multilevel Planning for Strengthening Mathematical Competencies in Rural Primary Education

Planeación multinivel y fortalecimiento de competencias matemáticas en educación primaria rural

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Abstract

The objective of the study was to analyze the effect of an intervention based on multilevel planning on strengthening basic mathematical competencies among fifth- and sixth-grade students at a rural primary school in Veracruz, Mexico. The research was conducted using a mixed-methods approach, with an action research design and a quasi-experimental scope involving measurements before and after the intervention. Thirty-nine students who completed both assessments participated in the study. Over ten weeks, a workshop-based course was implemented using differentiated activities, manipulatives, constructivist strategies, and contextualized problem-solving tasks. Data were collected through a pretest, posttest, classroom observations, teacher interviews, and monitoring logs. The results showed a significant increase in mathematical performance, accompanied by improvements in participation, autonomy, and confidence in solving problems. These findings indicated that organizing instruction through different levels of support and complexity promoted learning in heterogeneous groups. It was concluded that multilevel planning constitutes a relevant pedagogical strategy for strengthening basic mathematical competencies and helping reduce learning gaps in rural contexts.

Keywords: Mathematical competencies, multilevel planning, primary education, pedagogical intervention, rural education.

Resumen

El objetivo del estudio fue analizar el efecto de una intervención basada en planeación multinivel sobre el fortalecimiento de las competencias matemáticas básicas en estudiantes de quinto y sexto grado de una escuela primaria rural de Veracruz, México. La investigación se desarrolló mediante un enfoque mixto, con diseño de investigación-acción y alcance cuasi experimental con mediciones antes y después de la intervención. Participaron 39 estudiantes que completaron ambas evaluaciones. Durante diez semanas se implementó un curso-taller con actividades diferenciadas, recursos manipulativos, estrategias constructivistas y resolución de problemas contextualizados. La información se obtuvo mediante pretest, post-test, observación de aula, entrevistas a docentes y bitácoras de seguimiento. Los resultados evidenciaron un incremento significativo en el desempeño matemático, acompañado de mejoras en la participación, la autonomía y la confianza para resolver problemas. Estos hallazgos indicaron que la organización de la enseñanza mediante distintos niveles de apoyo y complejidad favoreció el aprendizaje en grupos heterogéneos. Se concluyó que la planeación multinivel constituye una estrategia pedagógica pertinente para fortalecer las competencias matemáticas básicas y contribuir a disminuir el rezago en contextos rurales.

Palabras clave: Competencias matemáticas, planeación multinivel, educación primaria, intervención pedagógica, educación rural.

Introduction

Mathematics learning during primary education is an essential process for the development of logical reasoning, information interpretation, and the ability to solve problems encountered in everyday life. Beyond mastering algorithms, mathematical competencies involve understanding numerical relationships, selecting appropriate procedures, justifying answers, and transferring knowledge to new situations. These abilities provide the foundation for subsequent learning and for individuals' active participation in different social contexts. However, international assessments continue to show that a substantial proportion of students experience difficulties in reaching satisfactory levels of mathematical performance. The results of PISA 2022 indicate a decline in performance compared with previous cycles and show that gaps associated with socioeconomic background remain one of the main challenges faced by education systems (OECD, 2023).

In Mexico, the 2022 Curriculum incorporates mathematical thinking into the formative field of Knowledge and Scientific Thinking and proposes that students construct knowledge through problem-solving, argumentation, and the analysis of contextualized situations (SEP, 2022). Nevertheless, teaching practice continues to rely heavily on activities focused on the repetition of procedures and the memorization of rules, with limited opportunities to promote conceptual understanding. Several studies indicate that learning improves when students participate actively, explain procedures, analyze errors, and develop cognitive strategies for solving problems (Son et al., 2020).

Basic mathematical competencies integrate numerical knowledge, procedures, and reasoning skills that enable students to interpret information and respond to diverse situations. During primary education, students are expected to consolidate fundamental operations, fractions, decimal numbers, elementary geometry, and problem-solving. These competencies support later learning; therefore, difficulties that arise at this stage tend to accumulate and negatively influence future academic performance (OECD, 2023). From a constructivist perspective, such learning is strengthened when students reorganize their prior knowledge through interaction with materials, peers, and teachers in environments where the explanation and discussion of procedures form part of the teaching process. In this regard, Bermejo et al. (2021) demonstrated that constructivist interventions support mathematical performance when content is presented progressively and teachers act as mediators of learning.

Within this approach, problem-solving constitutes a central instructional strategy because it promotes the interpretation of information, the selection of procedures, and the justification of results. Rather than being viewed solely as an application activity, it serves as a means of developing conceptual understanding and autonomy. According to Son et al. (2020), teaching approaches that incorporate problem-solving and active student participation produce significant improvements in mathematical performance. Likewise, the meta-analysis conducted by Vessonen

et al. (2025) found that interventions are more effective when they include a structured instructional sequence, teacher support, and consistent implementation.

The need to strengthen these competencies is particularly relevant in rural schools, where socioeconomic conditions, the availability of educational resources, and opportunities for family support are often heterogeneous. UNESCO (2023) states that responding to these differences requires inclusive pedagogical approaches capable of adapting instruction to students' characteristics. In this context, multilevel planning is a strategy that organizes a common learning objective through activities with different levels of support and complexity, allowing all students to engage with the same content without lowering learning expectations. This approach shares principles with differentiated instruction, which adjusts resources, processes, and forms of participation to respond to classroom diversity. Bal (2023) found that such strategies can improve both mathematical achievement and attitudes toward the subject when activities address students' learning needs.

Although research has examined differentiated instruction, problem-solving, and constructivist learning, the available evidence on pedagogical interventions that integrate these components through multilevel planning in rural primary education remains limited, particularly in the Mexican context. Most studies analyze these strategies independently or in urban settings; therefore, evidence concerning their combined application in rural schools with heterogeneous groups is still scarce. Rather than confirming an absolute knowledge gap, this situation highlights the need to document contextualized experiences that help explain how such approaches can be implemented under real teaching conditions.

At José María Morelos y Pavón Primary School, located in Acajete, Veracruz, an institutional assessment conducted at the beginning of the school year through a mathematical competency test administered to fifth- and sixth-grade students showed an average of 9.21 correct answers out of a maximum of 30 items, equivalent to 30.68% performance. The greatest difficulties were found in fractions, decimal numbers, and contextualized problem-solving. These results indicated low performance in basic mathematical competencies rather than educational underachievement in a broader sense and justified the implementation of a pedagogical intervention aimed at strengthening these areas of learning.

Based on the foregoing, the objective of the present study was to evaluate changes in the basic mathematical competencies of fifth- and sixth-grade students at a rural primary school after a pedagogical intervention based on multilevel planning.

Methodology

The study employed a mixed-methods approach with a quantitative emphasis and a complementary qualitative component. The quantitative component followed a one-group pre-

experimental design with pretest and posttest measurements, as all participants received the workshop-based intervention and no comparison group or random assignment was available. Accordingly, the design made it possible to assess changes in basic mathematical competencies between the pretest and posttest; however, it did not allow those changes to be attributed exclusively or causally to the intervention. The qualitative component was used to broaden the interpretation of the quantitative findings through information related to participation, autonomy, collaborative work, academic confidence, problem-solving strategies, and persistent difficulties.

The study was conducted during the 2024–2025 academic year at José María Morelos y Pavón Primary School, which belongs to Xalapa-Foráneas School Zone 012 and is located in Acajete, Veracruz, Mexico. The school had an enrollment of 141 students distributed across 11 classes from first through sixth grade. The eligible population consisted of 48 fifth- and sixth-grade students: 10 from Grade 5, Group A; nine from Grade 5, Group B; 14 from Grade 6, Group A; and 15 from Grade 6, Group B. A non-probability purposive sampling procedure was used because these grades represent the final stage of primary education, during which students are expected to consolidate fundamental operations, fractions, decimal numbers, elementary geometry, and problem-solving skills before entering secondary education.

Of the 48 students initially considered, 45 produced valid pretest records, and 39 completed both the intervention and the two assessments. The three students without valid diagnostic records were not included in the initial database, whereas six of the 45 students assessed at baseline did not complete the posttest because of absences or changes in school attendance during the final assessment period. The statistical analysis was therefore conducted exclusively with the 39 matched cases included in the comparative database. These participants represented 86.7% of those who completed the pretest and 81.3% of the initially selected population, as shown in Table 1.

Table 1

Participant flow throughout the study

Stage	Students	Percentage of the initial population
Students initially selected	48	100.0%
Students with a valid pretest	45	93.8%
Students with complete pretest and posttest data	39	81.3%
Records excluded from the paired analysis	9	18.7%

Source. Authors' own elaboration. Three students did not have a valid diagnostic record, and six did not complete the final assessment.

As shown in Table 2, the analytical sample consisted of eight students from Grade 5, Group A; eight from Grade 5, Group B; 11 from Grade 6, Group A; and 12 from Grade 6, Group B. All 39 participants included in the final analysis attended 100% of the scheduled workshop sessions. Age and sex were not collected during data gathering and were therefore not included in the sample characterization. The four classroom teachers also participated through semi-structured interviews.

Table 2

Distribution of the analytical sample by grade and class group

Grade and group	Frequency	Porcentage
5.º A	8	20.5%
5.º B	8	20.5%
6.º A	11	28.2%
6.º B	12	30.8%
Total	39	100.0%

Source. Authors' own elaboration based on the matched cases.

The inclusion criteria were enrollment in fifth or sixth grade, parental authorization and student assent, participation in the sessions, and availability of complete scores for both assessments. Cases without either a pretest or posttest score were excluded from the analysis. The baseline mean for the 45 students who completed the initial assessment was 9.24 points, whereas the corresponding mean for the 39 matched cases was 9.21 points. The difference of 0.03 points indicated that participant attrition did not substantially alter the initial group mean, although the possibility of attrition bias could not be completely ruled out.

Quantitative measurement was conducted using a 30-item test developed specifically for the study. The characteristics of the instrument are presented in Table 3. The test was administered face-to-face in paper-and-pencil format. Responses were subsequently entered into Google Forms and exported to Microsoft Excel. Each correct answer was awarded one point, whereas incorrect or unanswered items received zero points, resulting in a possible total score ranging from 0 to 30.

Table 3

Test specifications for mathematical competencies

Area assessed	Content included	Items	Possible score
Numbers and basic operations	Number reading, rounding, ordering, addition, and subtraction	1-5	0-5
Multiplication	Algorithms, mental calculation, error identification, and application	6-10	0-5
Division	Algorithms, remainders, verification, and sharing problems	11-15	0-5
Fractions and decimals	Equivalence, ordering, conversion, and operations	16-20	0-5
Geometry and measurement	Shapes, perimeter, area, and unit conversion	21-25	0-5
Integrated problems	Selection and combination of operations	26-30	0-5

Total	30	0-30
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Source. Authors' own elaboration based on the research instrument.

Three performance levels were established to interpret the scores: low, from 0 to 17 points; medium, from 18 to 23 points; and high, from 24 to 30 points. These categories served a descriptive purpose and were not intended as individual diagnostic classifications.

Before its final administration, the test was piloted with 20 students whose characteristics were similar to those of the target population. The pilot study made it possible to revise the wording of several items. Internal consistency in the pilot administration was $\alpha = .84$. Cronbach's alpha was .91 for the pretest and .80 for the posttest.

The test was also reviewed by three specialists in mathematics education and educational assessment, who evaluated the clarity, relevance, and alignment of the items. Interrater agreement reached a Fleiss' kappa of $\kappa = .81$, which was interpreted as almost perfect agreement according to Landis and Koch (1977). Pretest item difficulty indices ranged from .00 to .62, with a mean of .31, while corrected item-total correlations ranged from .21 to .75, with a mean of .48. Item 18 received no correct responses and therefore lacked sufficient variability to estimate its discriminatory capacity. Its revision was consequently considered necessary for future applications.

Qualitative information was collected through direct observation, weekly field logs, and semi-structured interviews with the four classroom teachers. The observations focused on students' comprehension of instructions, mathematical procedures, reliance on manual counting, selection of operations, review of results, concentration, confidence in participating, and collaboration with peers. The field logs documented the difficulties encountered, the progress observed, and the adjustments introduced during the sessions.

The interview guide consisted of 11 questions addressing mathematical performance, recurring errors, instructional strategies, motivation, attendance, family support, and the need for educational resources. This information complemented the diagnostic assessment and informed the selection of intervention content and support strategies.

As shown in Table 4, the intervention consisted of a 10-week workshop-based course implemented by the lead researcher with support from the classroom teachers. One session per week was conducted in each of the four groups, resulting in 10 sessions per group and 40 group-based sessions overall. Session length was adjusted according to the objectives established for each week. In lesson plans that included a detailed time allocation, sessions consisted of 15 to 20 minutes of activation activities, approximately 60 minutes of development, and 20 minutes of closure or conceptual introduction.

Table 4

Organization of the workshop-based intervention

Weeks	Purpose	Content	Strategies
1-4	Consolidate basic operations and understand remainders	Addition, subtraction, multiplication, division, grouping, and remainders	Formative assessment, modeling, mental calculation, linked exercises, and sharing problems
5-8	Broaden students' understanding of numbers	Fractions, equivalence, operations with fractions, decimals, and place value	Manipulatives, graphic representations, progressive exercises, and collaborative work
9-10	Integrate learning	Measurement, decimal numbers, perimeter, area, and integrated problems	Problem-solving, graphic representation, guided review, and independent work

Source. Authors' own elaboration based on the workshop lesson plans.

Multilevel planning maintained common learning objectives while varying the degree of support, the number of exercises, and the complexity of the tasks. Students who experienced greater difficulties received step-by-step modeling, worked examples, concrete resources, and visual support. Students with an intermediate level of mastery completed activities with less guidance and were required to explain their procedures, whereas those demonstrating more advanced performance solved integrated problems and completed tasks requiring mathematical argumentation and knowledge transfer.

Support was assigned flexibly on the basis of pretest performance, classroom observations, and students' performance in each area of content. In fifth grade, greater emphasis was placed on modeling and reinforcing basic operations. During the fourth week, both fifth-grade groups received extended support in grouping, multiplication, division, and interpretation of remainders. In the final integrative activity, fifth-grade students solved one comprehensive problem, whereas sixth-grade students completed two problems combining operations, fractions, decimals, measurement, and geometry.

Implementation fidelity was documented through lesson plans, field logs, and evidence of the activities completed. The records included the objectives, content, strategies, difficulties encountered, and instructional adaptations implemented. No standardized fidelity scale was administered, and no quantitative fidelity percentage was calculated; therefore, implementation monitoring was based on systematic documentary review.

The quantitative analysis was conducted using the 39 matched cases. Frequencies, percentages, means, medians, standard deviations, and minimum and maximum values were calculated. The normality of the difference scores was examined using the Shapiro–Wilk test. The result, $W = .950$, $p = .080$, supported the use of a paired-samples Student's t test, with statistical significance established at $p < .05$.

The magnitude of change was estimated using Cohen's d_z , which is appropriate for repeated measurements. The mean difference was 7.79 points, and the standard deviation of the

difference scores was 6.08, resulting in $d_z = 1.28$. The database was organized in Microsoft Excel, and inferential analyses were performed using IBM SPSS Statistics, version 29.

The qualitative analysis followed a descriptive thematic procedure. Meaning units were grouped into five categories: participation, autonomy, collaboration, attitudes toward mathematics, and problem-solving. The interviews, observations, and field logs were subsequently compared to identify similarities and differences. Integration was conducted by relating quantitative changes to qualitative records indicating reduced reliance on manual counting, greater confidence, improved selection of operations, and increased autonomy.

Before the intervention began, authorization was obtained from the school authorities. With their support, parents and legal guardians were invited to a meeting at which the study objectives, activities, instruments, voluntary nature of participation, and confidential use of the information were explained. Those who authorized participation signed an approval agreement. Students received an age-appropriate explanation of the study and provided their assent. The data were coded and reported in aggregate form, and the authorization documents remained under the custody of the school.

Results

The results comprised descriptive and inferential analyses of the 39 matched cases, together with qualitative information derived from classroom observations, teacher interviews, and field logs.

Pretest Results

As shown in Table 5, the 39 students obtained a mean score of 9.21 correct responses out of a maximum of 30, equivalent to an average performance level of 30.68%. The standard deviation of 5.85 indicated considerable variability across scores, which ranged from 0 to 21 correct responses. These findings reflected a limited initial level of mastery of the competencies assessed.

Table 5

Descriptive results of the pretest

Indicator	Result
Valid participants	39
Maximum possible score	30
Mean	9.21
Standard deviation	5.85
Median	9.00
Minimum score	0
Maximum score obtained	21
Mean performance percentage	30.68%

Source: Authors' own elaboration based on the matched cases.

Regarding performance levels, 34 students were classified at the low level and five at the intermediate level; none reached the high level. The responses revealed greater difficulties in fractions and decimal numbers, geometry, measurement, and integrated problems. Observations conducted during the diagnostic assessment also documented reliance on manual counting, errors in organizing algorithms, limited answer checking, and insecurity when addressing problems involving multiple instructions.

Posttest Results

At the end of the 10-week intervention, the same test used for the initial assessment was administered again. As shown in Table 6, the mean score increased to 17.00 correct responses, equivalent to 56.67% of the maximum possible score. The standard deviation was 5.12, and scores ranged from 9 to 26. The median score of 16 indicated that half of the students obtained at least this score.

Table 6

Descriptive results of the posttest

Indicator	Result
Valid participants	39
Maximum possible score	30
Mean	17.00
Standard deviation	5.12
Median	16.00
Minimum score	9
Maximum score obtained	26
Mean performance percentage	56.67%

Source: Authors' own elaboration based on the results of the 39 matched cases.

The most evident improvements were observed in the use of multiplication and division, the interpretation of remainders, and the selection of appropriate operations to solve problems. Nevertheless, the activities and field logs showed that fractions and decimal numbers continued to present difficulties, particularly when tasks required students to establish equivalences, perform conversions, or combine procedures.

Performance Comparison

As shown in Table 7, all groups increased their scores. The largest mean changes were found in Grade 5, Group A and Grade 5, Group B, which had also recorded the lowest initial means.

Table 7

Results by grade and group

Grade and group	n	Pretest mean	Posttest mean	Mean change
5.º A	8	6.88	17.50	10.63
5.º B	8	3.38	12.50	9.13
6.º A	11	10.45	18.18	7.73
6.º B	12	13.50	18.58	5.08
Total	39	9.21	17.00	7.79

Source: Authors' own elaboration based on the comparative dataset for the 39 participants.

The mean score increased from 9.21 to 17.00 correct responses, representing a difference of 7.79 points and an increase of 25.99 percentage points in average performance. Table 8 presents the overall comparison.

Table 8
Comparison of overall mean performance

Assessment	Mean number of correct responses	Performance percentage
Pretest	9.21 de 30	30.68%
Posttest	17.00 de 30	56.67%
Difference	7.79	25.99 percentage points

Source: Authors' own elaboration based on the 39 matched cases.

Changes were also observed in the distribution across performance levels. As shown in Table 9, 34 students were classified at the low level and five at the intermediate level in the pretest. After the intervention, 23 students remained at the low level, 10 were classified at the intermediate level, and six reached the high level. Accordingly, the proportion of students at the low level decreased by 28.2 percentage points, whereas the proportions at the intermediate and high levels increased by 12.8 and 15.4 percentage points, respectively.

Table 9
Comparison of performance levels

Level	Pretest, n (%)	Posttest, n (%)	Percentage-point difference
Low	34 (87.2%)	23 (59.0%)	-28.2
Intermediate	5 (12.8%)	10 (25.6%)	+12.8
High	0 (0.0%)	6 (15.4%)	+15.4
Total	39 (100%)	39 (100%)	—

Source: Authors' own elaboration. Performance levels were classified as low, from 0 to 17 points; intermediate, from 18 to 23 points; and high, from 24 to 30 points.

The descriptive results showed a shift toward higher performance categories. However, given the one-group pre-experimental design, these changes should be interpreted as differences observed after the intervention rather than as definitive causal evidence.

Inferential Analysis

The Shapiro–Wilk test did not indicate a statistically significant departure from normality, $W = .950$, $p = .080$. The mean score increased from 9.21 points on the pretest ($SD = 5.85$) to 17.00 points on the posttest ($SD = 5.12$). The mean difference was 7.79 points ($SD = 6.08$), with a 95% confidence interval ranging from 5.82 to 9.77. The paired-samples t test confirmed a statistically significant difference between the two assessments, $t(38) = 8.01$, $p < .001$.

The magnitude of change was large, $d_z = 1.28$. Although this value indicated practical relevance, the pre-experimental design did not allow the intervention to be identified as the sole cause of the observed difference.

Table 10

Inferential comparison between pretest and posttest scores

Indicator	Result
n	39
Pretest mean	9.21
Pretest standard deviation	5.85
Posttest mean	17.00
Posttest standard deviation	5.12
Mean difference	7.79
Standard deviation of the difference scores	6.08
95% confidence interval	[5.82, 9.77]
t	8.01
Degrees of freedom	38
p	< .001
Cohen's d_z	1.28

Source: Authors' own elaboration based on the analysis of the 39 paired observations.

Qualitative Findings

The observations, teacher interviews, and field logs made it possible to identify changes in participation, autonomy, collaboration, attitudes toward mathematics, and problem-solving. Because the records were descriptive rather than verbatim transcripts, the findings are presented as analytical summaries.

Table 11

Summary of qualitative findings

Category	Initial situation	Changes observed	Persistent difficulties
Participation	Insecurity and limited involvement	Greater willingness to respond and explain	Uneven participation in complex tasks
Autonomy	Dependence on the teacher and manual counting	More independent problem-solving and greater review of procedures	Continued need for modeling in abstract content

Collaboration	Limited interaction	Increased peer support and exchange of strategies	Dependence on higher-performing students
Attitudes toward mathematics	Fear of making mistakes and low confidence	Greater confidence and interest in contextualized activities	Insecurity regarding fractions and decimals
Problem-solving	Difficulty interpreting instructions and selecting operations	Improved identification of data and procedures	Problems involving multiple conditions and conversions

Source: Authors' own elaboration based on classroom observations, teacher interviews, and field logs.

The qualitative findings were consistent with the increase in scores, as they indicated greater participation, autonomy, and confidence. However, they also showed that progress was not uniform across all areas. Fundamental operations and some contextualized problems showed clear improvements, whereas fractions and decimal numbers continued to require greater instructional support. The findings should therefore be interpreted in light of the contextual nature of the study and the absence of a comparison group.

Discussion

The findings suggest that the observed improvement was not limited to a quantitative shift in test scores, but also involved a transformation in the way students engaged with mathematical activity. The increase in the overall mean, together with observational evidence of reduced reliance on manual counting, greater willingness to participate, and increased confidence in explaining procedures, suggests that the intervention influenced both procedural mastery and the progressive appropriation of mathematical reasoning practices. This interpretation is consistent with Bermejo et al. (2021), who documented that constructivist interventions in mathematics yield better outcomes when students assume an active role, teachers mediate the learning process, content is meaningfully sequenced, and classroom work promotes cooperation and contextualization.

There is also a clear connection with recent literature emphasizing that the quality of mathematics instruction depends on the underlying structures of classroom practice rather than solely on visible formats or isolated resources. Given that high-quality mathematics teaching is organized around five principles cognitive demand, conceptual focus, student orientation and adaptivity, longitudinal coherence, and enriched mathematical communication (Prediger et al., 2022) the improvements observed in this study, particularly in operations, problem interpretation, and oral participation, may be understood as indications that the intervention succeeded in simultaneously sustaining several of these principles. This is especially relevant in heterogeneous groups, particularly because the most consistent improvement programs do not rely on fragmented actions but rather on coherent frameworks shared by those responsible for teaching and supporting professional development processes (Prediger et al., 2024).

In the same vein, the findings move away from a reductionist understanding of differentiation in which responding to diversity would imply lowering expectations for students

experiencing greater difficulties. One of the most common distortions of adaptivity consists of providing low-performing or socially disadvantaged students with impoverished learning opportunities characterized by low cognitive demand and an excessive procedural focus (Prediger et al., 2022). The pattern observed in the present study, however, reflects a different logic: common content was maintained while levels of support, pacing, materials, and forms of participation were diversified. This distinction is important because it helps explain why the improvement was evident not only in the execution of algorithms but also in the comprehension of instructions and the more appropriate selection of mathematical operations.

The relevance of these improvements becomes even more apparent when considered within the international context. According to the OECD (2023), the recent decline in mathematics achievement and the strong association between socioeconomic background and academic performance show that socially disadvantaged students remain considerably more likely to fail to reach the basic level of mathematical proficiency. Within this context, the fact that an intervention implemented in a rural primary school produced such notable descriptive gains does not, of course, resolve the underlying structural problem. Nevertheless, it provides evidence that low achievement should not be regarded as a fixed condition and that the classroom can function as a meaningful space for pedagogical compensation when consistent instructional mediation is provided.

Another major strength of the study lies in demonstrating that multilevel planning can function as a strategy for accessing the curriculum rather than merely as a means of adapting activities for low-performing students. The increase in the overall mean score and the movement of students from the low-performance category toward the intermediate and high levels suggest that the diversification of activities contributed to academic inclusion. It enabled a greater number of students to remain engaged in a shared learning experience rather than being symbolically excluded from the content through homogeneous teaching practices. This finding is consistent with the principle of student orientation and adaptivity described by Prediger et al. (2022), according to which teaching should begin with an assessment of students' learning levels and lead to instructional decisions that maintain shared trajectories of progress while responding to heterogeneous needs.

Particularly noteworthy is that the improvement observed does not appear to have resulted from a simple simplification of schoolwork, but rather from a more refined balance between support and academic demand. The current QuaMath framework emphasizes that cognitive demand becomes educationally meaningful only when all students are able to participate in rich mathematical tasks, rather than when complexity is reserved for only a few learners (Prediger et al., 2022). From this perspective, the experience described in the study is valuable because it suggests that multilevel planning was most effective when it did not replace reasoning with repetition, but instead differentiated students' entry points into the content while sustaining understanding through materials, contextualized activities, and close instructional support.

The field logs, in turn, provide qualitative corroboration of this process. The transition from an initial pattern characterized by insecurity, dependence on the teacher, and predominant use of manual counting toward greater autonomy in solving and explaining tasks, together with more active collaborative work, is consistent with what has been described as “enriched mathematical communication.” In this form of instruction, mathematical discourse is not treated as an ancillary feature, but rather as a condition for deepening conceptual understanding (Bermejo et al., 2021; Prediger et al., 2022).

At the same time, the study itself shows that not all mathematical content responds at the same pace to a 10-week intervention. The fact that fractions and decimal numbers remained areas of difficulty does not weaken the intervention; rather, it helps clarify the areas in which its effects appear more immediate and those that require greater continuity. Recent literature suggests that more abstract mathematical learning requires longer developmental trajectories, a strong conceptual focus, and explicit connections among representations, procedures, and meanings. Within the QuaMath framework, this relates to two dimensions: conceptual understanding and longitudinal coherence in learning. Both emphasize that practice alone is insufficient and that continuity must be established across stages, representations, and uses of mathematical knowledge (Prediger et al., 2022; Prediger et al., 2024).

From a broader pedagogical perspective, the study reinforces three instructional decisions that merit particular attention. The first is to use diagnostic assessment as a genuine starting point for teaching rather than as a mere entry requirement. The second is to design tasks that preserve the same curricular horizon for the entire group while providing differentiated levels of support, representation, and instructional mediation. The third is to make the communicative dimension of mathematics more explicit so that explaining, arguing, comparing procedures, and discussing errors become part of the content itself rather than merely components of the methodology. These orientations are consistent both with Mexico’s 2022 Curriculum, which emphasizes contextualization, problematization, and connections with the community, and with recent research associating better learning opportunities with high-quality instruction, adaptive support, and formative monitoring of student progress (SEP, 2022; Prediger et al., 2022).

The rural context should not be understood solely as a setting characterized by material deprivation, but rather as an environment in which heterogeneous educational trajectories, unequal learning paces, varying levels of family support, and institutional limitations on sustained intensive support intersect. In this respect, perhaps the study’s main contribution lies in showing that measurable improvement can be achieved even in a school with accumulated difficulties in mathematics when the intervention systematically organizes progression, support, and learning expectations. However, scaling up experiences of this kind requires recognition that local improvement often depends on a high intensity of instructional work and carefully designed school-based support, both of which may not always be structurally available in rural settings.

The OECD (2023) has warned that education systems providing less timely support to students who fall behind and reporting greater shortages of teaching staff face more adverse conditions for sustaining mathematics achievement. This has clear implications for educational policy, particularly because improvement in schools located in challenging contexts depends less on standardized solutions than on context-sensitive development frameworks, school networks, continuous professional learning, additional resources, and cooperation among research, policy, and practice (Holzer et al., 2025). This perspective aligns closely with the type of intervention examined in the present study, which acquires its full meaning precisely because it begins with a local diagnosis, designs specific forms of support, and adjusts implementation according to classroom realities. Therefore, the principal policy implication is not to replicate the workshop mechanically, but rather to create the conditions that enable more schools to develop their own responses with technical support, institutional time, and appropriate materials.

Along the same lines, continuing teacher education should move away from episodic, short-term workshop formats and toward more sustained, collaborative models centered on problems of practice. Large-scale programs with greater potential for sustainability are those that articulate a shared vision of instructional quality, systematic professional development, coherent materials, and networks of exchange among schools and teacher educators (Prediger et al., 2024). The relevance of this approach for rural contexts is evident: when teachers experience professional isolation, heterogeneous classrooms, and limited external support, collaborative networks and shared instructional resources cease to be supplementary and instead become essential components of pedagogical infrastructure.

In the case analyzed, the use of contextualized problems appears to have supported both understanding and participation. Accordingly, and in line with the 2022 Curriculum, which explicitly proposes that problem-solving should be grounded in meaningful contexts and in relationships among family, school, and community, a reasonable recommendation for future interventions would be to deepen the territorial contextualization of mathematical tasks and connect it more systematically with family-based monitoring strategies, particularly in those areas identified as more fragile in the present study, such as fractions and decimal numbers.

Finally, it is important to emphasize that this study does not close the discussion regarding the effectiveness of multilevel planning in rural contexts. Rather, it opens the discussion in a meaningful way by showing that this approach warrants further examination through comparative designs, measures of learning retention, and implementation studies capable of distinguishing more clearly which components account for the changes observed..

Conclusions

Following the multilevel planning-based intervention, a statistically significant improvement was observed in the overall mathematical performance of the 39 students who

completed both assessments. The mean posttest score was higher than the pretest score, and the magnitude of change was large. These findings addressed the objective of the study by demonstrating favorable differences between the measurements conducted before and after the workshop-based intervention. However, given the one-group pre-experimental design, the observed changes cannot be attributed exclusively to the intervention.

Within the specific context of the rural primary school examined, multilevel planning provided a feasible approach for organizing common content through varying degrees of support, instructional guidance, and task complexity. Observation records, field logs, and teacher interviews suggested favorable changes in participation, autonomy, and academic confidence among some students, although these improvements were not uniform across all groups or content areas. Because the quantitative analysis was based on the overall test score, it was not possible to determine which specific mathematical competency or which component of the intervention was most strongly associated with the observed improvement.

The findings should be interpreted in light of the study's limitations. The research was conducted in a single institution, with a non-probability sample and no comparison group, which limits the generalizability of the findings and the possibility of establishing causal relationships. In addition, the use of the same instrument for both the pretest and posttest may have produced a familiarity effect, while regular classroom instruction and student maturation may also have influenced the results. The 10-week duration of the intervention likewise did not allow the persistence of the observed changes to be assessed over the medium or long term.

Future research could incorporate comparison groups, samples drawn from different rural schools, and follow-up assessments to examine the stability of the findings over time. It would also be relevant to analyze performance separately in operations, fractions, decimal numbers, geometry, and problem-solving, as well as to evaluate the specific contribution of visual supports, manipulatives, collaborative work, and contextualized tasks. Such analyses would make it possible to determine more precisely the scope of multilevel planning and the conditions under which it may support mathematics learning in primary education.

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Author Contributions

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