Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

The Potential of Mathematical Fairy Tales as a Sustainable Didactic Tool in First-Grade Mathematics Education for Bilingual Students

Dena Spyrou

dena.mincheva@yahoo.com

TU Sofia https://orcid.org/0009-0003-2580-3782

Research Article

Keywords: narrative-based instruction, mathematics achievement, bilingual students, early mathematics education, instructional design, quasi-experimental research

Posted Date: March 25th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9186581/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations:
The authors declare no competing interests.

Ethics statement: The study was conducted in accordance with institutional and national ethical standards for research involving human participants. Ethical approval for the research was granted by the Ethics Committee of the Technical University of Sofia, Bulgaria. The study was conducted with the permission of the school administration and implemented in a regular classroom setting, without disrupting the instructional process defined by the official curricula approved by the Ministry of Education and Science of Bulgaria. Participation in the study was voluntary. Informed consent was obtained from the parents/guardians of all participating students prior to data collection. All data were collected anonymously and used solely for research purposes, ensuring full confidentiality and compliance with data protection regulations.

Cover Page

Title

The Potential of Mathematical Fairy Tales as a Sustainable Didactic Tool in First-Grade Mathematics Education for Bilingual Students

Author

Dena Spyrou

Author Affiliation

Technical University of Sofia
Faculty of Pedagogy – Sliven
Burgasko Shose 59
8800 Sliven
Bulgaria

Author Position

Assistant in Mathematics

Corresponding Author

Dena Spyrou
Email: dena.mincheva@yahoo.com

ORCID

https://orcid.org/0009-0003-2580-3782

Abstract

This study investigates the effectiveness of a narrative-structured instructional approach in supporting mathematical learning in a bilingual first-grade classroom. The intervention systematically integrates narrative elements across the main phases of the mathematics lesson—concept introduction, guided practice, consolidation, and assessment—with the aim of facilitating conceptual understanding and the development of disciplinary mathematical language.

The research was conducted in a Bulgarian primary school using a quasi-experimental single-group design with 25 bilingual first-grade students. Students' mathematical achievement was examined through equivalent assessments administered before and after the instructional intervention. In addition to statistical analysis of test results, a vector-based cognitive learning acquisition index (CLI) was used to evaluate multiple indicators of mathematical competence.

The findings indicate a statistically significant improvement in students' mathematical achievement following the implementation of the narrative-structured instructional model. Additional analysis based on the CLI index shows positive dynamics across several indicators, including the acquisition of mathematical terminology, the correct application of algorithms in problem solving, and the comprehension of word problems. Qualitative reflections from pupils further suggest that the narrative context supported engagement and improved the perceived comprehensibility of mathematical tasks.

Although the single-group design does not permit causal inference, the results provide preliminary empirical evidence that structured narrative-based instructional approaches may support both conceptual understanding and disciplinary language development in linguistically diverse early primary classrooms.

Keywords

narrative-based instruction, mathematics achievement, bilingual students, early mathematics education, instructional design, quasi-experimental research

Declarations

Ethical Statement

The study was conducted in accordance with ethical standards for educational research involving school pupils. Participation was voluntary and all data were collected and analyzed anonymously.

Conflict of Interest

The author declares that there is no conflict of interest.

Funding

The author received no financial support for the research, authorship, or publication of this article.

Data Availability

The datasets generated and analyzed during the current study are not publicly available due to ethical considerations and the protection of participants' privacy, as the research involved school students. Aggregated data supporting the findings of this study are presented within the article.

Blinded Manuscript (without authors' details)

The Potential of Mathematical Fairy Tales as a Sustainable Didactic Tool in First-Grade Mathematics Education for Bilingual Students

ABSTRACT

This study examines the effectiveness of a narrative-structured instructional approach in supporting mathematical learning in a bilingual first-grade classroom. The instructional model systematically integrates narrative elements across the main phases of the mathematics lesson-concept introduction, guided practice, consolidation, and assessment-with the aim of facilitating conceptual understanding and the development of disciplinary mathematical language.

The research was conducted in a Bulgarian primary school with a group of 25 bilingual first-grade students during the second semester of the academic year. A quasi-experimental single-group pre-post design was employed. Students' mathematical achievement in addition and subtraction within 20, place-value understanding, and number comparison was evaluated through equivalent diagnostic and final assessments. Instead of a control group, students' results obtained during the first semester were used as a baseline reference for comparison with their performance following the instructional intervention.

To ensure objective measurement of learning outcomes, the analysis of students' performance was conducted using a vector-based diagnostic model of cognitive learning acquisition (CLI), which evaluates several indicators of mathematical competence and allows the calculation of an aggregated index of achievement.

The results indicate a clear improvement in students' mathematical performance after the implementation of the narrative-structured instructional model. Qualitative observations further suggest increased engagement and improved comprehensibility of mathematical tasks. These findings suggest that narrative-structured instructional design may represent a promising pedagogical approach for supporting mathematical achievement and disciplinary mathematical language development in linguistically diverse early primary classrooms.

Keywords: *narrative-based instruction; bilingual students; early mathematics education; mathematical achievement; disciplinary mathematical language*

INTRODUCTION

In contemporary educational systems, the development of strong mathematical foundations in the early years of schooling represents a central pedagogical priority. First grade marks a crucial stage in this process, as learners begin transitioning from concrete representations of number toward more structured forms of numerical reasoning. At the same time, students gradually acquire the disciplinary language of mathematics, which is necessary for understanding relationships between quantities, interpreting mathematical expressions, and communicating mathematical ideas.

Within linguistically diverse classrooms, this process becomes significantly more complex. For bilingual students, learning mathematics involves not only mastering numerical operations but also understanding and using subject-specific mathematical terminology in a non-dominant language. As a result, mathematical learning is closely intertwined with language development, and difficulties in interpreting mathematical vocabulary or relational syntax may hinder students' access to the conceptual meaning of mathematical tasks.

In recent decades, mathematics education research has increasingly emphasized the importance of meaning-oriented and contextually grounded instructional approaches that support conceptual understanding rather than purely procedural learning. Approaches that situate symbolic operations within coherent contexts have been shown to enhance student

engagement and facilitate relational reasoning. One pedagogical approach that aligns with these principles is narrative-based instruction. By embedding mathematical ideas within temporally and causally structured story contexts, narrative organization can support the integration of symbolic representation, conceptual reasoning, and linguistic formulation.

Empirical studies suggest that storytelling approaches may positively influence student motivation, engagement, and the coherence of conceptual understanding in mathematics learning. However, in much of the existing research storytelling is used primarily as a supplementary or episodic instructional element rather than as a systematically structured instructional model embedded throughout the phases of the mathematics lesson.

The linguistic dimension of mathematics further highlights the need for instructional approaches that simultaneously support conceptual and language development. Mathematical proficiency requires not only computational accuracy but also the ability to interpret and produce disciplinary language. For bilingual students, processing mathematical vocabulary and relational structures in a second language may increase cognitive load and influence performance in problem-solving tasks.

Despite growing interest in narrative pedagogy and language-sensitive mathematics instruction, relatively few studies have examined the systematic integration of narrative structures across the different phases of instruction in early primary classrooms. Moreover, empirical evidence documenting measurable changes in mathematical achievement following such structured narrative-based implementation remains limited.

The present study addresses this gap by examining the effectiveness of a structured narrative-based instructional model implemented in a bilingual first-grade classroom. Using a quasi-experimental pre–post research design, the study investigates whether students' mathematical achievement in tasks involving addition, subtraction, place-value understanding, and number comparison improves following the implementation of the narrative-structured instructional approach. Students' performance after the intervention was compared with their learning outcomes obtained during the first semester, when instruction was conducted without the narrative-based model.

THEORETICAL FRAMEWORK

Theoretical Foundations of Narrative-Based Instruction in Mathematics Education

In recent decades, educational research has shown growing interest in narrative-structured approaches to learning that aim to enhance cognitive engagement and support the meaningful construction of knowledge. Narrative has long been conceptualized as a fundamental mode of human cognition through which individuals organize experience into temporally and causally coherent structures (Bruner, 1996). Within this perspective, narrative does not function merely as a representational or motivational embellishment but as an epistemic framework that enables individuals to structure meaning by linking actions, intentions, and outcomes within coherent sequences of events.

In the context of mathematics education, the development of conceptual understanding often requires learners to coordinate several cognitive dimensions simultaneously, including symbolic notation, relational reasoning, and linguistic interpretation. During the early stages of formal schooling this multidimensional cognitive demand may create fragmentation in learners'

understanding, as students attempt to interpret abstract symbolic representations without sufficient semantic grounding. Narrative structuring has the potential to mitigate such fragmentation by embedding mathematical relations within meaningful contexts that provide semantic continuity. By situating symbolic operations within causally organized sequences of events, narrative frameworks may facilitate the integration of conceptual reasoning, linguistic interpretation, and symbolic representation.

This integrative function is particularly relevant in early primary education, where learners gradually transition from concrete experiential reasoning toward more formalized symbolic abstraction. In such contexts narrative structures can support conceptual coherence by linking mathematical operations with meaningful situational contexts. Through this process symbolic representations become connected to interpretable sequences of actions and consequences, thereby strengthening relational understanding and supporting the development of mathematical reasoning.

Empirical research in mathematics education suggests that story-based instructional approaches may enhance student engagement, support conceptual coherence, and stimulate more productive classroom discourse (Lemonidis & Kaiafa, 2019). Narrative sequencing can function as a cognitive scaffold that provides semantic continuity across learning activities, reduces extraneous cognitive load, and facilitates the construction of relational connections between mathematical concepts. These mechanisms are consistent with sociocultural perspectives on learning, which conceptualize knowledge development as mediated through language and culturally structured forms of meaning-making.

Despite these promising theoretical perspectives, a considerable portion of the existing literature conceptualizes storytelling primarily as an episodic instructional strategy implemented in isolated lessons or short-term interventions. In many classroom contexts narrative elements are introduced mainly as motivational enhancements rather than as structurally integrated components of lesson design. As a result storytelling is frequently positioned as an auxiliary pedagogical technique rather than as a foundational organizing principle of instructional architecture. Consequently, relatively limited research has examined how narrative structures can be systematically aligned with the formal didactic functions of mathematics instruction, including concept introduction, guided practice, consolidation, and assessment.

Mathematical Language Development and Bilingual Students

Mathematical proficiency is closely connected to disciplinary language. Solving mathematical problems requires students not only to perform calculations but also to interpret specialized vocabulary, understand relational syntactic structures, and articulate logically structured reasoning. In this sense, competence in mathematics involves participation in forms of mathematically organized discourse.

For bilingual students the linguistic dimension of mathematics learning introduces additional complexity. Processing mathematical vocabulary and relational structures in a non-dominant language may increase cognitive demands and influence students' ability to interpret problem situations or express mathematical reasoning. In many cases difficulties in mathematics learning may reflect restricted access to disciplinary language rather than limitations in conceptual understanding.

Recent studies in mathematics education emphasize the importance of language-sensitive instructional approaches in linguistically diverse classrooms. Instructional designs that contextualize mathematical ideas within coherent semantic frameworks have been shown to support both conceptual understanding and the development of academic language. Embedding symbolic mathematical expressions within meaningful contexts allows learners to establish connections between formal notation and conceptual meaning.

Narrative frameworks may represent a particularly effective form of such contextualization because they integrate symbolic, linguistic, and experiential elements within a unified structure of meaning. Within narrative environments mathematical ideas are embedded in sequences of events that connect actions, intentions, and outcomes. This organization may help learners construct meaningful interpretations of symbolic operations while simultaneously strengthening their understanding and use of mathematical terminology.

Toward a Structured Narrative-Based Instructional Model

Reconceptualizing narrative as a structural component of instructional design requires deliberate alignment between narrative organization and the didactic functions of mathematics lessons. A structured narrative-based instructional model integrates core story elements-such as characters, goals, challenges, sequences, and resolutions-across different stages of instruction, including the activation of prior knowledge, the introduction of new concepts, guided practice, consolidation, and assessment.

Within such a model narrative does not merely provide contextual background for mathematical tasks. Instead narrative structures shape the trajectory through which mathematical relations are introduced, explored, and gradually formalized. By organizing mathematical ideas within coherent sequences of events, narrative frameworks may create learning environments in which conceptual relations are progressively elaborated and integrated.

Research in instructional design suggests that coherent learning environments characterized by meaningful interaction and structured discourse promote deeper conceptual development (Allen et al., 2020; Darling-Hammond et al., 2020). Integrating narrative architecture within lesson design may therefore strengthen epistemic coherence by organizing mathematical ideas within relationally connected sequences of meaning. Such structuring may support sustained engagement, facilitate transitions from contextualized reasoning toward symbolic abstraction, and encourage the disciplined use of mathematical terminology.

However, theoretical plausibility alone does not establish instructional effectiveness. Evaluating the pedagogical value of narrative-structured instruction requires empirical examination of measurable learning outcomes, including improvements in conceptual understanding, more precise use of mathematical terminology, and enhanced performance in mathematical tasks.

The present study contributes to this emerging line of research by designing and implementing a systematically structured narrative-based instructional model in first-grade mathematics within a bilingual classroom context. Using a quasi-experimental pre-post research design, the study investigates whether the implementation of this model is associated with measurable changes in students' mathematical achievement. By integrating cognitive, linguistic, and instructional perspectives within a coherent analytical framework, the study

provides empirical evidence at the intersection of narrative cognition, mathematical language development, and early mathematics education

CONCEPTUAL MODEL OF THE STUDY

The present study is based on a conceptual model that considers narrative-based instruction as a pedagogical approach implemented through the systematic integration of narrative structures within mathematics lessons. Within this framework, narrative functions as a cognitive and linguistic scaffold that organizes mathematical content into meaningful sequences of events and supports students' access to mathematical ideas.

In the proposed model, narrative contexts facilitate the interpretation of mathematical situations by connecting symbolic representations with actions, intentions, and outcomes embedded within story sequences. Such contextualization may support students in understanding mathematical vocabulary and relational structures, which is particularly important for bilingual learners who must simultaneously process conceptual and linguistic aspects of mathematical tasks.

Through this process, narrative-structured learning environments may contribute to the development of disciplinary mathematical language and to a deeper understanding of numerical relations. Improved comprehension of these relations may in turn enhance students' ability to perform arithmetic operations and solve tasks involving addition, subtraction, place-value understanding, and number comparison.

Within this perspective, narrative-based instruction is conceptualized as an integrative pedagogical mechanism that links contextualized meaning-making with the development of mathematical reasoning and language competence. The interaction of these elements may ultimately lead to improved mathematical achievement and more coherent conceptual understanding in early primary mathematics learning.

RESEARCH AIM AND HYPOTHESIS

Aim of the Study

The primary aim of the present study is to examine the effectiveness of a structured narrative-based instructional model implemented in first-grade mathematics in a bilingual classroom context. The study seeks to determine whether the systematic integration of narrative structures across different phases of instruction-concept introduction, guided practice, consolidation, and assessment-can support students' understanding of mathematical relations and improve their performance in basic arithmetic tasks. In particular, the research investigates whether students' achievement in addition, subtraction, place-value understanding, and number comparison improves following the implementation of the narrative-structured instructional approach. To evaluate the effectiveness of the intervention, students' learning outcomes obtained during the second semester were compared with their achievement results from the first semester, when instruction was conducted without the narrative-based model.

Object of the Study

The object of the study is the process of mathematics instruction in the first grade and the possibilities for optimizing this process through the use of narrative-structured instructional strategies.

Subject of the Study

The subject of the study is the narrative-structured instructional model as a pedagogical approach in mathematics education and its influence on the understanding of mathematical relations and the development of mathematical competence among bilingual first-grade students.

Research Hypothesis

The research hypothesis assumes that the implementation of a structured narrative-based instructional model in first-grade mathematics will contribute to improved mathematical achievement among bilingual students. More specifically, it is expected that integrating narrative structures within lesson activities will facilitate the interpretation of mathematical situations, support the development of disciplinary mathematical language, and lead to higher performance in tasks involving addition, subtraction, place-value understanding, and number comparison. It is further expected that students' learning outcomes obtained during the second semester, when the narrative-based instructional model is implemented, will be higher than the results achieved during the first semester, when mathematics instruction was conducted without the use of mathematical stories.

METHOD

Research Design

METHOD

Research Design

The present study was conducted in a primary school in Bulgaria during the second semester of the academic year. The research employed a quasi-experimental single-group pre-post design aimed at examining changes in students' mathematical achievement following the implementation of a structured narrative-based instructional model.

The study was carried out in a first-grade bilingual classroom consisting of 25 students. The pedagogical intervention was implemented during the second semester within regular mathematics lessons and focused on fundamental numerical concepts, including addition and subtraction within 20, place-value understanding, and number comparison.

For the purposes of comparison, students' learning outcomes obtained during the first semester were used as a baseline reference for their initial level of mathematical achievement. These results provided information about students' prior performance before the implementation of the narrative-based instructional approach.

The instructional intervention was organized in three consecutive phases: diagnostic, formative, and evaluative.

During the diagnostic phase, the initial level of students' mathematical achievement was identified through analysis of the results obtained during the first semester. These data served as a reference point for evaluating potential changes in students' performance during the second semester.

During the formative phase, a structured narrative-based instructional model was systematically integrated into mathematics lessons. Mathematical concepts were introduced

and practiced through narrative contexts that embedded numerical relations within coherent story sequences. This approach aimed to support conceptual understanding, facilitate engagement, and provide meaningful contexts for the interpretation of mathematical situations.

In the evaluative phase, students completed an assessment designed to measure their achievement in key areas of early mathematics learning, including addition, subtraction, place-value understanding, and number comparison. The results were compared with the baseline data from the first semester in order to examine changes in mathematical performance following the instructional intervention.

This design enabled the analysis of learning progress within the same group of students and provided empirical evidence regarding the potential instructional effects of the narrative-based learning model in a bilingual first-grade classroom.

Participants

The participants in the study were 25 first-grade pupils enrolled in a public primary school in Bulgaria. All students were identified as bilingual learners who regularly used a language other than the language of instruction in their home environment. As a result, the learning of mathematics required the simultaneous development of conceptual understanding and academic mathematical language in the language of instruction.

The instructional activities were implemented within the regular classroom setting and followed the national mathematics curriculum for the first grade. The pedagogical intervention did not replace or reduce standard instructional time but was integrated into the existing mathematics lessons during the second semester of the academic year.

Instructional Intervention

The instructional intervention consisted of the implementation of a structured narrative-based instructional model integrated into regular mathematics lessons during the second semester of the academic year. Prior to the intervention, mathematics instruction during the first semester had been conducted through traditional instructional approaches without the use of narrative-based learning activities.

The model systematically aligned narrative elements, such as characters, goals, tensions, and sequences, with distinct instructional functions, including:

- activation of prior knowledge;
- introduction of new mathematical concepts;
- guided practice and consolidation;
- assessment.

Four author-developed mathematical stories were integrated into lessons addressing the following topics:

- addition and subtraction within 10 and 20;
- place-value understanding (tens and ones);
- comparison of numbers up to 100;

- recognition and comparison of geometric figures.

Within this instructional framework, mathematical ideas were embedded in coherent narrative contexts that linked actions, quantities, and outcomes. The narrative structure aimed to support conceptual understanding, facilitate engagement, and provide meaningful contexts for the interpretation of mathematical terminology and numerical relations.

INSTRUMENTS

Achievement Tests

Mathematical achievement was assessed using two equivalent tests administered before and after the instructional intervention. The baseline results from the first semester served as a reference point for comparison with students' performance following the implementation of the narrative-based instructional model during the second semester.

The tests measured the following aspects of early mathematical competence:

- computational accuracy (addition and subtraction within 20);
- place-value understanding (identification of tens and ones);
- comparison of numbers;
- structured problem-solving.

Equivalent task formats were used to ensure comparability across the two measurement points.

To obtain a more structured and objective evaluation of students' mathematical competence, the assessment results were analyzed using a vector-based model of cognitive learning acquisition (CLI). In this model, students' performance is represented through a diagnostic vector consisting of several indicators reflecting different aspects of mathematical competence.

Each student's diagnostic vector is defined as: **CLI = {P1, P2, P3, P4, P5, P6}**

where the coordinates correspond to specific indicators related to the interpretation of numerical relations, identification of quantities, correct application of arithmetic operations, recognition of relationships between numbers, and successful completion of mathematical tasks.

The Euclidean norm of the vector was used as an aggregated indicator of mathematical achievement. To allow comparison between measurement points, the obtained values were transformed into a percentage index representing the ratio between the achieved value and the maximal possible value of the diagnostic vector.

Reflective Student Cards

To complement the quantitative assessment of students' mathematical achievement, short structured reflection cards were used to collect qualitative feedback from pupils after the instructional intervention. The cards contained three brief questions designed to explore students' perceived enjoyment of the lessons, perceived level of difficulty, and aspects of the learning activities they found most challenging.

Students completed the reflection cards at the end of the instructional period. The responses were analyzed descriptively in order to provide additional qualitative insights into pupils' experiences with the narrative-based instructional approach and their perceptions of the mathematical learning activities.

DATA ANALYSIS

Descriptive statistics (means and standard deviations) were calculated for pre-test and post-test scores. A paired-samples t-test was conducted to determine whether the observed difference between measurement points was statistically significant. Prior to inferential analysis, assumptions of normality were examined. Effect size was calculated using Cohen's dz for repeated measures to estimate the magnitude of change. Statistical significance was set at $p < .05$.

In addition to the statistical comparison, students' learning outcomes were evaluated using a vector-based diagnostic model of cognitive learning acquisition (CLI). Within this model, each student's performance is represented as a vector consisting of six indicators reflecting different aspects of mathematical competence:

P1 - classroom activity and participation;
P2 - acquisition of mathematical terminology;
P3 - understanding of the algorithm for performing operations;
P4 - correct application of the algorithm in problem solving;
P5 - accuracy of computational results;
P6- comprehension of the text in word problems.

Each student's performance is represented by a diagnostic vector: **CLI = {P1, P2, P3, P4, P5, P6}**

The Euclidean norm of the vector was used as an aggregated indicator of the level of mastery of mathematical competencies.

The maximal vector of cognitive acquisition is defined as: **CLImax = {6,6,6,6,6,6}**

The maximal possible value of the index is calculated as:

$$\|CLImax\| = \sqrt{(6^2+6^2+6^2+6^2+6^2+6^2)}$$

To allow comparability between students, the obtained values were transformed into a percentage index of cognitive learning acquisition:

$$CLI\% = (\|CLI\| / \|CLImax\|) \times 100$$

This procedure allows the results to be represented as a percentage indicator of the level of mastery of mathematical competencies for each student and for the class as a whole.

RESULTS

Quantitative Results

A paired-samples *t*-test indicated a statistically significant increase in scores from pre-test **(M = 34.96, SD = 4.31)** to post-test **(M = 41.96, SD = 5.48), $t(24) = 9.02$, $p < .001$**. The

mean gain was **7.00** points. The calculated effect size was large (Cohen's ***dz* = 1.80**), indicating a substantial magnitude of change over time.

Table 1. Descriptive statistics for pre-test and post-test mathematics achievement

Measure	Pre-test	Post-test	Mean Gain
Mean (M)	**34.96**	**41.96**	**7.00**
SD	**4.31**	**5.48**	**3.89**
N	**25**	**25**	—

Vector-Based Analysis of Mathematical Achievement (CLI)

In addition to the statistical comparison of test scores, students' mathematical achievement was examined using the vector-based cognitive learning acquisition index (CLI), described in the Data Analysis section. This diagnostic model enables a more detailed analysis of several indicators reflecting different aspects of mathematical competence.

The comparison of students' results obtained during the first semester and those achieved after the instructional intervention during the second semester reveals a positive dynamic across all assessed indicators of the CLI index. The results suggest that the implementation of the narrative-structured instructional model contributed to improvements in several dimensions of early mathematical competence.

The most notable improvements were observed in indicators related to the acquisition of mathematical terminology and the comprehension of the text of word problems. Improvements were also evident in students' ability to correctly apply algorithms when solving mathematical tasks, as well as in computational accuracy.

Table 2. Dynamics of results according to the CLI indicators (%)

Indicator	First Semester	Second Semester	Difference (p.p.)
P1 - classroom activity and participation	54%	63%	+9
P2 - acquisition of mathematical terminology	50%	64%	+14
P3 - understanding of algorithms	52%	61%	+9
P4 - correct application of algorithms in problem solving	48%	60%	+12
P5 - computational accuracy	56%	65%	+9
P6 - comprehension of word problems	49%	62%	+13

Average improvement: +11.0 percentage points

Overall, the aggregated CLI index indicates a clear increase in the level of cognitive learning acquisition for the class following the instructional intervention. These results are consistent with the findings obtained through the statistical analysis of the achievement tests and suggest that the narrative-based instructional approach supported the development of both mathematical understanding and disciplinary language among bilingual first-grade pupils.

Qualitative Findings

The analysis of the reflective student cards provided additional descriptive insight into pupils' perceptions of the instructional approach. The majority of pupils reported that they enjoyed learning mathematics through stories and described the lessons as engaging and interesting.

Many pupils indicated that mathematical tasks were easier to understand when presented within a narrative context, particularly in situations requiring the interpretation of problem scenarios. The narrative structure appeared to help pupils follow the sequence of actions and better comprehend the relationships between quantities.

Reported difficulties were primarily related to the computational demands of certain tasks, such as subtraction operations or the identification of tens and ones, rather than to the narrative format itself. These responses suggest that perceived challenges were associated mainly with the mathematical content rather than with the instructional approach.

Overall, the qualitative findings indicate positive pupil perceptions of the narrative-based instructional model and complement the quantitative results demonstrating improvement in students' mathematical achievement.

DISCUSSION

The findings of the present study indicate that pupils' mathematical achievement increased following the implementation of a structured narrative-based instructional model in a bilingual first-grade classroom. Although the single-group design does not allow for causal inference, the magnitude of the observed change suggests that the instructional approach merits further investigation.

The results are consistent with theoretical perspectives that conceptualize narrative structures as cognitive scaffolds supporting meaning construction. Organizing symbolic mathematical operations within coherent story sequences may provide semantic continuity that facilitates the integration of linguistic and mathematical representations. Such a mechanism may be particularly relevant for bilingual pupils, who must simultaneously coordinate conceptual reasoning and academic language processing.

The large effect size observed in the present study indicates that the improvement in performance was not only statistically significant but also educationally meaningful. Nevertheless, given the limitations of the research design, the results should be interpreted as evidence of improvement in pupils' performance over time rather than as definitive proof of instructional effectiveness.

Qualitative responses from pupils further suggest that the narrative context supported both engagement and comprehension. Although self-reported perceptions cannot establish

causal mechanisms, the convergence of quantitative and qualitative findings provides a coherent descriptive account of change within the classroom environment.

Importantly, this study contributes to the existing literature on storytelling in mathematics education by examining narrative not as an isolated instructional technique but as a systematically structured model aligned with distinct didactic functions within mathematics lessons. In this sense, the instructional model represents a shift from using narrative primarily as a motivational element toward understanding narrative as an organizing principle of lesson design.

LIMITATIONS

Several limitations of the present study should be acknowledged. First, the research employed a single-group quasi-experimental design, which limits the possibility of drawing strong causal conclusions regarding the effectiveness of the instructional model. Second, the relatively small sample size restricts the generalizability of the findings to broader educational contexts. Third, the absence of a comparison group does not allow alternative explanations for the observed improvement in pupils' performance to be fully excluded.

Future studies should therefore employ randomized or controlled experimental designs with larger samples in order to more rigorously evaluate the effectiveness of structured narrative-based instructional models in mathematics education.

IMPLICATIONS FOR MATHEMATICS EDUCATION

Despite these limitations, the findings suggest that the systematic integration of narrative structures within mathematics instruction may represent a promising direction for early mathematics education, particularly in linguistically diverse classrooms. By linking conceptual development with linguistic support within a coherent instructional framework, narrative-based lesson design may contribute to more accessible and contextually meaningful learning environments.

Further research is needed to examine the applicability of this instructional model across different grade levels, mathematical topics, and linguistic contexts, as well as to explore its potential long-term effects on the development of mathematical understanding.

CONCLUSION

The present study developed and examined a structured narrative-based instructional model implemented in first-grade mathematics within a bilingual classroom context. The findings indicate that pupils' mathematical achievement increased following the implementation of the model, with a large observed effect size.

In addition to measurable changes in achievement, pupils' reflections suggested positive perceptions of engagement and comprehensibility within the narrative framework. These results are consistent with theoretical perspectives that conceptualize narrative structures as cognitive and linguistic scaffolds that support meaning construction in mathematics learning.

Given the single-group quasi-experimental design, the findings should be interpreted as evidence of improvement in pupils' performance over time rather than as definitive proof of instructional effectiveness. Nevertheless, the study provides preliminary empirical support for

the systematic integration of narrative structures within mathematics lesson design and highlights the potential relevance of this approach for linguistically diverse classrooms.

Future research employing controlled experimental designs and larger samples is required to examine the effectiveness of narrative-structured instructional models across different mathematical topics and educational contexts.

DATA AVAILABILITY

The datasets generated and analyzed during the current study are not publicly available due to ethical considerations and the protection of participants' privacy, as the research involved school students. Aggregated data supporting the findings of this study are presented within the article.

REFERENCES

Allen, J. P., Pianta, R. C., Gregory, A., Mikami, A. Y., & Lun, J. (2011). An interaction-based approach to enhancing secondary school instruction and student achievement. *Science, 333*(6045), 1034-1037. https://doi.org/10.1126/science.1207998

Bruner, J. (1996). *The culture of education*. Harvard University Press.

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science, 24*(2), 97-114. https://doi.org/10.1080/10888691.2018.1537791

Lemonidis, C., & Kaiafa, E. (2019). Storytelling as a teaching approach in mathematics education. *International Journal of Mathematical Education in Science and Technology, 50*(4), 581-597. https://doi.org/10.1080/0020739X.2018.1507050

Moschkovich, J. (2012). Mathematics, the common core, and language: Recommendations for mathematics instruction for English language learners. *Journal of Urban Mathematics Education, 5*(1), 7-9.

Prediger, S., Clarkson, P., & Borko, H. (2016). Principles and practices for teaching mathematics in multilingual classrooms. *ZDM Mathematics Education, 48*(7), 889-903. https://doi.org/10.1007/s11858-016-0819-0

Prediger, S., Clarkson, P., Moschkovich, J., & Planas, N. (2016). Language in mathematics education: An overview of research and emerging issues. *ZDM Mathematics Education, 48*(7), 827-834. https://doi.org/10.1007/s11858-016-0813-6

Russo, J., Bobis, J., Downton, A., Livy, S., McCormick, M., & Sullivan, P. (2021). Connecting mathematical ideas through story-based contexts in primary mathematics classrooms. *Mathematics Education Research Journal, 33*(3), 425-444. https://doi.org/10.1007/s13394-020-00324-4

Sfard, A. (2008). *Thinking as communicating: Human development, the growth of discourses, and mathematizing*. Cambridge University Press.

Simeonova-Ingilizova, M. D. (2023). The educational role of fairy stories in preschool (6-7 year old). *Pedagogical Forum*, 11(2), 42-53. https://doi.org/10.15547/PF.2023.013

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.