
PEDAGOGICAL MODEL FOR THE DEVELOPMENT OF MATHEMATICAL COMPETENCES IN FIRST GRADE FOR BILINGUAL STUDENTS THROUGH THE THEORY OF MULTIPLE INTELLIGENCE

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Abstract: The contemporary primary education system is increasingly characterized by linguistic and cultural diversity, posing significant challenges for the development of fundamental academic competencies in subjects like mathematics. This report investigates a multidimensional pedagogical model tailored specifically for first-grade bilingual students, integrating Howard Gardner's Theory of Multiple Intelligences, social-semiotic approaches to mathematical communication, and the implementation of cognitively "rich" tasks. The study addresses the critical problem of the "language barrier," which often leads to the misidentification of linguistic challenges as cognitive deficiencies in mathematical potential. By shifting the instructional focus from mere vocabulary acquisition to active participation in mathematical discourse practices—such as justifying, modeling, and generalizing—the proposed model provides a structured framework for inclusive education. The methodology employs the Concrete-Pictorial-Abstract (CPA) sequence to bridge the gap between physical manipulation and symbolic representation, allowing students to leverage their dominant intelligences—such as musical, spatial, or kinesthetic—as effective entry points into complex logical-mathematical concepts. This approach aligns with the latest global guidance on multilingual education, which advocates for treating the native language as a cognitive resource rather than a hindrance. Quantitative results from experimental implementation indicate a significant improvement in student performance, with average scores rising from 16.37 to 22.20 points, reflecting a 35.6% increase in mathematical proficiency. Qualitatively, the model fosters increased engagement, self-efficacy, and a more robust conceptual understanding by allowing "low threshold – high ceiling" access to all learners. The findings suggest that mathematical learning for bilinguals is most effective when it is multimodal, interactive, and personalized to the student's intellectual profile. The report concludes with comprehensive recommendations for restructuring classroom environments into "intelligence centers" and enhancing teacher training programs to support diverse learners in the initial stage of primary education.

Keywords: Multiple Intelligences, Bilingualism, Mathematical Competence, Rich Tasks, Mathematical Discourse.

1. INTRODUCTION

The process of forming mathematical skills in the first grade is a critical milestone in a child's academic development (Nestorova, 2010), as it is during this period that the foundations of logical thinking, the ability to abstract, and attitudes towards learning in general are laid. For bilingual students, this challenge is burdened with additional cognitive complexity, arising from the need to simultaneously master mathematical content and the language of instruction (Angelova, 2018), which is often a second or even foreign language for them. Traditional educational approaches often prove ineffective, as they do not take into account the multimodal nature of intelligence (Gardner, 1983). They rely primarily on verbal instructions and mechanical learning of procedures, often proving ineffective when working with children from minority language groups, which leads to systematic lagging behind and demotivation at a very early age.

The development of an innovative pedagogical model that integrates the Theory of Multiple Intelligences (MI), the support of mathematical communication and the use of enriching tasks offers a holistic and humanistic approach to overcoming these multifaceted barriers. Mathematical competence should not be considered in isolation, but as an integral part of the cognitive and personal development of the child, including the ability to apply knowledge in real-life situations and build confidence in one's own intellectual abilities. In this context, the school should function as a bridge that connects the prior experience and home environment of bilinguals with academic requirements, turning linguistic diversity into an educational asset, not an obstacle.

The global context highlights the urgent need for inclusive policies, with recent UNESCO reports highlighting the fact that over 40% of the world's population does not have access to education in a language they understand (UNESCO, 2025). In Bulgaria, the problems of bilingualism are compounded by the specific sociocultural dynamics in which Bulgarian has to be taught as a second language (BLL), rather than as a foreign language, due to everyday intercultural communication. "Mathematical competence includes not only numerical operations, but also the ability to model real-world situations" (Nestorova, 2010). The present study is based on the concept that activating

different forms of intelligence – visual, musical, kinesthetic – can effectively compensate for linguistic deficits (Gardner, 2006; Morgan, 2021).

The purpose of the proposed report is to present a theoretically grounded and experimentally verified pedagogical model that stimulates the mathematical development of bilingual first graders through personalized “entry points” to knowledge. The model seeks to transform the classroom from a place of passive listening to a space of active exploration, where mathematical communication is viewed as a social practice, and tasks are designed with a “low threshold and high ceiling” to ensure success for every child. Through this integrated approach, not only is improved mathematics achievement achieved, but also an increase in the general academic literacy and social equity of students is achieved.

2. MATERIALS AND METHODS

The construction of the proposed pedagogical model is based on the intersection between psychological theories of intelligence and modern linguistic didactics. The research methodology encompasses four main components: the theory of multiple intelligences, communication support strategies, the design of enriching tasks and the specific system for diagnosing results.

The theory of multiple intelligences (MI)

The theory of multiple intelligences (MI), proposed by Howard Gardner, serves as a fundamental pillar of the model, as it challenges traditional psychometric views that measure intelligence solely through language and logic tests. According to Gardner (1983), people possess a diverse set of intelligences that are activated in unique combinations to solve problems. For bilingual students, this means that their mathematical potential can be accessed through channels that are not directly dependent on proficiency in Bulgarian.

The study identified eight main types of intelligence. (World Journal of Education, 2023), which have direct relevance for 1st grade education, each of which is integrated into the methodology through specific activities and tools. Their main characteristics and respective application in first grade are as follows :

- Verbal-linguistic - Sensitivity to the rhythm and meaning of words - Math stories and discussions (LearningBP, 2022).
- Logical-Mathematical - Conceptual Thinking and Numerical Models - Logical Puzzles and Abstract Connections (UoPeople, 2023).
- Visual-Spatial - Thinking in Images and Schemes - Color Codes and Geometric Patterns (TeacherVision, 2023).
- Bodily-kinesthetic - Movement control and manipulation - "Living number lines" and constructors (Morgan, 2021).
- Musical - Perception of Rhythm and Pitch - Counting and Rhythmic Arithmetic Songs (LearningBP, 2022).
- Interpersonal - Understanding feelings and motivation - Cooperative learning and pair work (Agustin et al., 2021).
- Intrapersonal - Self-knowledge and Reflection - Self-assessment and personal diaries of the number (UoPeople, 2023).
- Naturalistic - Connecting with nature and classification - Sorting natural objects (TeacherVision, 2023).

Mathematical Communication and CPA Approach

Teaching bilinguals in Bulgaria requires a differentiated approach, based on the understanding of three types of bilingualism: compound, coordinated and subordinating. For many children, school is a place of language clash, where the Bulgarian language becomes an obstacle to understanding mathematical instructions. The methodology of the proposed model follows the principle of “Input before output”, developed by Angelova (Angelova, 2018), according to which the child cannot produce linguistic information if it has not been presented to him in an appropriate and understandable manner.

Mathematical communication is seen as a social practice (Moschkovich, 2013). The CPA (Concrete-Pictorial-Abstract) approach is used, which provides a “scaffolding” for linguistic expression (Ashton St Peter's, 2025). Bilinguals use their entire linguistic repertoire (translingualism), which should be supported in the classroom (Moschkovich, 2017). In the classroom, this is achieved by allowing children to discuss their ideas in their native language in small groups to clarify mathematical concepts before attempting to verbalize them in the official language of instruction. The focus shifts from pure vocabulary learning to engaging in mathematical discourse practices – making generalizations, recognizing patterns and justifying claims through multiple resources (gestures, drawings, objects).

Enrichment tasks and the CAPE model

One of the most effective methodological tools in the model is the CPA approach (Concrete-Pictorial-Abstract),

which is the basis of the concept of "Mathematics Mastery". This approach structures the learning process in three sequential stages:

- **Concrete stage:** Students explore concepts through physical manipulation of objects (cubes, tens frames, abacus). Here, communication is primarily nonverbal or consists of simple language structures related to the action.
- **Pictorial stage:** Students represent the problem through drawings, diagrams, or illustrations (e.g., bar models or "cherry models" for whole-part). The visual representation serves as a "scaffolding" for linguistic expression, as it provides support for speaking.
- **Abstract Stage:** Students write down their reasoning using numbers and mathematical symbols. For bilinguals, it is critical that the teacher use the strategy of "revoicing," in which the teacher validates the child's ideas by restating them in the correct mathematical terminology.

This consistency ensures that abstract symbols are firmly grounded in concrete experience, which prevents formalism in knowledge and supports conceptual understanding.

The central place is occupied by tasks with a "low threshold – high ceiling" (Radmehr, 2023). They allow access to every child, while stimulating a high cognitive load (NRICH, 2024). Their solution follows the CAPE model: Comprehension, Analysis, Planning and Evaluation (NRICH, 2011).

The methodology envisions personalized learning, encouraging students to use their strongest intelligence as an "entry point" to the new concept while simultaneously practicing the other forms. This is especially important in the transition from play to learning activities to maintain motivation and psychological comfort for bilinguals.

Enrichment task design and the CAPE model

Central to the learning process are Rich Tasks, which transform mathematics into a living and connected system. These tasks are characterized by a "low threshold – high ceiling" architecture, meaning that they have an easy entry point for any child, but also the potential to reach high levels of complexity and generalization.

Evaluation) is applied:

- **Comprehension:** Making sense of the problem by retelling or creating a mental image.
- **Analysis and synthesis:** Identifying the necessary knowledge and stating assumptions (hypotheses).
- **Planning and execution:** Thinking about approaches and implementing the solution.
- **Evaluation:** Reflection on the decision and communication of the results.

This process is not linear, but iterative, allowing students to go back and adjust their ideas.

Experimental design and diagnostics

To verify the effectiveness of the model, a pedagogical study was conducted, including diagnostics at the entry level, design of "MI centers" and experimental testing. The assessment system used is qualitative, in accordance with the requirements for 1st grade in Bulgaria. The assessment criteria are cognitive, communicative and personally motivated, with relevant indicators: counting and comparing up to 20; solving word problems; modeling situations; . Use of terminology; ability to explain (verbalize); participation in discussions and Degree of engagement in MI tasks; confidence and self-assessment. Statistical processing of the data includes comparing pretest and posttest results, as well as observing children's participation through mathematical discourse protocols.

3. RESULTS

The results of the implementation of the integrated pedagogical model show a significant positive change in the mathematical competencies and overall learning engagement of bilingual first graders. The data confirm that the activation of multiple intelligences successfully compensates for linguistic difficulties and creates conditions for an "even start".

Quantitative indicators of mathematical achievement

The main indicator of the effectiveness of the model is the significant increase in the test scores of students in the experimental group /Table 1/.

Table 1. Comparative analysis between the initial and final levels

Research stage	Average score (x)	Standard deviation	Growth rate
Pretest (entry level)	16.37	3.42	-
Posttest (final level)	22.20	2.15	+35.6%

Source: Author research

This increase of over 35% is statistically significant and shows that the model not only helps to master the minimum standards, but also stimulates the achievement of higher levels of competence. Students show particularly high progress in addition and subtraction tasks with the transition to 20.

Qualitative analysis of communicative activity

In addition to the quantitative results, the study registered a qualitative transformation in the way students participate in the learning process. The observation of mathematical communication shows the following trends:

- **Reducing the “silent period”:** Bilingual students begin to engage in discussions much earlier, using visual cues and gestures as a transition to speaking.
- **Improved verbalization of actions:** Through the CPA approach, students gain the ability to explain what they are doing while manipulating objects, which is the first step towards academic mathematical discourse.
- **Effective use of resources:** Children independently choose tools (diagrams, cubes, number lines) to support their claims during group work.

Participation in "MI Centers" allows children with weaker language skills in Bulgarian to emerge as leaders in tasks requiring visual-spatial or bodily-kinesthetic intelligence, which sharply increases their self-esteem and social status in the group.

Analysis of the results shows an interesting correlation between dominant intelligence and success in specific mathematical activities.

Table 2. Distribution of achievements according to the MI profile

Dominant intelligence	Strengths in Mathematics (1st Grade)	Effect achieved through the model
Visual-spatial	Geometric shapes, bar patterns.	Quick transition from image to symbol.
Musical	Rhythmic counting, number sequences.	Automation of arithmetic through songs.
Bodily-kinesthetic	Measuring, working with manipulatives.	Deep conceptual understanding through action.
Interpersonal	Cooperative problem solving.	Increased language confidence through discussion.

Source: Author research

Students who were initially classified as “having difficulties” made the greatest gains in their scores when instruction targeted their kinesthetic and spatial channels, supporting the idea that intellectual limitations are often situational and dependent on the way information is presented.

4. DISCUSSIONS

The results obtained open a wide field for discussion on the transformation of pedagogical practices in a multicultural environment. The success of the model is not due to the mechanical addition of new tasks, but to the fundamental change in the didactic philosophy, which places the focus on cognitive resources, not on linguistic deficits.

One of the key aspects of the discussion is the role of multimodality in overcoming the language barrier. For bilingual learners, the language of instruction is often an “insurmountable obstacle” when it is the only channel for information. However, when a math problem is presented through sound (musical intelligence), movement (kinesthetic), and image (spatial), the child’s brain activates multiple neural networks that work in synergy.

This approach is in line with contemporary research on “mathematical mastery,” which demonstrates that understanding builds from the concrete to the abstract. For bilinguals, this transition is even more critical, as they must negotiate the meaning of words in different contexts. Multimodal representations serve as scaffolding, allowing the child to demonstrate high intelligence while their language skills are still developing.

Another important point is the legitimization of the home language in the classroom. Traditionally, it has been believed that the use of the mother tongue hinders the acquisition of a second language. However, the current study, supported by the positions of Stanford University and UNESCO, shows exactly the opposite - allowing children to discuss their ideas in a familiar language accelerates the conceptual understanding of mathematics.

When the child understands the concept of " adding" in their native language, they simply have to learn a new word for that concept in Bulgarian. However, if they are forced to learn both the concept and the language simultaneously, the cognitive load becomes excessive, leading to failure. The integrated model successfully balances conceptual understanding and procedural fluency by maintaining a high cognitive demand for the tasks.

Enrichment tasks are also a key tool for inclusion. The discussion of Rich Tasks emphasizes their ability to engage students with widely varying levels of preparation in the same activity. In Grade 1, this is vital, as children come with very different preschool experiences. “Low-threshold, high-ceiling” tasks remove the stigma of “slower” students, as everyone can contribute to the solution in their own way—some by drawing, others by counting objects, and still others by discovering numerical patterns.

These types of tasks stimulate reasoning and questioning, which is the foundation of modern mathematical competence. Students do not just learn facts, but learn to think like mathematicians – to make assumptions, look for counterexamples, and explain their reasoning.

Despite the proven effectiveness of the model, its implementation is associated with challenges that should not be overlooked. First of all, there is the need to change the professional identity of the teacher – from a provider of information to a facilitator of discourse. Many teachers experience difficulties in working with open-ended tasks and managing a classroom organized in MI centers due to a lack of appropriate materials and training. Also, the administrative requirements to cover a certain amount of material often conflict with the time needed for in-depth exploration of enrichment tasks. However, the investment of time in 1st grade pays off many times over in the later stages, as it builds a solid conceptual foundation and a positive attitude toward the subject.

5. CONCLUSIONS

The conducted research and the developed pedagogical model for the development of mathematical competencies in 1st grade among bilinguals provide grounds for the formulation of several fundamental conclusions and applied recommendations that are important for both pedagogical theory and educational practice.

The pedagogical integration of multiple intelligences and mathematical communication creates a qualitatively new educational environment in which linguistic diversity is transformed from a challenge into a cognitive resource. Mathematics in first grade ceases to be an abstract discipline and becomes a field for social interaction and personal expression, where each child can find their own path to knowledge through their individual intellectual profile.

The model proves that the language barrier can be successfully overcome through multimodal strategies and a CPA approach that ensure understanding in the learning process. Shifting the focus from vocabulary to discourse practices allows bilinguals to develop high cognitive skills in parallel with the acquisition of the language of instruction.

The quantitative data from the study confirm the high effectiveness of the model, expressed in a 35.6% increase in mathematical achievements. This improvement is accompanied by increased motivation, engagement and confidence of bilingual students, which is a key factor in preventing early school leaving and ensuring social equity. The qualitative analysis shows that children become more active participants in mathematical discourse, using a wide range of resources to express their ideas.

In conclusion, the proposed pedagogical model offers a sustainable and scientifically sound path to improving the quality of bilingual education in Bulgaria, meeting contemporary requirements for inclusion, innovation, and humanity in the initial stage of education.

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