DEVELOPMENT OF MATHEMATICAL COMPETENCIES IN PRESCHOOLERS FROM ROMANIAN-HUNGARIAN BILINGUAL INSTITUTIONS IN HUNGARY, THROUGH THE INTRODUCTION OF NEW TEACHING-LEARNING-EVALUATION METHODS

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Abstract

This study explores the development of mathematical competencies in preschoolers attending Romanian-Hungarian bilingual institutions in Hungary, through the implementation of innovative teaching, learning, and evaluation methods. By comparing interdisciplinary and interactive teaching strategies with traditional approaches, the research examines their impact on cognitive development, engagement, and learning

outcomes. The study involved two groups of 51 preschoolers each, selected from four bilingual kindergartens. The experimental group participated in interdisciplinary activities integrating mathematics with language, art, and environmental studies. Using an experimental design, the study compares the effectiveness of interdisciplinary, interactive teaching methods with traditional, monodisciplinary ones. Two groups of preschoolers were observed over two months in bilingual institutions. Quantitative and qualitative data were collected through evaluations and teacher observations. Results showed that the experimental group exhibited significantly higher academic performance, attention span, and engagement. Activities combining mathematics with storytelling, arts, and physical movement proved particularly effective. Visual tools and structured methods, like Venn diagrams and the Cube method, supported understanding and retention. Traditional methods, while consistent, lacked the same level of engagement. Interdisciplinary strategies helped close gaps between children with varying initial abilities. Findings support the need for a play-based, integrative pedagogical approach. The study highlights the transformative potential of modern teaching in early mathematics. Implications are significant for curriculum design and early childhood policy.

Keywords: preschool education, mathematical competencies, interdisciplinary teaching, cognitive development, interactive learning, early childhood mathematics, play-based learning.

Discipline: Education Science

Absztrakt

A MATEMATIKAI KOMPETENCIÁK FEJLESZTÉSE MAGYARORSZÁGI ROMÁN–MAGYAR KÉTNYELVŰ INTÉZMÉNYEK ÓVODÁSKORÚ GYERMEKEI KÖRÉBEN ÚJ TANÍTÁSI–TANULÁSI–ÉRTÉKELÉSI MÓDSZEREK BEVEZETÉSÉVEL

A tanulmány a magyarországi román–magyar kétnyelvű intézményekbe járó óvodáskorú gyermekek matematikai kompetenciáinak fejlődését vizsgálja innovatív tanítási, tanulási és értékelési módszerek alkalmazásán keresztül. Az interdiszciplináris és interaktív pedagógiai stratégiák hagyományos módszerekkel történő összevetésével a kutatás azok kognitív fejlődésre, tanulói bevonódásra és tanulási eredményekre gyakorolt hatását elemzi. A vizsgálatban két, egyenként 51 főből álló óvodáscsoport vett részt, amelyeket négy kétnyelvű óvodából választottak ki. A kísérleti csoport interdiszciplináris tevékenységekben vett részt, amelyek a matematikát a nyelvi neveléssel, a művészeti tevékenységekkel és a környezeti neveléssel integrálták. A kísérleti kutatási elrendezés lehetővé tette az interdiszciplináris, interaktív oktatási módszerek és a hagyományos, monodiszciplináris megközelítések hatékonyságának összehasonlítását. A két óvodás-

csoportot kéthónapos időtartam alatt figyelték meg kétnyelvű intézményekben. A kvantitatív és kvalitatív adatgyűjtés értékelések és pedagógusi megfigyelések útján történt. Az eredmények azt mutatták, hogy a kísérleti csoport szignifikánsan magasabb tanulmányi teljesítményt, hosszabb figyelmi időt és nagyobb bevonódást mutatott. Különösen hatékonynak bizonyultak a matematikát meséléssel, művészeti tevékenységekkel és mozgásos elemekkel ötvöző foglalkozások. A vizuális eszközök és strukturált módszerek – például a Venn-diagramok és a kocka módszer – elősegítették a megértést és az ismeretek tartós rögzülését. A hagyományos módszerek következetesek voltak, ugyanakkor nem érték el az interdiszciplináris megközelítésekre jellemző bevonódási szintet. Az interdiszciplináris stratégiák hozzájárultak a gyermekek eltérő kiinduló képességeiből fakadó különbségek csökkentéséhez. Az eredmények alátámasztják a játékos, integratív pedagógiai megközelítés szükségességét. A tanulmány rámutat a korszerű oktatási módszerek korai matematikai nevelésben rejlő transzformatív potenciáljára, és jelentős következményekkel bír a tantervfejlesztés és a kisgyermekkori neveléspolitika számára.

Kulcsszavak: óvodai nevelés, matematikai kompetenciák, interdiszciplináris oktatás, kognitív fejlődés, interaktív tanulás, koragyermekkori matematika, játékos tanulás

Diszciplína: neveléstudomány

Theoretical Background

The role and importance of mathematical activities in preschool education: preschool serves as the foundational stage of formal education, significantly influencing the development of young children during their most formative years. At this age, children exhibit heightened plasticity, curiosity, and motivation to explore the world around them. Among the diverse activities provided in preschool, mathematical activities hold a critical role in shaping children's cognitive, sensory, and social development. These activities support the acquisition of basic logical reasoning and problem-solving skills essential for future learning (Piaget, 1952).

Developing cognitive abilities through mathematics: mathematical activities in preschool involve the use of tactile and visual resources to aid in the development of key cognitive processes such as classification, serialization, and spatial reasoning. By interacting with objects, children enhance their sensory experiences, facilitating the development of tactile, visual, and auditory analyzers (Montessori, 1964). These early experiences allow children to recognize attributes like shape, size, color, and spatial relationships, forming the basis for more advanced logical operations. Children are introduced to basic numerical concepts, including counting, addition, and subtraction within manageable

limits (e.g., 1-5). Activities such as sorting, grouping, and sequencing foster logical thinking and help children establish relationships between quantities, thereby developing their mathematical reasoning (Gelman & Gallistel, 1978).

The role of mathematical language: mathematical language acts as a vehicle for cognitive development, enabling children to articulate their reasoning and problem-solving strategies. Due to the abstract nature of mathematical terminology, its introduction must be gradual and contextual. Preschool educators emphasize verbalization, encouraging children to describe their actions and solutions, thus facilitating the internalization of mathematical concepts (Vygotsky, 1978). Effective verbalization strengthens memory, attention, and problem-solving abilities while enhancing vocabulary with specific terms such as "equal," "greater," and "lesser." Visual aids and carefully formulated problem statements play a vital role in making abstract concepts accessible.

When paired with direct interaction and exploration, children develop a clearer understanding of mathematical principles, preparing them for formal schooling.

Mathematics and play in preschool: play is central to preschool education, providing a natural and engaging context for learning. Mathematical games, particularly those designed as didactic tools, integrate cognitive development with the joy of discovery. These games stimulate curiosity, foster creativity, and encourage collaborative learning (Piaget, 1962). Examples include: 1. Set-formation games: encouraging sorting and grouping based on attributes like shape and size. 2. Numeration games: reinforcing skills in pairing, counting, and understanding ordinal and cardinal numbers. 3. Logical-mathematical games: introducing basic operations and problem-solving through playful activities.

By combining instructional objectives with play, these activities ensure children experience mathematics as both accessible and enjoyable. Mathematical activities in preschool serve as a cornerstone for intellectual development. They nurture logical thinking, creativity, and problem-solving skills, while promoting the acquisition of mathematical language. Educators play a pivotal role in designing engaging, age-appropriate activities that inspire voluntary participation and sustained attention. The integration of mathematics with play not only enhances learning outcomes but also fosters positive attitudes towards the subject, laying the groundwork for lifelong learning.

Interdisciplinarity in preschool mathematics: the concept of interdisciplinarity, defined as the establishment of relationships between multiple fields of study, has become increasingly relevant in early childhood education. By integrating mathematics with other subjects, preschool activities become more engaging and effective, fostering children's creativity, flexibility, and originality. Interdisciplinary

approaches also familiarize children with diverse research techniques and encourage their curiosity for knowledge (Larousse, 1995).

In preschool, interdisciplinarity often involves transferring concepts and methods from related domains, such as using stories and songs from language education or exercises from physical education to teach mathematical concepts. For example: 1. Mathematics and sciences: activities involve observing and experimenting with objects, linking mathematical notions such as size, color, and spatial relationships to environmental exploration. 2. Mathematics and communication: rhymes and stories containing numbers (e.g., "The Three Billy Goats Gruff") reinforce counting and problem-solving, while introducing children to mathematical vocabulary. 3. Mathematics and physical education: spatial orientation exercises during sports help solidify concepts of position and measurement, making abstract ideas more concrete. 4. Mathematics and visual arts: drawing, cutting geometric shapes, and assembling figures help children internalize shapes, sizes, and dimensions while stimulating creativity.

Interdisciplinary activities cultivate integrative thinking and help children see mathematics as a practical, life-enhancing discipline rather than an abstract subject confined to the classroom. Effective teaching strategies in preschool mathematics: the methods employed in preschool mathematics aim to make abstract concepts accessible to young learners through engaging, hands-on experiences. Effective strategies include both traditional and modern methods, emphasizing the active participation of children in their learning process.

Traditional methods:

• Conversation: encourages interacti-on through questions and answers, clarifying and deepening understanding.

• Explanation: provides clear descriptions of concepts and procedures, often paired with demonstrations.

• Demonstration: uses tangible materials, such as toys or visual aids, to illustrate mathematical concepts, bridging concrete actions with mental representations.

• Observation: involves direct exploration of objects and phenomena, helping children identify key attributes.

• Problem Solving: introduces cognitive challenges that encourage children to discover solutions independently, fostering critical thinking.

• Exercises: repeated, purposeful actions to build skills and internalize mathematical principles.

Modern and interactive methods: interactive methods actively engage children in group settings, enhancing creativity, collaboration, and problem-solving abilities. Examples include:

• Brainstorming: encourages children to generate diverse solutions to a problem, promoting divergent thinking.

• The Snowball method: combines individual, pair, and group activities to progressively solve a problem, fostering cooperation and confidence.

• Venn diagrams: helps children compare and classify objects based on shared and unique attributes.

• Cube method: guides children to explore topics from multiple perspectives, such as describing, comparing, analyzing, and associating concepts.

• Starbursting: develops creativity through structured questioning (e.g., "Who? What? When? Where? Why? How?").

Modern research emphasizes the importance of these approaches. For instance, digital tools such as interactive whiteboards and educational apps have shown promise in enhancing engagement and learning outcomes in preschool mathematics (Clements & Sarama, 2014). Additionally, gamification elements, like progress tracking and reward systems, foster intrinsic motivation (Zosh et al., 2017). Collaborative learning activities, such as peer-assisted learning strategies, also promote social and cognitive development, preparing children for future teamwork and problem-solving scenarios (Fisher et al., 2021).

Active learning through play: play-based learning is a cornerstone of preschool education. Mathematical games, such as sorting or counting activities, merge instruction with enjoyment, fostering a positive attitude toward mathematics. Specific games include: 1. Didactic mathematical games: combine playful elements with structured learning tasks, such as pairing, comparing, and counting. 2. Role-playing and story-based games: use familiar narratives and characters to introduce mathematical concepts in relatable contexts.

By integrating interactive methods and interdisciplinary approaches, mathematical activities in preschool can effectively nurture logical reasoning, problem-solving, and creativity, providing a strong foundation for lifelong learning.

Research Design and Methodology

Mathematics instruction at the preschool level is foundational for cognitive development. However, the effectiveness of teaching approaches—whether traditional or modern—remains a subject of pedagogical research. This study aims to evaluate the outcomes of using interdisciplinary, interactive methods versus classical, monodisciplinary ones in teaching mathematics to preschool children. Specifically, it analyzes children's performance, attention span, and level of engagement across different instructional settings.

Research Design: this study utilized a comparative design to evaluate the effectiveness of interdisciplinary, interactive teaching methods versus traditional, monodisciplinary approaches in preschool mathematics education. Two heterogeneous groups of preschoolers, each consisting of 51 children, ages 4,5-6 years

old, from eight classes in four bilingual preschools (Battonya, Gyula, Méhkerék, Kétégyház), were formed:

1. Experimental group: engaged in interdisciplinary mathematical activities incorporating modern, interactive teaching methods. This group consisted of four groups, one from each preschool, which were taught separately.
2. Control group: participated in traditional monodisciplinary mathematical activities using classical methods. Like the experimental group, it consisted of four groups, one from each preschool, which were taught separately.

The research spanned two months, with systematic assessments conducted to measure the impact of teaching methodologies on children's performance, attention, and engagement.

Hypotheses

H1: By the end of the research period, the children in the experimental group will achieve higher scores in mathematical assessments compared to the control group.

H2: Children in the experimental group will demonstrate an improvement in attention spans during activities, as observed and recorded by educators.

H3: Participation rates in mathematical activities will increase for children in the experimental group, compared to baseline levels, exceeding the engagement rates of the control group.

Research objectives

O1: Assess the initial developmental levels of participants.

O2: Implement interdisciplinary methods in the experimental group and classical methods in the control group.

O3: Measure final developmental levels and analyze improvements.

O4: Highlight the effects of interdisciplinary activities on mathematical learning outcomes.

Assessment instruments

1. Initial evaluation:
   - Participants in both groups were tested to establish baseline knowledge and skills in mathematics using structured worksheets.
   - Six items evaluated competencies such as counting, recognizing numerical neighbors, and solving illustrated problems.
2. Experimental stage:
   - Interdisciplinary activities for the experimental group included tasks integrating mathematics with language, art, and environmental studies. Examples:
   - The control group performed standard preschool counting exercises and games and numerical manipulations, without interdisciplinary links.

3. Final evaluation:
   - Eleven items assessed broader competencies, such as recognizing and describing geometric shapes, performing basic arithmetic operations, and applying spatial concepts.
   - Results were tabulated, graphed, and statistically analyzed, to compare outcomes across groups.

Ethical considerations: the research adhered to ethical guidelines for educational studies. Parents provided informed consent for their children's participa-tion, and activities were designed to align with developmental norms and educati-onal standards. Data collection ensured participant anonymity and confidentiality.

Methodological approach: the study employed a mixed-methods approach, combining quantitative and qualitative data:

- Quantitative data: Scores from initial and final evaluations provided measurable insights into academic performance.
-
- Qualitative observations: Educators documented engagement levels, attention spans, and group interactions during activities, offering contextual depth to the findings.

This comprehensive methodology ensures robust and actionable insights into the effectiveness of interdisciplinary, interactive teaching methods in preschool mathematics education.

Results and findings of the study

Instruments and initial evaluation. The initial assessment aimed to determine the baseline mathematical skills of both the experimental and control groups. The evaluation consisted of 6 items assessing basic numerical recognition, counting, problem-solving based on visual stimuli, and comparison of quantities.

Outcome: Both groups showed relatively low but comparable averages. This established a baseline for evaluating progress after the intervention. Although the experimental group had a marginally higher average score (5.73), the two groups were fairly aligned, enabling a balanced comparison during the experimental phase (Table 1).

Experimental phase. The experimental phase was conducted following the centralization and analysis of the data obtained through the initial assessment tests. During this phase, participants from experimental group were engaged in inter-

Table 1. Initial Assessment – Average Scores by Group (own source)

Item	Max Points	Experimental Group	Control Group
Color, recognize colors	2	0.35	1.18
Count and circle number	1	0.98	0.35
Complete series	2	1.06	1.04
Identify neighboring numbers	2	1.06	1.00
Count ascending/descending (1–5)	1	1.12	0.98
Solve visual-based problems	2	1.12	1.08
Total Average (out of 10)	**10**	**5.73**	**5.63**

disciplinary mathematical activities that incorporated one innovative, interactive teaching method per session.

In contrast, participants from control group were involved in monodisciplinary mathematical activities that utilized traditional teaching methods.

Throughout these sessions, we observed and recorded both the duration of sustained attention and the level of active engagement exhibited by the children during the activities (Table 2.3.4.)

Outcome and teachers' observations:

The data reveals that activities conducted in an interdisciplinary format with modern methods led to significantly longer durations of sustained attention and higher levels of active engagement.

Table 2. Overview of experimental activities by group, method, and type (own source)

No.	Activity Title	Group Type	Activity Type	Activity Duration (min)	Number of Sessions	Method Type
1	In the World of Stories	Experimental Group	Interdisciplinary	30	4	Modern
2	At the Zoo	Experimental Group	Interdisciplinary	25	2	Modern
3	Spring is Coming!	Experimental Group	Interdisciplinary	20	3	Modern
4	Please Give Me...	Control Group	Monodisciplinary	25	3	Classical
5	The Magic Pouch	Control Group	Monodisciplinary	25	4	Classical
6	Let's Organize the Table!	Control Group	Monodisciplinary	20	2	Classical

Table 3. Interpretation of sustained attention times by activity (own source)

No.	Activity Title	Activity Type	Average Sustained Attention (min)	Observed Trend
1	In the World of Stories	Interdisciplinary	28	Very High – sustained throughout session
2	At the Zoo	Interdisciplinary	23	High – slight decline near end
3	Spring is Coming!	Interdisciplinary	18	Moderate – occasional attention shifts
4	Please Give Me...	Monodisciplinary	16	Moderate – fluctuating throughout session
5	The Magic Pouch	Monodisciplinary	15	Low – brief focused periods
6	Let's Organize the Table!	Monodisciplinary	13	Low – rapid loss of attention

Table 4. Interpretation of direct involvement levels by activity (own source)

No.	Activity Title	Activity Type	Level of Active Engagement (Scale 1–5)	Observed Behavior
1	In the World of Stories	Interdisciplinary	5	Fully engaged, enthusiastic participation
2	At the Zoo	Interdisciplinary	4.5	High involvement, interactive responses
3	Spring is Coming!	Interdisciplinary	4	Generally active, some variation among children
4	Please Give Me...	Monodisciplinary	3	Moderate engagement, task-focused
5	The Magic Pouch	Monodisciplinary	2.5	Passive involvement, limited initiative
6	Let's Organize the Table!	Monodisciplinary	2	Minimal interaction, required frequent redirection

Notably, *"In the World of Stories"* maintained an average attention span of 28 minutes and achieved the highest engagement rating, indicating a strong correlation between innovative instructional strategies and children's focus and motivation.

In contrast, classical methods applied in monodisciplinary contexts yielded shorter attention spans and lower levels of participation, with some children requiring ongoing guidance to remain focused. These findings support the hypothesis that interdisciplinary, methodologically modern activities are more effective in capturing and sustaining young learners' attention while fostering active involvement, thus contributing to the development of deeper and more meaningful learning experiences in early

mathematical education. „In the experimental group, children frequently initiated discussions and completed tasks collaboratively." (teacher)

Activities involving Venn diagrams, storytelling, or drawing (e.g., "In the World of Stories" or "Spring Is Coming") captured and sustained attention more effectively than classic exercises like "Magic Bag" or "Let's Clean the Table."

Final evaluation: impact assessment. To determine the educational impact, a final comprehensive test of 10 items was conducted. This test focused on number operations, logical reasoning, spatial awareness, geometric recognition, and problem-solving (Table5).

Table 5. Final evaluation – average scores by group (own source)

Item	Max Points	Experimental Group	Control Group
Count ascending/descending (1–5)	7	6.94	6.76
Number–quantity correspondence	8	7.92	7.57
Compose/decompose numbers (1–5)	10	9.20	8.22
Neighboring numbers	10	9.80	9.49
Addition and subtraction	10	9.27	8.25
Compare two sets	10	9.20	8.94
Use of pre-math terms	15	13.22	11.41
Geometric recognition	10	9.27	8.43
Logic problem-solving	10	9.33	6.96
Word problem-solving	10	9.33	6.24
Total Average (out of 100)	**100**	**93.14**	**82.27**

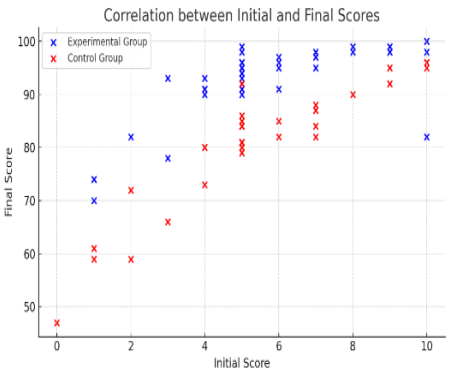
Detailed interpretation of the visual graphs and analyses

Figure 1 plots each child's initial score on the x-axis and their final score on the y-axis.

Experimental group (blue):

- Data points are more spread out, showing greater improvement across various initial ability levels.
- Indicates that even children with lower initial scores improved significantly

Figure 1. Scatter plot – initial vs final scores (correlation visualization, own source).



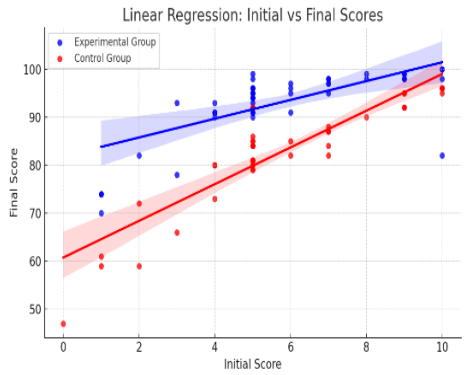
Control group (red):

- Data points are tightly clustered along the diagonal, showing that performance remained closely tied to initial abilities.

Conclusion: interactive teaching reduces dependency on prior knowledge, enabling more transformative progress.

Trend lines are drawn for each group, based on the correlation between initial and final scores (Figure 2).

Figure 2. Linear Regression Lines – Initial vs Final Scores (own source).



Red line (control group):

- Steeper slope, indicating a strong dependency on the initial score.
- Children's final performance largely mirrored their starting level, reflecting limited growth.

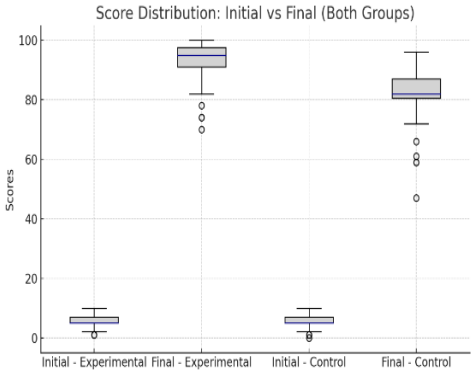
Blue line (experimental group):

- Gentler slope, suggesting wider improvement across different starting levels.
- Final scores reflect a positive shift regardless of where the child began.

Conclusion: modern, interdisciplinary methods lift all students, not just those with high initial performance.

Boxplots for each group display the distribution, median, and range of initial and final scores (Figure3).

Figure 3. Boxplot – score distribution (initial vs final, own source).



Experimental group:

- Final scores have a higher median and more compact distribution.
- Indicates consistent, high-level performance.

Control group:

- Final scores show greater variance and lower median.
- Suggests some improvement, but not uniform across all children.

Conclusion: interactive methods result in more equitable and elevated learning outcomes.

Pearson Correlation Comparison. Correlation coefficient between initial and final scores for both groups.

Performance Growth (Table 6):

- Experimental Group: improved from 5.73 to 93.14 (Δ +87.41 points)
- Control Group: improved from 5.63 to 82.27 (Δ +76.64 points)
- Difference in final average scores: +10.87 in favor of the experimental group

Table 6. Pearson correlation analysis

Group	Initial–Final Correlation	Interpretation
Experimental	0.671	Moderate correlation, strong progress
Control	0.824	High correlation, limited transformation

A lower correlation in the experimental group indicates that progress was not solely dependent on prior knowledge interdisciplinary methods had a transformational impact, especially on initially lower-performing children (Table 6).

Overall interpretation and final remarks

Children exposed to interdisciplinary, interactive teaching methods demonstrated higher academic performance, longer attention spans, and greater involvement.

The graphical tools offer concrete visual evidence supporting the positive transformational impact of modern preschool pedagogy.

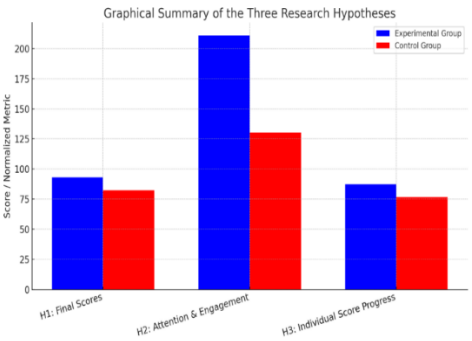
This study confirmed three key hypotheses (Figure4):

H1: Final performance was significantly higher in the interdisciplinary group, demonstrating superior outcomes through integrated learning.

H2: Children maintained attention lon-ger during interactive sessions, confirming the engagement power of modern methods.

H3: Participation was significantly higher in the experimental group, revealing that children were more involved when the material was interdisciplinary and playbased.

Figure 4. Summary of the three research hypotheses (own source).



Recommendations for early child-hood education

Incorporate interdisciplinary lessons combining mathematics with language, art, and science.

Use interactive tools such as Venn diagrams, tactile games, and storytelling to sustain attention and promote engagement.

Replace repetitive drills with meaningful problem-solving activities that encourage reasoning and collaboration.

Conclusions

This study demonstrates that mathematical activities in preschool, when delivered through interdisciplinary and interactive methods, significantly enhance children's cognitive performance, engagement, and attention. The experimental group consistently outperformed the control group in all metrics, including final assessment scores and observed involvement. The integration of mathematics with language, arts, and science made abstract concepts tangible and enjoyable. Activities like story-telling, drawing, and movement allowed children to internalize mathematical knowledge naturally. Teachers observed that children in the experimental group were more eager to participate, collaborated effectively, and maintained longer attention spans. These findings affirm the importance of combining traditional content with modern methodology. Interdisciplinary teaching not only benefits high-performing students but also supports those with lower starting competencies, reducing educational disparities. Furthermore, play-based learning emerged as a crucial strategy for fostering positive attitudes toward mathematics. The research confirms all three hypotheses and provides strong empirical support for revising early education frameworks. Ultimately, integrating creativity, interaction, and context into mathematics instruction ensures more inclusive, engaging, and effective learning experiences in preschool settings.

References

Clements, D. H., & Sarama, J. (2014). *Learning and teaching early math: The learning trajectories approach* (2nd ed.). Routledge.

Fisher, K. R., Hirsh-Pasek, K., Newcombe, N., & Golinkoff, R. M. (2021). *Playing to learn: A comparison of free play and guided play in building children's STEM skills*. Child Development Perspectives, 15(2), 82-87.

Gelman, R., & Gallistel, C. R. (1978). *The child's understanding of number*. Cambridge, MA: Harvard University Press.

Larousse. (1995). *Le petit Larousse en couleurs*. Paris, France: Larousse.

Montessori, M. (1964). *The Montessori method*. New York, NY: Schocken Books.

Piaget, J. (1952). *The origins of intelligence in children*. New York, NY: International Universities Press.

Piaget, J. (1962). *Play, dreams, and imitation in childhood*. New York, NY: Norton.

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

Zosh, J. M., Hopkins, E. J., Jensen, H., Liu, C., Neale, D., Hirsh-Pasek, K., & Solis, S. L. (2017). *Learning through play: A review of the evidence*. LEGO Foundation.