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THE ROLE AND EFFECTIVENESS OF TEACHING METHODS IN DEVELOPING SPATIAL THINKING

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Abstract. This paper examines the role of teaching methods in developing students' spatial thinking skills. Spatial thinking is a key cognitive process that integrates logical, mathematical, and creative reasoning. The aim of the study is to analyze mathematics teachers' perceptions of traditional and innovative methods used in teaching stereometry and to identify practical approaches to developing spatial cognitive skills in the school learning process.

A questionnaire was conducted among 120 mathematics teachers from various regions of Kazakhstan using Google Forms. The results showed that 39.2% of teachers consider model construction and physical modeling to be the most effective approaches for developing three-dimensional understanding. Traditional methods, selected by 24.1% of respondents, are associated with the development of proportional reasoning, while 25% emphasized the importance of digital tools in enhancing visualization and digital literacy.

Technologies such as GeoGebra, Tinkercad, and AR/VR are perceived by teachers as effective tools for supporting spatial reasoning. The study also identified challenges related to insufficient digital competence among teachers and limited technological resources in schools.

The findings suggest that a balanced integration of traditional and modern teaching methods is essential for the development of spatial thinking. The results provide pedagogically grounded recommendations, including the expansion of modeling techniques, systematic use of digital tools, and the enhancement of teachers' professional competencies. The development of spatial thinking is considered an important factor in improving students' functional literacy and creative abilities.

Keywords: *spatial thinking, stereometry, innovative technologies, modeling, GeoGebra, Tinkercad, teacher competence.*

Introduction

The primary purpose of education is to develop individuals capable of critical and analytical thinking. In this context, the teaching of spatial thinking in pedagogy is regarded as one of the chief factors in the development of the cognitive, logical, imaginative faculties of pupils and their functional literacy. The development of students' spatial thinking is particularly important in mathematics, especially in geometry. Geometry teaching should not be limited solely to the study of rules that define figures and measure their surfaces, but should also include the relationships between figures, their spatial properties, and the visualization of geometric objects. For this reason, it is part of the teacher's work to organize the more efficient means of developing pupils' spatial thinking in their geometry lessons. The development of the pupils' spatial reasoning enables them to interpret the abstract ideas in a concrete way, to practice logical thinking, and to form creative conclusions. To illustrate, in the stereometric section of geometry, students develop the ability to visualize three-dimensional objects, understand their structure, and represent their transformations, such as rotations and cross-sections.

The development of the pupils' spatial thinking in geometry teaching plays a very important part in the pupils mastering the several departments of mathematics. In plane geometry pupils perfect their powers of spatial sight and power of division by visualizing, comparing, decomposing, and calculating the areas of plane figures. In their study of stereometry pupils acquire powers of imagination in three dimensions, which consists in their being able to visualize figures in their own volume, to rotate them, to make some cross-section and to derive the points of places in space, having gotten views of symmetry and orientation with regard to axes. In vector algebra, they will be called upon at times to interpret and see figures in their algebraic coordinates and with regard to their directional points, which supply visual space thought, while those departments of elementary analysis in virtue of their correlation consist in the visualization of figures of function graphs in their rotations in space, to give a mental observation of spatial thought. In trigonometry, the visualization of the conditions incident on the figure placed in a circle, and of the values of the functions characterized by the angular values, gives the visual-spatial view of the conception of spatial situation.

Overall, the development of spatial thinking in the pedagogic field is to be regarded in its relation to the theories of powers of cognitive thought development and education centering round the learner, and the appreciations of competencies in the education process. Hence, it becomes necessary for the school to have its methods of teaching in a way directed to these principles, while the competent teacher is one whose abilities in the clever application of activity methods are made use of, for the purpose of making for spatial thought.

Despite the extensive body of international research highlighting the importance of visualization, modeling, and digital technologies in developing spatial thinking, several gaps remain insufficiently addressed. First, there is a lack of empirical evidence on how mathematics teachers in Kazakhstan prioritize these methods in actual school practice. Second, limited attention has been paid to the relationship between teachers' professional experience and their preference for traditional versus digital approaches. Third, the influence of contextual factors, such as urban–rural differences and access to technological resources, has not been sufficiently explored.

Therefore, the novelty of this study lies not in reasserting the general importance of spatial thinking, but in providing a context-specific empirical analysis of Kazakhstani teachers' methodological preferences (Table 1), identifying patterns related to teaching experience and school conditions, and proposing a structured framework for selecting teaching methods in stereometry instruction.

Based on this, the study addresses the following research questions:

1. Which teaching methods do mathematics teachers consider most effective for developing students' spatial thinking?
2. How do teachers' preferences vary depending on their professional experience?
3. What differences exist between urban and rural schools in the use of digital tools?
4. What methodological implications can be derived from these patterns?

Table 1 – Effective Methods for Developing Students' Spatial Thinking in Geometry

Methods	Description
Visual Method	Presenting geometric figures using real models or colored diagrams makes it easier for students to imagine shapes in space and understand their visual structure.
Differentiated and Level-Based Tasks	Since students differ in their spatial abilities and interests, individualized learning allows the teacher to adapt the level and type of tasks to each learner's potential.
Creating Models or Mock-Ups	Students can "see" the figure with their eyes, "touch" it with their hands, and "assemble" it physically, thus gaining a concrete understanding of shape and section in space.
Visualization Through Drawings	Abstract notions are interpreted with the concrete representations and ease of graphic illustration, they render their connections greatly appreciable.
Use of Digital Tools	Digital tools enable students to rotate three-dimensional objects, observe them from different perspectives, and interact with their structure, which supports spatial visualization.
Use of Interactive Constructive Structures	Interactive models help students better understand spatial figures by making abstract concepts more visible and easier to manipulate.

Methods	Description
Group Work	Group work allows students to discuss spatial problems, exchange ideas, and collaboratively construct solutions, which supports the development of spatial reasoning and communication skills.
STEM/Project-Based Approaches	Integrating spatial tasks with real-world problems helps students apply theoretical knowledge in practical contexts.
Problem-Solving Tasks	Problem-solving tasks develop students' spatial reasoning through logical analysis, visualization, and structured explanation.

Since the second half of the twentieth century, spatial cognition has been widely examined in cognitive psychology and mathematics education. Classical theories developed by Jean Piaget [1] and Lev Vygotsky [2] emphasize the developmental nature of cognitive processes and highlight the role of social and instructional environments in shaping students' understanding. Today, spatial abilities are increasingly viewed as an important factor influencing mathematical achievement.

A growing body of research points to a strong connection between spatial reasoning and students' performance in different areas of mathematics, including geometry, arithmetic, and data analysis. In particular, meta-analytical studies have shown that dynamic visualization tools can substantially improve students' ability to interpret spatial relationships [3, 4]. GeoGebra-based instruction, for example, has been associated with notable gains in spatial visualization, suggesting that interactive environments help students form more stable mental representations of three-dimensional objects [5].

In addition to dynamic geometry software, augmented reality (AR) has attracted increasing attention in recent years. Studies indicate that AR-supported learning enhances students' three-dimensional mental rotation skills and improves their ability to work with complex spatial structures [6]. When combined with physical models, digital tools appear to support a deeper and more integrated understanding by engaging both visual and tactile perception.

Evidence from experimental research further supports the effectiveness of targeted instructional approaches. A longitudinal intervention conducted by Lowrie et al. [7] showed that structured spatial training can significantly improve both spatial reasoning and overall mathematical performance. Moreover, the early development of spatial skills has been linked to long-term benefits in problem-solving and academic achievement [8]. These findings underline the importance of treating spatial cognition as a core component of mathematics education.

The role of the teacher remains particularly important in this process. Studies suggest that teachers' professional competencies, including their ability to use modeling strategies and digital tools, directly influence students' learning outcomes. At the same time, many teachers report difficulties when dealing with tasks that require three-dimensional visualization, such as rotations, cross-sections, and transformations. As noted by Michael T. Battista [9], limited understanding of spatial models can reduce the effectiveness of geometry instruction.

Taken together, the literature suggests that the development of spatial abilities is most effective when different instructional approaches are used in combination. The integration of theoretical knowledge, digital technologies, and hands-on modeling provides a more comprehensive learning environment and supports the development of higher-order cognitive skills.

However, despite the growing body of research in this area, there is still a lack of context-specific studies that examine how teaching method preferences vary depending on teachers' professional experience and school environment. Unlike previous studies, this research provides a comparative analysis of teaching method preferences based on teaching experience and school context, which has not been systematically examined in Kazakhstani educational research.

This allows the study to move beyond general theoretical conclusions and provide context-specific insights into teaching practices in Kazakhstan.

Materials and methods

This study employed a quantitative descriptive survey design aimed at identifying mathematics teachers' perceptions of methods used for developing students' spatial thinking in geometry instruction. The study does not directly measure students' learning outcomes; instead, it focuses on teachers' pedagogical judgments and reported instructional practices.

The study involved 120 mathematics teachers from various regions of Kazakhstan, including both urban and rural schools. The participants differed in their professional experience (0–5 years, 6–15 years, and over 15 years), which made it possible to analyze how teaching experience influences methodological preferences. The sampling was based on voluntary participation through online distribution.

Data were collected using a structured questionnaire developed on the Google Forms platform. The questionnaire included items related to preferred teaching methods, perceived effectiveness of these methods, use of digital tools, teaching experience, and school context. Its design was based on the analysis of relevant literature on spatial thinking and geometry education.

The questionnaire primarily consisted of categorical and preference-based items; therefore, internal consistency reliability was not calculated. Content validity was ensured through alignment with theoretical frameworks and expert evaluation of item relevance.

The collected data were analyzed using descriptive statistics, including frequencies and percentages. Comparative analysis was conducted to identify differences in methodological preferences depending on teaching experience and school type (urban vs. rural). As the study is exploratory in nature, the analysis focuses on identifying patterns rather than establishing causal relationships.

Participation in the study was voluntary and anonymous. Respondents provided informed consent, and the data were used solely for research purposes.

Although the study is based on descriptive statistical analysis, it provides an empirical foundation for further hypothesis testing and experimental research. The identified patterns can be used to design controlled studies aimed at measuring the direct impact of specific teaching methods on students' spatial thinking development.

Results and discussion

The survey results show that the method that received the highest number of responses was model construction using paper or clay (39.2%) (Figure 1). This method enhances students' ability to visualize spatial structures by allowing them to observe, manipulate, and construct their own models. Model construction increases students' engagement and contributes to deeper conceptual understanding and better retention of learning material (Table 2). This method is particularly effective when dealing with subject matter, e.g. geometric figures and volume, when students must integrate both visual and tactile perception with abstract reasoning.

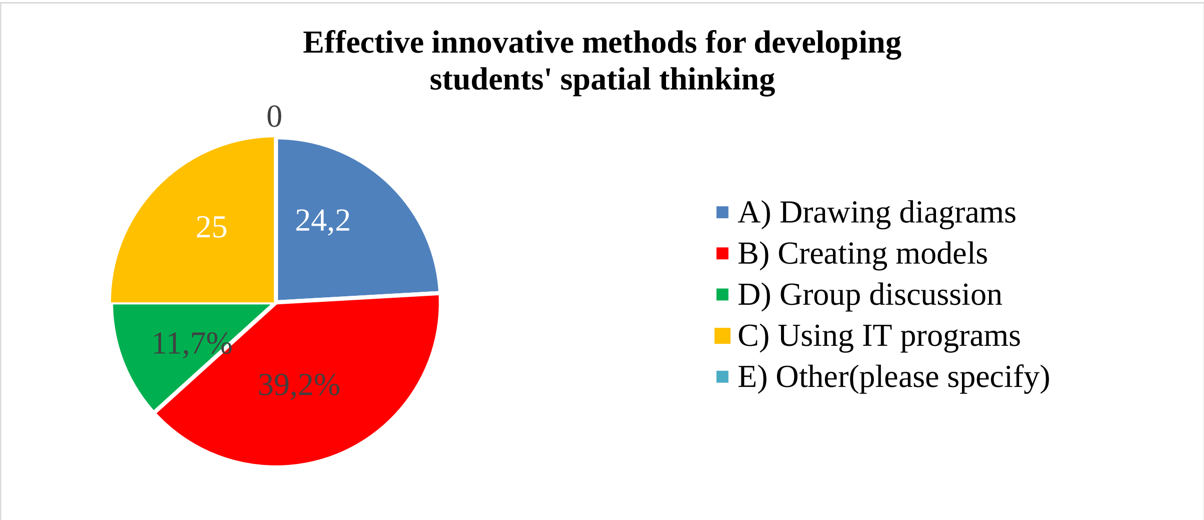

Figure 1 – Most effective methods for developing students' spatial thinking

Table 2 – Analysis of Teachers’ Preferred Methods for Developing Students’ Spatial Thinking

№	Methods	Percentage / Number of Teachers	Explanation	Recommendations
1	Traditional Drawing of Diagrams	24.1%/29 teachers	Students learn to project three-dimensional space onto a plane and maintain proportions and logical order in their drawings. It was observed that representing the relationships between geometric figures through diagrams effectively enhances spatial reasoning.	Students should receive systematic training in converting abstract mental images into tangible graphical representations. Instructing them to depict abstract forms through drawings fosters structured and logical reasoning.
2	Creating Models	39.2%/47 teachers	Through the observation and manipulation of geometric figures, students engage their creativity and hands-on skills to gain a deeper understanding of complex concepts. This approach enhances both practical and visual perception.	It is important to consistently demonstrate spatial figures in lessons using visual aids and physical models whenever appropriate.
3	Using IT Programs	25%/30 teachers	The dynamic presentation of spatial figures significantly enhances student engagement and fosters digital literacy. Educators have shown a marked preference for integrating digital technologies and 3D modeling software into their teaching practices.	Educators are encouraged to proficiently employ digital tools like GeoGebra and Tinkercad to build spatial models and improve visual comprehension.
4	Group Discussion and Peer Support	11.7%/14 teachers	Through dialogue, collaboration, and exchanging ideas, students develop the ability to consider different perspectives and evaluate multiple solutions. Teachers noted that fostering cooperative learning and idea-sharing contributes to developing the social aspects of spatial thinking.	Facilitating small-group activities centered around constructing geometric models can improve students' communication skills and foster their creativity.
5	Individual Suggestions	No responses provided	This indicates that teachers tend to pay little attention to creative, project-based, or experimental approaches in their teaching practice.	Teachers should be encouraged to integrate elements of experimentation and project-based learning into their classroom practice to promote innovation.

From the survey results, it is clear that the method of modeling, currently used by teachers, is the most preferred method of teaching mathematics for the purpose of students' development of spatial thinking skills in the process of learning. The method of using IT technologies and methods of modeling diagrams are a methodological addition to this teaching method. The justified and balanced use of traditional teaching methods and contemporary methods of using digital tools and modeling diagrams is widely recognized in educational practice. Further analysis has given a clear relationship between the number of years of teaching experience and preferred methods of teaching. Teachers who have up to 5 years of experience prefer the use of digital means (37%), whereas the more experienced teachers (over five years of experience) prefer the traditional and modeling methods (42-43%) (Figure 2). The differences in the teaching methods which are favored can be accounted for partly by the difference in the teachers' digital competence and their ability to tailor the work to their students within the learning process.

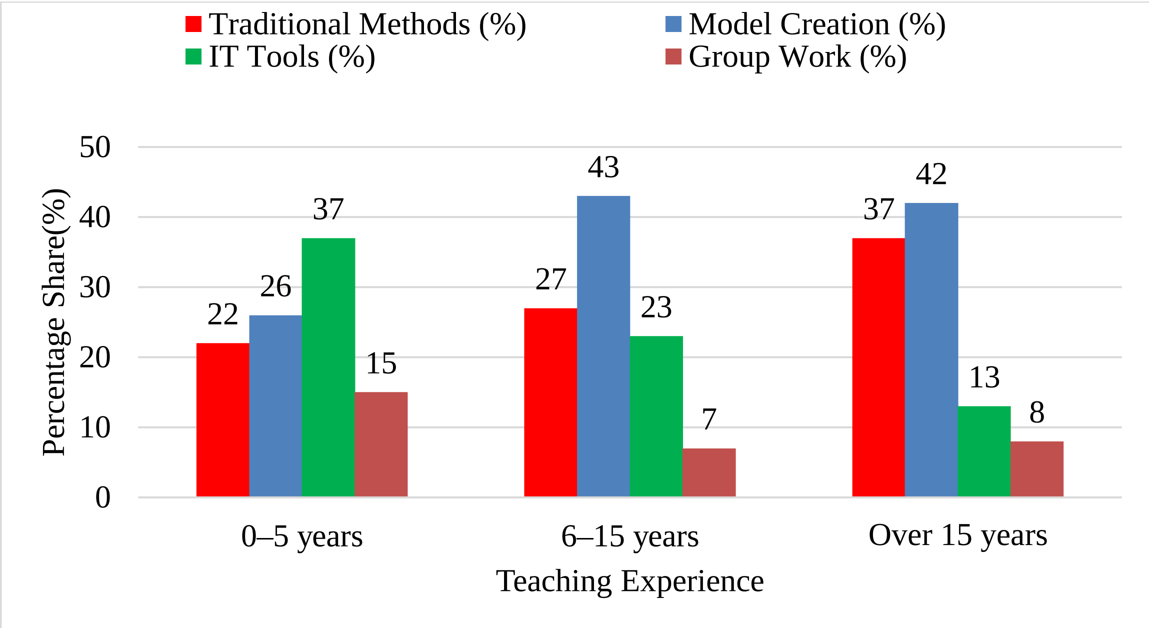

Figure 2 – Correlation Between Teachers' Work Experience and Preferred Teaching Methods for Developing Students' Spatial Thinking

In contemporary educational practice, the role of the teacher extends beyond knowledge transmission to facilitating students' spatial, logical, and creative development (Table 3). Therefore, the successful introduction of modern methods of teaching into the educational process is an important part of the professional responsibility of a modern teacher.

Table 3 – Comparative Characteristics of Teaching Methods for Developing Spatial Thinking

№	Methods	Description of the Method	Visual Perception	Logical Thinking	Creativity	Commu-nication
1	Traditional Drawing of Diagrams	This method develops students' ability to visualize concepts. It cultivates accuracy, logical reasoning, and a sense of aesthetic perception through schematic representations of spatial figures.	Very high	Good	Moderate	Weak

№	Methods	Description of the Method	Visual Perception	Logical Thinking	Creativity	Commu-nication
2	Creating Models – Building the Practical Foundation of Spatial Thinking	Practical modeling encourages student engage-ment, a deeper understanding, and a longer retention of his knowledge. It connects the theoretical with his sensitivity to the learning processes and produces greater spatial imagination in students.	Very high	Good	Very high	Moderate
3	Using IT Programs to Develop Digital Skills	It is a method that was invented for the digital age. Thanks to applications such as GeoGebra and Tinkercad, students do things such as rotating, projecting and measuring complex spatial shapes that allow them to understand things spatially in a dynamic way.	Very high	Good	Good	Moderate
4	Group Discussion and Peer Support for Collaborative Spatial Thinking	This method encourages joint problem-solving from dialogue and collective analysis. During complex exercises and through practical exercises, students share different points of view, complement their proposals and develop teamwork skills.	Good	Good	Good	Very high

Selection and Adaptation to Students' Level.

The effectiveness of using innovative methods in developing students' spatial thinking skills within the learning process.

Table 4 – Methodological Recommendations and Criteria for Differentiating Teaching Methods

Methodological Recommendations for Analysis		**Criteria for Differentiating Teaching Methods**	
Methodological Recommendations for Analysis	Explanation	Differentiation Criteria for Methods	Explanation
Clarifying and Systematizing the Structure of Analysis	During the analysis of teaching methods, the framework "Purpose – Advantages –Limitations – Adjustments/Improvements" should be applied. The analysis must be precise and comparative in nature.	Frequency of Use	The significance of a method within the educational process is gauged by how often it is utilized by teachers.

Methodological Recommendations for Analysis		Criteria for Differentiating Teaching Methods	
Focusing on Practical Application	Each approach ought to incorporate case-based examples and tasks that are aligned with particular lesson objectives.	Effectiveness Level	The effectiveness of the methods is evaluated by analyzing the qualitative performance indicators of the students.
Prioritizing Effective Methods	It is necessary to identify which methods are most suitable for learning objectives through empirical observation.	Accessibility	The method's implementation must correspond to the school's material and technical capabilities.
Teachers' Professional Competence	The capability to utilize interactive tools and digital software designed to enhance spatial reasoning in alignment with educational objectives.	Student Engagement	Determining which method most effectively increases students' motivation and participation in the learning process.
Integrating STEM and Project-Based Learning Elements	It is recommended to design interdisciplinary and research-oriented exercises within the STEM framework.	Consideration of Age Characteristics	Evaluating how effectively the method addresses the developmental and cognitive requirements of students in primary, middle, or high school.
Developing Evaluation Criteria	Presenting certain criteria for evaluating spatial thinking that include accuracy of modeling, creativity, and consistency of structure.	Level of Innovation	Investigating how contemporary, original, and innovative this method is among modern teaching methods.

The effectiveness of innovative teaching methods directly depends upon their proper selection and skillful application (Table 4). Every method should be correctly correlated with the age characteristics of the students, grade level, mechanical resources, and the subject content. When choosing a method, the teacher should expect not only its advantages but also potential challenges and limitations. Only in this case can innovative methods lead to genuine educational outcomes and become effective tools for developing students' spatial thinking.

The analysis of the survey data revealed several important patterns. First, model construction was identified as the most frequently preferred method (39.2%), followed by the use of IT tools (25%) and traditional diagram-based approaches (24.1%). Second, teachers with less professional experience demonstrated a stronger preference for digital tools, whereas more experienced teachers more often selected traditional and modeling methods. Third, urban teachers reported a higher level of digital tool usage compared to rural teachers, indicating the influence of institutional and technological conditions. Finally, collaborative methods, although recognized as valuable, were less frequently applied in practice.

These findings indicate that teachers' methodological choices are influenced not only by pedagogical considerations but also by experience and contextual constraints.

Discussion

The contribution of this study can be viewed from several perspectives. From a theoretical standpoint, the findings reinforce the idea that spatial thinking in geometry is best developed through a combination of approaches rather than reliance on a single method. The integration of traditional instruction, hands-on modeling, and digital tools creates more favorable conditions for the formation of stable spatial representations.

From a methodological perspective, the study offers a structured overview of teaching practices by linking commonly used methods with their pedagogical functions and classroom applicability. This makes it possible to better understand how different approaches operate in real teaching contexts. From an empirical point of view, the research provides data specific to Kazakhstan, highlighting how teachers' experience and school conditions influence their methodological choices, particularly in relation to the use of digital technologies.

The results clearly indicate that modeling activities play a central role in the development of spatial understanding. According to the survey, 39.2% of teachers identified model construction as the most effective method. This approach allows students to interact with geometric forms directly, which helps them grasp spatial relationships more confidently. Similar conclusions have been reported in studies, where structured spatial training and modeling tasks were found to improve both spatial reasoning and overall mathematical performance [10]. At the same time, model-based learning has been shown to increase students' engagement with three-dimensional concepts and support deeper conceptual understanding [11].

Despite the growing emphasis on innovation, traditional techniques such as diagram construction and problem-solving continue to play an important role. These approaches support the gradual shift from concrete visual perception to more abstract forms of reasoning. This idea is consistent with the theoretical views of Jean Piaget [1] and Lev Vygotsky [2], who emphasized the progressive development of cognitive structures and the role of guided learning in this process.

Digital technologies, however, offer opportunities that are difficult to achieve through traditional instruction alone. Tools such as GeoGebra, Tinkercad, and AR/VR environments allow students to manipulate objects dynamically, observe transformations, and explore spatial relationships from multiple perspectives. Research findings confirm that such tools contribute significantly to the development of spatial visualization skills [12]. In the present study, approximately 25% of teachers rated digital technologies as highly effective, although some respondents pointed to practical challenges, including limited access to equipment and insufficient technical training. These responses suggest that the successful use of digital tools depends not only on their instructional potential but also on teachers' preparedness and the availability of resources.

Collaborative learning also deserves attention. Although only 11.7% of teachers reported actively using group-based methods, those who did emphasized their positive impact on students' reasoning and communication. Working in groups encourages learners to articulate their ideas, compare different approaches, and refine their understanding through discussion [13, 14]. Previous research has similarly shown that verbalizing spatial strategies in a collaborative setting improves flexibility in problem-solving [15]. The relatively low use of such methods indicates that their potential has not yet been fully realized in school practice.

Overall, the findings indicate that the effectiveness of these approaches depends on how they are adapted to specific teaching contexts. In particular, factors such as teachers' professional experience, access to resources, and school environment play a crucial role in determining which methods are most appropriate in practice.

In addition, regional differences were clearly observed. In urban schools, 35% of teachers reported usage of IT tools to develop spatial thinking, whereas in rural schools, traditional methods (over 40%) prevailed (Figure 3). This imbalance is closely related to differences in material and technical resources, internet quality, and teachers' levels of professional competence

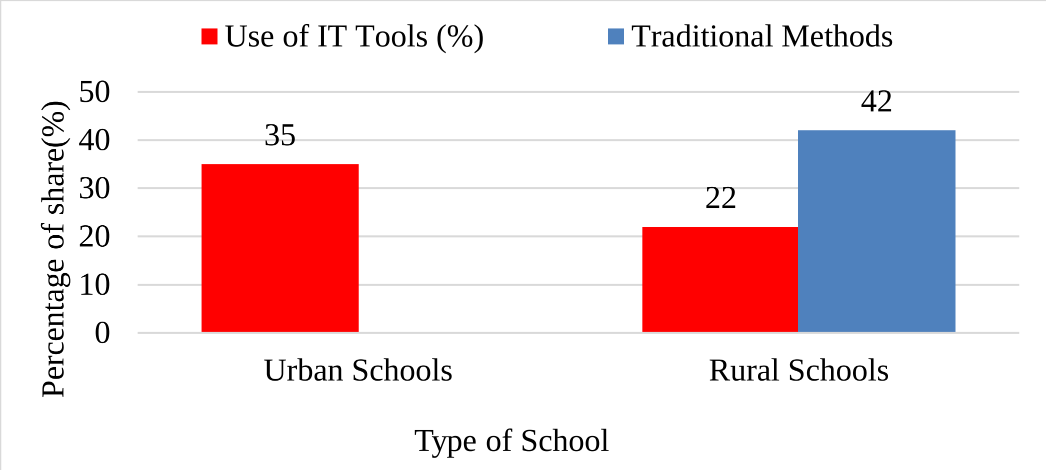

Figure 3 – Comparison of IT Tool Usage and Traditional Methods Between Urban and Rural Schools

When compared with international research, several consistent patterns emerge. First, spatial thinking has a measurable impact on students' performance not only in geometry but also in related areas such as algebra, trigonometry, and data analysis. Recent studies confirm that spatial reasoning supports students' ability to interpret mathematical structures, perform calculations, and analyze complex information [7].

Second, the role of the teacher appears to be a key factor in the development of spatial thinking. Research shows that students' outcomes are closely related to teachers' professional competence, including their ability to select appropriate methods and effectively use instructional tools. In particular, studies indicate that structured spatial training and well-designed instructional strategies can significantly improve students' spatial reasoning and overall mathematical performance [6].

These findings suggest that the quality of instruction depends not only on the choice of teaching methods but also on the teacher's ability to apply them in a pedagogically meaningful way.

Analyzing the results of this research allows for several practical conclusions:

The importance of traditional methods. Drawing diagrams and problem analysis should continue to serve as fundamental tools for developing students' logical reasoning.

Expanding the use of model-building techniques. This approach helps students develop spatial perception through practical activity and facilitates the process of memory retention.

Systematic integration of digital technologies. The effective use of GeoGebra, Tinkercad, and AR/VR tools in the classroom is one of the key directions in promoting spatial thinking.

Enhancing teachers' professional competence. Specialized professional development courses are needed to help teachers master innovative methods and new digital programs.

Strengthening cooperative learning. Regular use of group work and collaborative discussion enhances students' social and communication skills and allows them to view spatial concepts from multiple perspectives.

In conclusion, the research findings show that developing spatial thinking in Kazakhstani schools remains a highly relevant issue. Although traditional methods are still predominant, there is a rapidly growing demand for innovative technologies. Successful practice in this area depends largely on teachers' professional competence and their ability to combine different teaching methods effectively. Therefore, the main task for the future is to preserve the strengths of traditional approaches while enriching them with modern digital tools to improve the overall quality of teaching.

The study has several limitations. It is based on teachers' self-reported perceptions and does not include direct measurement of students' spatial thinking development. In addition, the survey design does not allow for establishing causal relationships between teaching methods and learning outcomes. Future research should incorporate experimental or quasi-experimental designs, including pre- and post-assessment of students' spatial abilities, as well as statistical analysis of learning gains associated with specific instructional interventions.

An important contribution of this study lies in demonstrating that the effectiveness of teaching methods is not universal but context-dependent. The findings show that methodological preferences are shaped by both professional experience and institutional conditions, which highlights the need for differentiated instructional strategies. This perspective extends existing research by emphasizing the role of contextual adaptation in the development of spatial thinking.

Conclusion

This study explores mathematics teachers' perceptions of teaching methods used to develop students' spatial thinking in geometry education. The results show that model construction is the most preferred approach, followed by the use of digital tools and traditional diagram-based methods. These findings indicate that no single method is sufficient on its own; rather, the effective development of spatial thinking requires a thoughtful combination of complementary instructional strategies.

The novelty of the study lies in providing a context-specific analysis of teaching practices in Kazakhstan, revealing how methodological preferences vary depending on teachers' professional experience and school conditions. In particular, the results highlight differences in the use of digital technologies between urban and rural schools, as well as variations in method selection across experience levels.

From a practical perspective, the study emphasizes the importance of integrating traditional instruction, hands-on modeling, and digital technologies in a balanced manner. Such an approach supports not only the development of spatial visualization skills but also enhances students' logical reasoning, creativity, and engagement. The findings also underline the need to strengthen teachers' professional competencies, especially in the use of digital tools for teaching geometry.

At the same time, the study has certain limitations, as it is based on self-reported data and does not directly measure students' learning outcomes. Future research should focus on experimental and quasi-experimental designs to evaluate the actual impact of different teaching methods on students' spatial thinking development.

Overall, the results contribute to a better understanding of how teaching methods can be effectively adapted to specific educational contexts and provide a foundation for improving geometry instruction in modern school practice.

Author Contributions:

Kalilanova K. – conducted the main research, developed the methodology, analyzed the data, wrote the manuscript, and performed its editing.

Mustafayev A. – proposed the main idea of the research, contributed to the development of the methodology and the analysis of the results.

Zhanuzakova D. – served as the academic supervisor, provided scientific guidance, and assisted in the development and editing of the manuscript.

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КЕҢІСТІКТІК ОЙЛАУДЫ ҚАЛЫПТАСТЫРУДА ОҚЫТУ ӘДІСТЕРІНІҢ РӨЛІ МЕН ТИІМДІЛІГІ

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Аңдатпа. Бұл мақала оқушылардың кеңістіктік ойлау дағдыларын дамытудағы оқыту әдістерінің рөлін зерттеуге арналған. Кеңістіктік ойлау – логикалық, математикалық және шығармашылық ойлауды біріктіретін маңызды когнитивтік үдеріс. Зерттеудің мақсаты – стереометрияны оқытуда қолданылатын дәстүрлі және инновациялық әдістерге қатысты математика мұғалімдерінің көзқарастарын талдау және мектептегі оқу үдерісінде кеңістіктік когнитивтік дағдыларды дамытудың практикалық тәсілдерін анықтау.

Осы мақсатта Қазақстанның әртүрлі өңірлерінен 120 математика мұғалімі арасында Google Forms платформасы арқылы сауалнама жүргізілді. Зерттеу нәтижелері көрсеткендей, мұғалімдердің 39,2%-ы кеңістіктік (үшөлшемді) түсінікті дамытуда модель құрастыру мен макет жасауды ең тиімді әдістердің бірі деп есептейді. Респонденттердің 24,1%-ы таңдаған дәстүрлі әдістер пропорционалдық ойлауды дамытуға ықпал етеді, ал 25%-ы цифрлық құралдардың көрнекілікті арттыру мен цифрлық сауаттылықты дамытудағы маңыздылығын атап өтті.

GeoGebra, Tinkercad және AR/VR сияқты технологиялар мұғалімдер тарапынан кеңістіктік ойлауды қолдаудың тиімді құралдары ретінде қарастырылады. Сонымен қатар, зерттеу барысында мұғалімдердің цифрлық құзыреттілігінің жеткіліксіздігі және мектептердегі техникалық ресурстардың шектеулілігі сияқты мәселелер анықталды.

Зерттеу нәтижелері кеңістіктік ойлауды дамыту үшін дәстүрлі және заманауи оқыту әдістерін теңгерімді түрде біріктірудің маңыздылығын көрсетеді. Алынған нәтижелер модельдеу әдістерін кеңейту, цифрлық құралдарды жүйелі түрде қолдану және мұғалімдердің кәсіби құзыреттілігін арттыру сияқты педагогикалық тұрғыдан негізделген ұсыныстарды ұсынады. Кеңістіктік ойлауды дамыту оқушылардың функционалдық сауаттылығы мен шығармашылық қабілеттерін арттырудың маңызды факторы ретінде қарастырылады.

Кілт сөздер: *кеңістіктік ойлау, стереометрия, инновациялық технологиялар, модельдеу, GeoGebra, Tinkercad, мұғалім құзыреттілігі.*

РОЛЬ И ЭФФЕКТИВНОСТЬ МЕТОДОВ ОБУЧЕНИЯ В ФОРМИРОВАНИИ ПРОСТРАНСТВЕННОГО МЫШЛЕНИЯ

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Аннотация. В данной статье рассматривается роль методов обучения в развитии пространственного мышления учащихся. Пространственное мышление представляет собой важный когнитивный процесс, объединяющий логическое, математическое и творческое мышление. Цель исследования заключается в анализе представлений учителей математики о традиционных и инновационных методах, используемых при обучении стереометрии, а также в определении практических подходов к развитию пространственных когнитивных навыков в школьном образовательном процессе.

В исследовании приняли участие 120 учителей математики из различных регионов Казахстана, анкетирование проводилось с использованием платформы Google Forms. Результаты показали, что 39,2% учителей считают моделирование и создание макетов наиболее эффективными методами для формирования трёхмерного представления. Традиционные методы, выбранные 24,1% респондентов, способствуют развитию пропорционального мышления, тогда как 25% отметили значимость цифровых инструментов для повышения наглядности и развития цифровой грамотности. Такие технологии, как GeoGebra, Tinkercad и AR/VR, рассматриваются учителями как эффективные средства поддержки пространственного мышления. В ходе исследования также были выявлены проблемы, связанные с недостаточным уровнем цифровой компетентности учителей и ограниченностью технических ресурсов в школах.

Результаты исследования показывают, что для эффективного развития пространственного мышления необходима сбалансированная интеграция традиционных и современных методов обучения. Полученные данные позволяют сформулировать педагогически обоснованные рекомендации, включающие расширение использования методов моделирования, системное применение цифровых инструментов и повышение профессиональной компетентности учителей. Развитие пространственного мышления рассматривается как важный фактор повышения функциональной грамотности и творческих способностей учащихся.

Ключевые слова: *пространственное мышление, стереометрия, инновационные технологии, моделирование, GeoGebra, Tinkercad, компетентность учителя.*

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