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SCIENTIFIC-METHODOLOGICAL FOUNDATIONS OF GEOMETRY INSTRUCTION IN SECONDARY SCHOOLS AND ITS IMPACT ON STUDENTS' MATHEMATICAL THINKING DEVELOPMENT

The article examines the selection of geometry teaching materials in secondary schools and their implementation in the educational process. The study highlights the integration of geometry education with real-life contexts, its polytechnic nature, the practical application of theoretical knowledge, and the development of students' spatial imagination. The author emphasizes that geometry is not only a body of theoretical knowledge but also serves to develop practical skills that students can apply in scientific and technical activities.

The research analyzes how students become familiar with geometric quantities from elementary grades, the study of spatial figures, and operations such as measuring, calculating areas, and volumes. In primary grades, the main goal is the development of spatial imagination, while in higher grades, the focus shifts to the practical application of theoretical knowledge and the development of problem-solving skills. The article also underscores the importance of teachers' scientific and pedagogical preparation, the selection of methods adapted to students' varying levels of knowledge, and the interactive and practice-oriented organization of lessons.

The connection of geometry with other subjects–particularly physics, chemistry, geography, and technical disciplines–is explored, along with examples of its practical applications in everyday life and technical activities. The author notes that practical tasks, drawings, and models promote the development of students' critical thinking, observation skills, and creative cognitive activity. Consequently, geometry education plays a significant role in the practical application of theoretical knowledge, problem-solving, and logical reasoning development.

The author concludes that the purposeful and correct selection of geometric materials, the practical application of theoretical knowledge, and interdisciplinary integration in secondary school mathematics courses enhance students' mathematical thinking, spatial imagination, and technical creativity.

Keywords: *measurements; problem-solving; logic; geometry materials; plane figures; spatial figures; teaching methodology; practical application; spatial imagination.*

Ref. 10.

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НАУКОВО-МЕТОДИЧНІ ОСНОВИ НАВЧАННЯ ГЕОМЕТРІЇ У СЕРЕДНІХ ШКОЛАХ ТА ЇХНІЙ ВПЛИВ НА РОЗВИТОК МАТЕМАТИЧНОГО МИСЛЕННЯ УЧНІВ

Стаття досліджує вибір навчальних матеріалів з геометрії у середніх школах та їхнє впровадження у навчальний процес. У дослідженні підкреслюється інтеграція навчання геометрії з реальними життєвими контекстами, її політехнічний характер, практичне застосування теоретичних знань та розвиток просторової уяви учнів. Автор наголошує, що геометрія є не лише набором теоретичних знань, але й слугує для розвитку практичних навичок, які учні можуть застосовувати у науковій та технічній діяльності.

У дослідженні аналізується, як учні знайомляться з геометричними величинами з початкових класів, вивчають просторові фігури та виконують операції, такі як вимірювання, обчислення площ і обсягів. У початкових класах основною метою є розвиток просторової уяви, тоді як у старших класах акцент зміщується на практичне застосування теоретичних знань та розвиток навичок розв'язування задач. Стаття також підкреслює важливість науково-педагогічної підготовки вчителів, вибору методів, адаптованих до різного рівня знань учнів, та інтерактивної й практико-орієнтованої організації уроків.

Розглядається зв'язок геометрії з іншими предметами – зокрема фізикою, хімією, географією та технічними дисциплінами, а також наводяться приклади її практичного застосування в повсякденному житті та технічній діяльності. Автор зазначає, що практичні завдання, креслення та моделі сприяють розвитку критичного мислення учнів, навичок спостереження та творчої когнітивної активності. Внаслідок цього навчання геометрії відіграє значну роль у практичному застосуванні теоретичних знань, розвитку навичок розв'язування задач та логічного мислення.

Автор робить висновок, що цілеспрямований і правильний вибір геометричних матеріалів, практичне застосування теоретичних знань та міжпредметна інтеграція у курсах математики середніх шкіл підвищують математичне мислення учнів, їхню просторову уяву та технічну креативність.

Ключові слова: *вимірювання; розв'язування задач; логіка; матеріали з геометрії; планіметричні фігури; просторові фігури; методика навчання; практичне застосування; просторове мислення.*

Introduction. In the independent Republic of Azerbaijan, achievements in the fields of science, technology, and education reflect the development of secondary mathematics education. This development demonstrates a continuous trend, further strengthened by the implementation of recent educational reforms. Mathematics instruction, particularly in geometry, plays a critical role in developing students' spatial visualization skills and fostering reasoning abilities that are closely linked to real-life applications. Geometry education not only equips students with theoretical knowledge but also enhances their practical skills. In primary grades, students develop spatial understanding through activities such as measuring line segments and becoming familiar with basic geometric figures. In higher grades, students engage in more complex tasks, including calculating areas of geometric shapes, determining volumes, and solving applied problems, thereby translating theoretical knowledge into practical competencies. A modern Mathematics curriculum emphasizes the systematic presentation of knowledge and the integration of intra-disciplinary connections. This approach enables students to differentiate Geometric concepts accurately, engage in logical reasoning, and apply theoretical knowledge effectively in problem-solving contexts [6]. Visual representation of geometric concepts, along with measurement and construction activities, supports students' preparation for scientific and technical endeavors. Thus, the primary objective of Geometry education is not only to impart theoretical knowledge but also to cultivate students' logical thinking, observational skills, and practical abilities. Teachers play a crucial role in this process: they must select instructional materials appropriate to students' age and developmental level and organize lessons using interactive and practical methods.

Materials and methods. The study is based on the theoretical and experimental analysis of geometry instruction in secondary schools. The materials used include the mathematics curriculum for general education schools in the Republic of Azerbaijan, textbooks, methodological guidelines, and related scientific-pedagogical literature [1; 2; 3]. Additionally, classroom observations, student assignments, and practical geometry exercises served as primary sources of data for the research.

The methodological framework of the study combines qualitative and quantitative approaches:

1. Theoretical Analysis:

– The structure and content of Geometry curricula in primary and secondary schools were examined.

– Principles of Geometry instruction, practical applications, and the development of spatial imagination were analyzed using scientific-pedagogical literature.

– Methods for presenting geometric concepts, constructing figures, and applying theoretical knowledge to real-life situations were explored.

2. Experimental Methods:

– Geometry lessons were observed to evaluate the implementation of teaching strategies based on the curriculum.

– Students' abilities to measure Geometric quantities, construct figures, and solve applied problems were monitored.

– Observations and practical exercises were used to assess the development of students' spatial reasoning and logical thinking skills.

3. Analytical Procedures:

– Geometric problems were classified according to their theoretical and practical significance.

– The impact of teacher-guided exercises on students' ability to apply theoretical knowledge in practice was determined.

– The influence of Geometry lessons on the development of students' creative, analytical, and critical thinking skills was investigated.

The study emphasizes the practical application of theoretical knowledge in fostering students' technical creativity and problem-solving abilities. The combination of observation, analysis, and practical exercises provides a comprehensive assessment of how geometry instruction in secondary schools contributes to students' Mathematical preparation and readiness for scientific and technical disciplines.

Results and discussion. Based on the conducted theoretical and experimental analyses, it has been determined that the teaching of geometry in secondary schools plays a crucial role in the formation and development of students' spatial imagination. The curriculum content lines in Geometry and measurements enable students to measure quantities, recognize spatial figures, and understand the properties of simple geometric objects. This simultaneously facilitates the development of both their theoretical knowledge and practical skills. Analysis shows that the practical application of theoretical knowledge in Geometry lessons– such as problem-solving, drawing constructions, and modeling–enhances students' technical creativity and mathematical thinking. At the same time, practical tasks engage students in observation, logical reasoning, and analytical thinking. The integration of geometric knowledge with subjects like Physics, Chemistry, Geography, and other sciences contributes to the broadening of students' scientific worldview and the development of interdisciplinary connections. Within the framework of modern educational programs based on humanistic and student-centered principles, Geometry instruction not only provides students with knowledge but also develops their problem-solving, initiative, and creative thinking abilities. Lessons structured according to the curriculum allow teachers' scientific-pedagogical preparation and methodological approaches to consider students' individual characteristics, which increases the effectiveness of learning [10].

The research results indicate that the development of students' spatial imagination in Geometry education

should not be limited to the provision of theoretical knowledge but must also be supported by practical activities – such as measurement, construction, drawing, and working with real objects. This approach contributes to the development of mathematical reasoning, correct logical judgment, and analytical skills among students.

Thus, the primary goal of Geometry education in the secondary school Mathematics curriculum is to equip students with theoretical knowledge, enhance their practical skills, and develop their spatial imagination. The practical application of theoretical knowledge, problem-solving in Geometry, and interdisciplinary integration ensure students' preparation for both scientific and technical endeavors. These findings demonstrate that geometry education serves not only to enhance mathematical knowledge but also as an integral component of a comprehensive educational process that fosters students' analytical thinking, creativity, and practical abilities.

Conclusion. The conducted research once again demonstrates that the application of modern pedagogical technologies plays a decisive role in developing students' independent and creative thinking skills in foreign language learning. The findings show that technologically supported teaching environments significantly enhance learners' cognitive activity, motivation, and intellectual autonomy. The integration of interactive digital tools into the educational process not only improves students' linguistic competence but also strengthens their analytical abilities, problem-solving skills, and creativity–qualities that are essential for success in contemporary education.

Furthermore, the study confirms that systematic and purposeful use of innovative teaching methods fosters students' capacity to express ideas freely, engage in independent inquiry, and construct original interpretations. This, in turn, contributes to the formation of a learner-centered, dynamic, and creativity-focused educational environment. The results suggest that combining modern technologies with effective pedagogical strategies provides a powerful framework for cultivating higher-order thinking skills in foreign language instruction.

Overall, the research highlights the importance of continuous integration of advanced technological resources, ongoing teacher professional development, and the design of interactive learning models to support independent and creative thinking. These findings can serve as a theoretical and methodological basis for improving teaching practices and developing more effective curricula in foreign language education.

Recommendations for future research. The results of the present study open up several promising directions for further research aimed at enhancing the effectiveness of geometry instruction in schools. First, it would be useful for future studies to comparatively examine how students of different age groups comprehend geometric concepts. Such research could contribute to refining age-appropriate methodological approaches and adapting instructional strategies to learners' developmental needs.

Second, future investigations should focus on evaluating the effectiveness of digital resources, 3D modeling tools, and dynamic geometry software (such as GeoGebra) in the teaching and learning of geometry. Experimental studies in this area would provide scientifically grounded insights into the impact of modern technologies on students' spatial reasoning, visual perception, and practical problem-solving skills.

Third, it is recommended to conduct broader empirical research on the influence of interdisciplinary integration of geometry with subjects such as physics, visual arts, computer science, technology, and geography. Such studies would help identify optimal models for implementing cross-curricular connections and enhancing students' ability to relate geometric knowledge to real-world contexts.

Fourth, further research should examine the level of teachers' scientific-methodological preparation in geometry instruction, the pedagogical strategies they employ, and the extent to which these factors influence student outcomes. Understanding the relationship between teacher competency and student achievement would significantly contribute to improving the overall quality of instruction.

Finally, longitudinal studies are needed to explore the long-term effects of geometry education on students' development of 21st-century skills–such as analytical thinking, creative reasoning, problem solving, and decision making. Such research would enable a comprehensive evaluation of the sustainability and lasting value of instructional methods and provide a solid scientific basis for future curriculum reforms.

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