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ЗАСТОСУВАННЯ ДИФЕРЕНЦІЙНИХ ТЕХНОЛОГІЙ У ПІДГОТОВЦІ ВЧИТЕЛЯ МАТЕМАТИКИ

APPLICATION OF DIFFERENTIAL TECHNOLOGIES IN MATHEMATICS TEACHER PREPARATION

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ABSTRACT

In academic institutions, improving the organization of professional and methodological preparation for prospective mathematics teachers is regarded as a perennially urgent issue, especially amidst the information society's rising societal demands. The development of society's scientific potential and the assimilation of advanced scientific and technological achievements are intricately linked to mathematical education. In the realm of preparing future mathematics educators within higher educational institutions, the integral linkage between a nation's military and economic prowess and its educational framework stands as an enduringly pertinent issue. The role of exact sciences, particularly mathematics, extends beyond economic governance to encompass the imperative of ensuring national military security. In the contemporary era, there exists a pressing need to equip all segments of society with proficiencies in information technologies, alongside the implementation of novel and effective pedagogical approaches, which are among the foremost challenges confronting educators. The global educational landscape is swiftly evolving, placing greater emphasis on pragmatic competencies over purely theoretical foundations, reflecting societal preferences for practical skill sets.

Within pedagogical institutions of higher learning, the primary focus in the preparation of mathematics educators' centers on cultivating cadres for secondary education. Given the context of the information society, it becomes crucial to meticulously organize the scholarly and methodological dimensions of future mathematics educators' activities, aligning them with the imperatives of educational reform. The process of preparing personnel for diverse educational settings in mathematics education across colleges and secondary schools entails a notably intricate endeavor. Notably, mathematics is taught through distinct curricula at these institutions, demanding heightened scientific and pedagogical aptitude from educators, especially in settings comprising academically gifted students.

Addressing these challenges necessitates substantive transformations in the substance of mathematics teacher training, fostering humanistic approaches in defining educational

objectives, content structuring, methodological practices, and institutional arrangements. The professionalism and innovative contributions of prospective mathematics educators assume pivotal roles in navigating these complexities. This article scrutinizes the application of differential instructional technologies in mathematics education and explores their potential implications.

Key words: *secondary education, mathematics curriculum, teacher preparation, instructional technologies, differentiated instruction, differential pedagogy, developmental teaching, curriculum frameworks.*

Formulation of the Problem. Mathematics education and its development are considered fundamental challenges confronting educational practitioners. The adaptation of educational plans in higher pedagogical institutions and revisions to middle school mathematics curricula not only aim to elevate instructional quality but also engender specific complications in the pedagogical process. Each innovation and evolution in education, when implemented comprehensively, may struggle to sustain its efficacy over conventional instructional methodologies and resources. The efficacy of teacher preparation hinges on the effective implementation of new initiatives and educational reforms. The state of mathematical education, both theoretically and practically, significantly relies on the scholarly and pedagogical endeavors of mathematics educators.

The «State Strategy for Education Development in the Republic of Azerbaijan», endorsed by the President in 2013, delineates precise avenues for achieving educational objectives in the country and addressing contemporary challenges.

Data from the State Examination Center and the Teacher Recruitment Commission of the Republic of Azerbaijan indicate that performance metrics in mathematics exams for applicants and teacher recruitment lag behind those of other subjects. Substandard mathematical education levels contribute to challenges in teaching other disciplines. Enhancing the quality of mathematics teacher preparation is a multifaceted process contingent upon various elements. Emphasis must be placed on the acquisition of specialized professional competencies by high school students enrolled in secondary education. This underscores the imperative of maintaining scientific and methodological continuity across educational standards. Moreover, the rapid evolution of science and technology, alongside existing educational dilemmas globally, necessitates the adoption of novel approaches and technologies in education. This mandates the application of a differentiated approach across all educational domains.

Degree of problem elaboration in scientific literature. In academic and methodological literature, research on the preparation of mathematics educators is extensive. Rather than specific enumeration, these studies can be characterized in generalized terms.

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These investigations include diagnostics of the professionalism and pedagogical competence of mathematics educators [9], strategies for enhancing the quality of mathematics instruction [10], criteria for assessing the knowledge and skills of mathematics instructors [11], identification of mathematical concepts, and modernization of tools that enhance teacher professionalism [12, 13], among others.

For the effective development of skilled and competent mathematics educators, educators must engage in continuous exploration, innovation, and practical application of acquired knowledge [4]. The dynamic formation of methodological approaches for future mathematics educators should be considered both in higher education and secondary schools, as these two pillars are integral components of each other [8]. The principle of succession must also be taken into account.

Studies in Azerbaijan on the historical development of scientific-pedagogical personnel training, contemporary requirements for teacher preparation, and methodological issues in higher education institutions [3, 5] extensively explore these matters.

The use of diverse approaches during the modernization of the work system in mathematics teacher preparation, application of contemporary technologies in mathematics teacher training, and enhancement of developmental pedagogy in education are considered pivotal tools. It is crucial to revise and develop the module program of the «Teaching Methodology of Mathematics» course taught at universities. Some researchers advocate prioritizing problematic presentations of teaching materials and organizing practical activities during lectures [6].

Efforts must be made to refine the methodological preparation of future mathematics educators and promote the development of methodological approaches among practicing mathematics instructors. Collaboration between pedagogical universities and secondary school teachers is essential for ensuring the creative character of methodological activities [7].

Recent modifications to the mathematics curricula in Azerbaijan's higher education institutions and secondary schools [2] have re-emphasized the organization of mathematics educator preparation systems.

Goals and objectives. The aim of this study is to assess the current state of mathematics educator preparation, synthesize scholarly perspectives on associated problems, and enhance students' research capabilities in individualized approaches to mathematics education.

Methods. The article employs methods of analysis, synthesis, comparison, and generalization in its writing process.

Main Section.

Differentiated Instruction and Individualized Approaches in Teaching

The consideration of educational stakeholders' scientific and methodological potentials holds particular significance in modernizing the application

of methods and technologies in teaching. Experience shows that there is a specific need for differentiated instruction and individualized approaches across all pillars of education.

The development and level of mathematical education in secondary school play a crucial role in subsequent stages of education. Mathematical knowledge formed during grades 11–12 in secondary school is further refined in high school over 4–5 years in terms of both scientific and methodological aspects. The foundation of mathematical education primarily takes shape during secondary school.

In Azerbaijan, admission of students to high schools is based on entrance examinations conducted by the State Examination Center (SEC). Statistical data from the SEC confirms that students' proficiency in mathematics is relatively lower compared to other subjects.

Analysis of surveys and inspection reports conducted among students of mathematical faculties at pedagogical universities related to our research further corroborates those difficulties in learning certain topics in secondary school mathematics led to specific challenges in teaching topics from other content areas in high school.

Partially addressing these problems can be achieved through different approaches in high school. There are certain contradictions between the curriculum plans of mathematical subjects envisaged in teacher education and the mathematics curriculum of secondary schools. I believe that resolving these contradictions and utilizing proclaimed and differentiated instructional technologies in a complex manner is more effective for enhancing the professional methodological skills of future mathematics teachers.

Research indicates that a programmed instructional method yields better results when applied to foster independent creative activities among students (Rustamov, 2007). Careful consideration should be given to the stages during the application of this instructional method.

Teachers should ensure that the educational materials they present to students are divided into logical analyses and subgroups (cadres) based on didactic requirements, enabling each step (stage) to facilitate independent learning in subsequent sections.

The teaching methodology of mathematics involves the study of specific topics and methodological analysis in the respective classes of secondary school as a special assignment for students.

The student engages in autonomous learning, systematically building upon prior knowledge, conducting specific analyses, and prioritizing the resolution of applied tasks. The theoretical and practical scrutiny of instructional materials, exemplified by resolving issues pertinent to each subsection, affords extensive opportunities for acquiring new knowledge. As a result, instances should be provided regarding the integration of specific principles

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or regulations as theoretical content, and instances related to solution algorithms should be furnished.

Anticipating challenges that students may encounter should be preemptively considered, with provisions made for fostering their independent activities. Various methodologies should be contemplated for addressing issues related to topics covered in the secondary school mathematics curriculum, and the evaluation of these resolutions within respective classrooms should be meticulously regarded.

In the educational process, programmed instruction methodologies enhance the pace of comprehending mathematical concepts and cultivate students' independent creative endeavors. Differential teaching methods are extensively employed to reveal students' aptitudes and capabilities, as well as to mitigate existing challenges. For instance, organizing lessons flexibly within the classroom setting, alternating between individual and collective work, strengthens students' cognitive engagement and augments their interest in developing specialized pedagogical approaches within their field.

In scholarly and methodological literature, preparing academically challenged learners in differential teaching predominantly focuses on adequately preparing them to assimilate new content and maximizing their observational proficiencies. It is widely acknowledged that not all students within the same cohort can uniformly grasp specific materials, rendering it impractical. These considerations should inform the preparation of future mathematics educators within higher educational institutions specializing in pedagogy. Due to temporal constraints, providing comprehensive theoretical instruction and methodological commentary for every topic covered in the secondary school curriculum at the high school level is practically unfeasible.

Question: How can a secondary school educator effectively address these identified issues?

It is argued that in a secondary school setting, expanding the scope of independent tasks provided to students based on their preferences and interests, prioritizing developmental and applied activities in the instructional process, and facilitating collective analysis of theoretical and practical materials pertaining to the mathematics curriculum are crucial.

When employing differentiated instructional elements in mathematics education, the following considerations should be applied:

– To what extent can students internalize newly introduced material?
– Can students conceptually and practically justify the presented topic?
– Does the student possess adequate scholarly capacity to receive methodological insights related to teaching the subject, and what role does the educator play in its implementation?

Throughout the instructional phase, despite variations in individualized approaches and differentiation, the overarching objective remains consist-

ent. The primary aim is to foster the individual proficiency and intellectual curiosity of each student, alongside advancing their educational endeavors.

Methodical approach in practical pedagogical activities

A prospective mathematics educator should demonstrate a comprehensive understanding of topics within the secondary school mathematics curriculum, adept at proposing and substantiating novel pedagogical approaches for teaching any given topic.

To this end, students can autonomously assign tasks across diverse classes. It is imperative for students to investigate the appropriateness of these assignments for specific classes and determine the most effective methodologies for their resolution. Let's review one of the proposed issues.

Problem. Find the smallest and largest values of the function f(x) =3^{x^2+2x-2} f over the interval [-2; 0].

This problem can be solved using various methods.

Method I. (Using substitution)

Firstly,

The critical point of the function f(x) = f(x) =3^{x^2+2x-2} is found.

$$f'(x)=3^{x^2+2x-2}\cdot\ln 3\cdot(x^2+2x-2)'=3^{x^2+2x-2}\cdot\ln 3\cdot(2x+2)$$

At the point x=−1x=−1, f′(x)=0f′(x)=0.

$$f(-1)=3^{1-2-2}=3^{-3}=\frac{1}{27};\ f(-2)=3^{4-4-2}=3^{-2}=\frac{1}{9};\ f(0)=3^{-2}=3^{-2}=\frac{1}{9}.$$

The function's minimum value is $\frac{1}{27}$ and its maximum value is $\frac{1}{9}$. The problem was solved using the concept of derivatives, and no additional suggestions based on logical reasoning were used in the solution process.

Method II.

The problem belongs to the theoretical section of exponential functions. It is known that for the function y=a^x, the domain D(f)=R=(−∞; +∞), and the range of values is mostly D(f)=(0;+∞)D(f)=(0;+∞). When a>1, the function is monotonically increasing, and when 0<a<1, it is monotonically decreasing, hence the function has no extremum points.

To find the minimum and maximum values of the function given x∈[−2;0], let's determine the minimum and maximum values of the function x^2+2x-2 over the interval [−2;0]. Based on the expression x^2+2x-2=$(x+1)^2$-3, if we add 1 to both sides of the inequality 2≤x≤0, then square both sides, and add negative 3 to both sides, we will receive inequality -3≤ $(x+1)^2$-3≤-2. This means that the function x^2+2x-2 has a minimum value of -3, and a maximum value of -2. In other words,

$$f_{min.}=3^{-3}=\frac{1}{27},\ f_{max.}=3^{-2}=\frac{1}{9}.$$

In this solution method, we used a reasoned approach based on theoretical knowledge to find the minimum and maximum values of the quadratic function.

ICV 2022: 80.27
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Method III.

The power function is quadratic, and its graph is a parabola. Here, with a=1>0, b=2 and -2, we can say that the arms of the parabola point upwards, and it has a minimum value. The abscissa of the vertex point is calculated using the formula $x=\frac{-b}{2a}$, and since $x=\frac{-2}{2\cdot 1}=-1$, the ordinate of the vertex point is y=-3. Thus, the minimum value of the function is equal to -3. In the problem statement, given that $x\in[-2;0]$ it is possible to determine the maximum value of the function, which is equal to -2. Therefore, the exponential function's minimum value is -3, and its maximum value is -2. This means that the minimum value of the given exponential function is equal to $\frac{1}{27}$ and its maximum value is equal to $\frac{1}{9}$.

Research indicates that students typically favor the initial method (implementation of the algorithm) when tackling such problems. This approach follows a specific algorithmic procedure, eliminating the necessity for additional deliberation in the problem-solving process. In the context of secondary school mathematics, this method may be considered only after covering the topic of algorithmic comprehension. If students are tasked with considering program perspectives in resolving assignments, they will develop supplementary skills conducive to fostering creative endeavors. Opting to prioritize solving one problem through three distinct methods rather than addressing three problems in a uniform manner leads to enhanced outcomes.

Conclusion. We contend that in structuring practical exercises at the secondary school level, precedence should be given to engaging students in creative pursuits. The phases of accurate and methodical problem-solving should be effectively organized from a pedagogical standpoint. The efficacy of exercises hinges upon the level of differentiation and the efficacy of pedagogical discourse. Therefore, it is imperative to establish a robust framework for nurturing the potential and creative aptitudes of students. Educators should account for the mastery and preparedness levels of each student when delineating the tasks to be addressed during lessons.

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АНОТАЦІЯ

В академічних закладах удосконалення організації професійно-методичної підготовки майбутніх учителів математики розглядається як постійне актуальне питання, особливо в умовах зростання суспільних вимог інформаційного суспільства. Розвиток наукового потенціалу суспільства, засвоєння передових досягнень науки і техніки тісно пов'язані з математичною освітою. У царині підготовки майбутніх викладачів математики у вищих навчальних закладах невід'ємний зв'язок між військовою та економічною могутністю нації та її освітньою системою залишається актуальною проблемою. Роль точних наук, зокрема математики, виходить за межі економічного управління й охоплює імператив забезпечення національної військової безпеки. У сучасну епоху існує нагальна потреба оснастити всі сегменти суспільства знаннями в інформаційних технологіях, поряд із впровадженням нових та ефективних педагогічних підходів, які є одними з головних завдань, з якими стикаються освітяни. Глобальний освітній ландшафт стрімко розвивається, роблячи більший акцент на прагматичних компетенціях, ніж на суто теоретичних основах, що відображає суспільні переваги щодо практичних навичок.

У педагогічних закладах вищої освіти основна увага при підготовці вчителів математики приділяється підготовці кадрів для середньої освіти. Зважаючи на контекст інформаційного суспільства, надзвичайно важливо ретельно організувати науково-методичні виміри діяльності майбутніх викладачів математики, узгоджуючи їх з імперативами освітньої реформи. Процес підготовки кадрів для різноманітних навчальних закладів математичної освіти в коледжах і середніх школах передбачає надзвичайно складну роботу. Примітно, що в цих закладах математика викладається за окремими навчальними програмами, що вимагає від викладачів підвищених наукових і педагогічних здібностей, особливо в умовах, де навчаються академічно обдаровані учні.

Вирішення цих завдань вимагає суттєвих перетворень у змісті підготовки вчителя математики, сприяння гуманістичним підходам у визначенні освітніх цілей, структуруванні змісту, методичних практик та організаційних механізмів. Професіоналізм та інноваційний внесок майбутніх викладачів математики відіграють ключову роль у подоланні цих складнощів. У цій статті детально розглядається застосування диференційованих навчальних технологій у математичній освіті та досліджуються їхні потенційні наслідки.

Ключові слова: *середня освіта, програма з математики, підготовка вчителя, навчальні технології, диференційоване навчання, диференційна педагогіка, розвиваюче навчання, рамки навчального плану.*