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PROBLEMS IN TEACHING ORDINARY DIFFERENTIAL EQUATIONS IN HIGHER EDUCATIONAL INSTITUTIONS

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Abstract.

This article analyzes the current problems encountered in the teaching process of ordinary differential equations in higher educational institutions. In particular, factors such as insufficient basic mathematical knowledge of students, the gap between theory and practice, the predominance of traditional teaching methods, the ineffective use of information technologies, and psychological barriers are examined. Furthermore, recommendations and suggestions are provided for the use of interactive teaching methods, the integration of computer technologies, the organization of practice-oriented education, and the improvement of independent learning efficiency in teaching differential equations. The article also highlights issues related to improving the quality of teaching differential equations based on modern pedagogical approaches.

Keywords: ordinary differential equations, higher education, pedagogical technologies, mathematical modeling, information technologies, quality of education, methodological problems.

Introduction. Nowadays, the course of ordinary differential equations occupies a special place within the system of mathematical sciences. This is because the theory of differential equations is not only one of the important branches of pure mathematics, but also a fundamental tool for describing mathematical models of numerous processes in physics, mechanics, biology, economics, engineering, information technologies, and other technical fields. Through the in-depth teaching of this subject in higher education institutions, students develop competencies such as analytical thinking, mathematical modeling, problem analysis, and drawing scientific conclusions. In the modern educational concept, the quality of mathematical training is regarded as one of the key factors determining the scientific and technological development of a country. From this perspective, the effective teaching of the ordinary differential equations course plays a significant role in shaping the professional competence of future specialists. In particular, having strong knowledge of differential equations is considered an essential requirement for future mathematics teachers, engineers, programmers, economists, and students in the natural sciences.

Problem Statement. Practice shows that a number of pedagogical, methodological, and psychological problems arise in the process of teaching ordinary differential equations in higher educational institutions. Factors such as differences in students' mathematical preparedness, difficulties in understanding abstract concepts, the gap between theory and practice, and the insufficient use of modern pedagogical technologies negatively affect the effectiveness of education.

The course of ordinary differential equations is formed as a logical continuation of many mathematical disciplines. In order to successfully master this subject, students are required to have sufficient background knowledge in mathematical analysis, linear algebra, analytic geometry, and integral calculus. However, in practice, the lack of fundamental mathematical knowledge among students often creates serious difficulties in understanding new topics. As a result, students tend to memorize methods for solving differential equations mechanically without deeply understanding their essence and meaning.

Furthermore, the abstract nature of differential equations is one of the major problems in the teaching process. Many students fail to relate concepts such as derivatives, integrals, parameters, general solutions, and particular solutions to practical applications. In particular, while solving the Cauchy problem, Bernoulli equations, Riccati equations, or higher-order differential equations, students may know how to apply formulas, yet experience difficulties in understanding their geometric or physical interpretations.

In the era of digital technologies, teaching mathematics through innovative methods has become an urgent issue. However, in some higher educational institutions, traditional lecture-based teaching methods still dominate. As a result, students often remain passive listeners during the learning process. The insufficient use of interactive teaching methods, computer algebra systems, mathematical modeling software, and visual platforms reduces the effectiveness of lessons.

Moreover, connecting differential equations with real-life problems is also considered one of the important challenges in teaching. In many cases, students cannot clearly answer the question: “Where is this topic applied in practice?” Consequently, their motivation toward the subject decreases. In fact, differential equations are widely used in modeling epidemic spread, economic growth, heat transfer, population dynamics, electrical circuits, and mechanical motion processes.

The introduction of the credit-module system in higher education has also created new requirements in teaching differential equations. The increasing proportion of independent learning requires students to develop independent thinking and research skills. However, not all students possess the ability to study complex mathematical topics independently, which places additional methodological responsibilities on teachers.

Approaches and Solutions. Another important factor affecting the quality of education is the condition of textbooks and methodological manuals. In some textbooks, topics are presented either too briefly or in a highly complex scientific language, making them difficult for students to understand. In certain cases, examples are insufficiently provided or modern scientific approaches are not adequately reflected. Therefore, there is an increasing need for interactive electronic resources developed on the basis of new pedagogical technologies in teaching differential equations. From a psychological perspective, differential equations are also considered one of the subjects that evoke feelings of fear and complexity among students. In particular, students with weak mathematical backgrounds often struggle to express their ideas freely during lessons and develop a lack of confidence in solving problems. This situation negatively affects their learning activity and participation.

For this reason, improving the methodology of teaching ordinary differential equations in higher educational institutions, introducing innovative approaches, applying methods that encourage active thinking, ensuring the integration of theory and practice, and effectively using information technologies are among the urgent tasks of today.

Conclusion. In conclusion, the process of teaching ordinary differential equations in higher educational institutions is a complex and multifaceted pedagogical process. This subject requires students to possess deep mathematical thinking, logical reasoning, and analytical approaches. Therefore, identifying and eliminating the methodological and pedagogical problems arising in the educational process in a timely manner is of great importance.The research results indicate that factors such as students’ insufficient basic knowledge, the abstract nature of topics, the low level of use of modern information technologies, and the gap between theory and practice negatively affect the effective mastery of the subject. In addition, the predominance of traditional teaching methods in some cases turns students into passive listeners.

Thus, it is necessary to apply innovative pedagogical technologies in teaching differential equations, use interactive teaching methods, expand visual explanations based on mathematical software, and involve more practical problems related to real-life processes. This, in turn, increases students' interest in the subject, develops their independent thinking skills, and helps connect theoretical knowledge with practice.

As a result, improving the quality of teaching ordinary differential equations in higher education institutions contributes to the preparation of competitive specialists equipped with modern knowledge and skills.

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