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ISSUES OF DEVELOPING ALGEBRAIC THINKING BASED ON PROBLEM-BASED LEARNING IN FOREIGN PEDAGOGICAL RESEARCH

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Abstract. This article provides a comprehensive analysis of the didactic potential of problem-based learning (PBL) technology in forming and developing algebraic thinking, based on foreign pedagogical research. During the study, the scientific perspectives of leading scholars such as G. Polya, J. Van de Walle, J. Bruner, and J. Kaput were systematically examined, highlighting the theoretical and practical aspects of using problem situations in teaching algebra. It is scientifically substantiated that problem-based learning develops students' logical, analytical, and creative thinking, ensuring a conscious and firm mastery of algebraic concepts.

Keywords: problem-based learning, algebraic thinking, problem situation, mathematics education, foreign experience.

Introduction In the context of the modern educational system, an individual's ability to think independently, analyze problem situations, and make reasoned decisions is considered a vital competence. Specifically, developing students' algebraic thinking in mathematics is one of the key factors determining the quality of education. Algebra holds particular importance as a subject that shapes logical reasoning, generalization, modeling, and abstract thinking skills.

In the current traditional teaching system, algebraic concepts are often presented through ready-made rules and formulas. This leads to mechanical memorization by students and fails to sufficiently develop their independent thinking and problem-analysis skills. Consequently, students encounter difficulties when solving complex algebraic problems.

Therefore, implementing problem-based learning technology in algebra instruction is a pressing task for modern pedagogy. Foreign pedagogical research demonstrates that this approach increases students' cognitive activity and facilitates a deep and conscious acquisition of knowledge.

The Essence and Pedagogical Significance of Problem-Based Learning Technology

Problem-based learning (PBL) is a pedagogical approach aimed at transforming the student into an active participant in the educational process. The core idea of this technology is to create a need for knowledge through problem situations.

Problem situations:

- Ignite cognitive interest in students;
- Stimulate independent thinking;
- Develop analysis and conclusion-making skills.

According to foreign researchers, in the process of problem-based learning, students do not acquire knowledge in a ready-made form; instead, they gain it through exploration, comparison, and generalization. This ensures the long-term retention of knowledge.

The Concept of Problem-Based Approach in G. Polya's Work

The famous mathematician and educator G. Polya scientifically analyzed the process of solving mathematical problems and proposed an effective model for the problem-based approach. He recommended implementing the problem-solving process in the following stages:

1. **Understanding the problem**
2. **Devising a plan**
3. **Carrying out the plan**
4. **Looking back (Analysis of the result)**

According to Polya, these stages specifically facilitate the development of students' logical and algebraic thinking. In algebraic problems, this approach helps students understand the essence of formulas rather than merely memorizing them.

The Concept of Algebraic Thinking and Its Components

In foreign pedagogical literature, the concept of algebraic thinking is interpreted broadly. J. Kaput emphasizes that algebraic thinking is not just about solving equations but the ability to identify general patterns and analyze relationships.

Algebraic thinking includes the following components:

- Identifying patterns and relationships;
- Working with variables;
- Algebraic modeling;
- Generalization and drawing conclusions.

Problem-based learning creates a favorable pedagogical environment for developing all these components.

Practical Aspects of Problem-Based Learning in J. Van de Walle's Research

J. Van de Walle emphasizes the necessity of ensuring active student participation in teaching algebra. In his view, open-ended problem tasks develop students' creative and independent thinking.

According to Van de Walle's research, the following effectively shape algebraic thinking:

- Problems based on real-life situations;
- Tasks with multiple solutions;
- Situations focused on discussion and analysis.

Problem-Based Learning Experience in Foreign Educational Systems

Problem-based learning technology is widely used in the educational systems of countries like Finland, Singapore, and Japan. In these countries, the algebra teaching process is organized around problems, and students' independent research activities are encouraged.

The results of international assessment programs (PISA, TIMSS) confirm the effectiveness of this approach. Students in these countries demonstrate a high level of mathematical literacy.

Advantages and Limitations of Problem-Based Learning

Advantages:

- Increases students' cognitive activity;
- Develops algebraic thinking;
- Knowledge becomes conscious and stable;
- Forms a creative approach.

Limitations:

- Requires high methodological preparation from the teacher;
- Lesson planning becomes more complex;
- May require more time.

Conclusion

Analysis results show that problem-based learning technology is an effective pedagogical tool for developing algebraic thinking. The scientific views of G. Polya and J. Van de Walle substantiate that using problem situations in algebra teaching develops students' logical and creative reasoning.

Lessons organized on the basis of problem-based learning serve to help students consciously master algebraic knowledge and develop mathematical modeling skills. Therefore, adapting this approach to the national educational system and implementing it in practice holds significant scientific and practical importance.

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