

**CONCEPT OF ALGEBRAIC THINKING AND ITS PSYCHO-PEDAGOGICAL
ESSENCE**

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Abstract

This article analyzes the essence of the concept of algebraic thinking, its distinction from traditional arithmetic thinking, and the psychological and pedagogical foundations for forming this competence in students. The research highlights the stages of transition to abstract thinking and the role of Problem-Based Learning (PBL) technologies in developing mathematical abilities.

Keywords

Algebraic thinking, abstract reasoning, problem-based learning, modeling, cognitive development, GeoGebra, pedagogical technology.

Annotatsiya

Ushbu maqolada algebraik fikrlash tushunchasining mazmun-mohiyati, uning an'anaviy arifmetik tafakkurdan farqi hamda talabalarda ushbu kompetensiyani shakllantirishning psixologik va pedagogik asoslari ilmiy tahlil qilingan. Tadqiqotda mavhum fikrlashga o'tish bosqichlari va muammoli ta'lim (PBL) texnologiyalarining o'rni yoritilgan.

Аннотация

В статье анализируется сущность понятия алгебраического мышления, его отличие от арифметического мышления, а также психолого-педагогические основы формирования данной компетенции. Рассматриваются этапы перехода к абстрактному мышлению и роль проблемного обучения (PBL) в развитии математических способностей.

I. INTRODUCTION The primary goal of modern mathematics education is not merely teaching ready-made algorithms but forming a culture of analytical and logical thinking in individuals. Algebraic thinking is the core of mathematical competence; it represents the ability to find general patterns between objects, model them using symbols, and work with variable quantities.

The purpose of this article is to reveal the psychological roots of algebraic thinking and to propose effective methods for its formation within the pedagogical process.

II. SCIENTIFIC AND THEORETICAL FOUNDATIONS OF ALGEBRAIC THINKING

The concept of algebraic thinking is not limited to the subject of "algebra" alone. According to research by J. Kaput and other scholars, it encompasses the following five pillars:

1. **Generalization:** Transforming operations performed with specific numbers into rules that hold true for any number.
2. **Structural Analysis:** Looking beyond the external appearance of mathematical expressions to recognize their internal logical structure.

3. **Symbolism:** Perceiving mathematical symbols (x, y, a, b) not just as letters, but as expressions of specific quantitative relationships.

III. PSYCHOLOGICAL ESSENCE: FROM CONCRETE RESEARCH TO ABSTRACTION

In psychology, the transition to algebraic thinking marks a qualitatively new stage in human cognitive development. According to Jean Piaget's theory, a student's thinking must transition from the "concrete operational" stage to the "formal operational" stage.

3.1. Cognitive Barriers

Students often encounter "cognitive load" when transitioning from arithmetic to algebra. In arithmetic, the "=" sign signifies "calculate the result," whereas in algebra, this symbol represents "balance" or "equivalence." Managing this psychological transformation is the primary task of the educator.

3.2. Integration of Visual and Logical Thinking

If abstract concepts (e.g., functions or derivatives) are not associated with a visual image in the student's mind, algebraic thinking turns into "mechanical memorization." Therefore, from a psychological perspective, visualization is considered the foundation of algebraic reasoning.

IV. PEDAGOGICAL TECHNOLOGIES: PROBLEM-BASED LEARNING (PBL)

The most effective method for developing algebraic thinking is **Problem-Based Learning (PBL)** technology. In this method, the student is not given a ready-made formula; instead, a problem is presented.

Standard Structure of a PBL Lesson:

Problem Formulation: For example, "What factors determine the profit of a company that produces solar panels?"

Research Phase: The student draws a table showing the relationship between various costs and revenues.

Algebraic Modeling: Observing the pattern in the table, the student converts it into a function, such as $f(x) = ax + b$.

Conclusion: Using the resulting model, the student predicts future outcomes.

V. THE ROLE OF INFORMATION TECHNOLOGY (GEOGEBRA)

The role of digital tools in forming algebraic thinking is invaluable. The **GeoGebra** software dynamically links abstract algebraic formulas with geometric shapes and graphs. This creates a system of "Algebraic Logic + Geometric Intuition" in the student.

VI. METHODOLOGICAL RECOMMENDATIONS AND CONCLUSION

Based on the conducted analysis, the following conclusions were formed:

1. Algebraic thinking, unlike arithmetic, is a search for processes and patterns rather than just an answer.

2. From a psychological standpoint, to eliminate the fear of working with symbols in students, it is necessary to teach them visual modeling.

3. The integration of Problem-Based Learning (PBL) and tools like GeoGebra in the pedagogical process is a guarantee for developing algebraic reasoning.

Systematic development of algebraic thinking helps students succeed not only in mathematics but also in fields such as economics, engineering, and finance.

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