AMERICAN JOURNAL OF EDUCATION AND LEARNING
ISSN: 2996-5128 (online) | ResearchBib (IF) = 10.91 IMPACT FACTOR
Volume-3| Issue-11| 2025 Published: |30-12-2025|

CONTEXTUAL PROBLEMS IN THE METHODOLOGICAL TRAINING OF MATHEMATICS TACHERS IN CLASSICAL UNIVERSITIES

https://doi.org/10.5281/zenodo.17899336

Juraeva Mukhayo Nematillaevna
Senior Lecturer of the Department of Algebra and Geometry of Karshi State University
Emaill: jurayeva.76@mail.ru
ORCID: https://orcid.ord/0000-0003-0242-2592

Annotatsiya

Ushbu ilmiy maqolada birinchi bosqich talabalari uchun matematik tahlil fanini faoliyatga yo'naltirilgan yondashuv nuqtai nazaridan o'qitishning nazariy-metodik asoslari bayon etilgan. Maqolada faoliyatga asoslangan yondashuvning mohiyati, uning matematik tayyorgarlik jarayonidagi ahamiyati hamda talabalarning o'quv faoliyatini samarali tashkil etishdagi o'rni ilmiy jihatdan tahlil qilinadi.

Maqolada faoliyatga yo'naltirilgan yondashuv negizida matematik tahlilni o'qitish bo'yicha takliflar va tavsiyalar keltirilib, talabalarning mustaqil fikrlash qobiliyatini, yangi bilimlarni egallash ehtiyojini va o'quv motivatsiyasini oshiruvchi metodik yechimlar taklif etiladi.

Kalit so'zlar

matematik tahlil, faoliyatga yo'naltirilgan yondashuv, birinchi kurs talabalari, o'quv jarayoni, tushunchalarni shakllantirish, abstraksiyadan konkretlashtirish, o'qitish metodologiyasi, o'quv amaliyoti, algoritmik tafakkur, mustaqil ta'lim, matematik funksiyalar.

Аннотация

В данной научной статье освещены теоретико-методические основы преподавания математического анализа для студентов первого курса с точки зрения деятельностного подхода. В статье научно анализируется содержание деятельностного подхода, его место в процессе математической подготовки и его значение в эффективной организации учебной деятельности студентов.

В статье представлены предложения и рекомендации по преподаванию математического анализа на основе деятельностного подхода, а также предлагаются методические решения, повышающие самостоятельное мышление, потребность в усвоении новых знаний и учебную мотивацию студентов.

Ключевые слова

математический анализ, деятельностный подход, студенты первого курса, учебная деятельность, формирование понятий, от абстракции к конкретизации, методика преподавания, учебная практика, алгоритмическое мышление, самостоятельное обучение, математические функции.

Abstract

This scientific article highlights the theoretical and methodical foundations of teaching mathematical analysis for first-year students from the perspective of an activity-based approach. The article scientifically analyzes the content of the activity-based approach, its place in the process of mathematical training, and its importance in effectively organizing students' educational activities.

The article provides suggestions and recommendations for teaching mathematical analysis based on the activity-based approach, and offers methodical solutions that enhance students' independent thinking, the need to acquire new knowledge, and educational motivation.

Keywords

mathematical analysis, activity-based approach, first-year students, educational activity, concept formation, from abstraction to concretization, teaching methodology, educational practice, algorithmic thinking, independent learning, mathematical functions.

Introduction

In modern higher education, one of the urgent scientific and methodological tasks is the teaching of mathematical disciplines based on innovative pedagogical approaches. In particular, **mathematical analysis** occupies an important place in the formation of students' intellectual competencies, such as **logical thinking, analytical activity, comparison, generalization, proof, and independent judgment**. The difficulties encountered by first-year students in mastering the key concepts and methods of mathematical analysis necessitate the improvement of the methodology for teaching this discipline.

In recent years, the **activity approach** has proven itself to be one of the most effective methodological and didactic directions in mathematical education. This approach suggests not a passive assimilation of ready-made knowledge, but their independent "**discovery**" by the student in the process of performing educational actions. In this regard, teaching the initial sections of mathematical analysis based on the activity approach contributes to a deep understanding of the content of the educational material, the concretization of abstract concepts, and the formation of skills to apply them in practice.

This article examines the theoretical and methodological foundations of teaching initial topics of mathematical analysis to first-year students in the context of the activity approach, analyzes the factors influencing the increase in the effectiveness of the educational process, and also suggests practical mechanisms for organizing educational activities.

At present, an intensive search is underway to improve mathematics teaching in higher education. The use of the **activity approach** in teaching mathematics has significantly stimulated research. The ideas of the activity approach have found wide application in psychology, pedagogy, subject methodologies, and others. In the methodology of teaching mathematics, the activity approach is considered in four versions: the creation of a situation of **independent discovery** and the assimilation of ways of activity; the allocation of a set of actions adequate to their subject content; educational activity; and the activity approach as one of the constituent methodologies of the mathematics teaching methodology.

In the context of the contemporary actualization of the ideas of the activity approach to teaching, the option of using it as one of the constituent methodologies of the mathematics teaching methodology is the most promising. Its implementation involves **building activity** that is adequate to the educational material and the motivational sphere, various kinds of actions, ways of activity, control, and self-control.

To teach first-year students mathematical analysis in the context of the activity approach, it is necessary to **define the goals** of studying the initial topics of mathematical analysis from the viewpoint of the activity approach.

The mental development of students when studying mathematical analysis proceeds simultaneously in two directions: in the **comprehension of the abstract** and in the **concretization of abstractions**. Moreover, the second direction cannot be qualified as elemental and less important. The ability to see the particular in the general, to anticipate, and to apply general provisions to specific things is an equally difficult form of mental activity.

At the initial stages of learning mathematics in school, the main difficulty for students is the **ability to abstract from concrete objects and master abstract concepts**. When studying mathematical analysis, the main difficulty is no longer in generalization (concepts are usually given in a sufficiently general and abstract form), but in **concretization**, i.e., the ability to see concrete images behind mathematical terms and their definitions, to establish relationships between these concepts.

Evidently, the success of understanding the fundamentals of mathematical analysis in a university depends on how well the first-year student masters the concepts and their initial actions in the school course of analysis, as well as educational actions of a general and specific nature.

Studying a subject in a university at any stage, and even more so in the 1st year, presents a specific difficulty: **what to start with?** If, in terms of content, it is clear what to start with, then how to organize the educational activity of students for the assimilation of the material being studied, choose teaching methods and means – these questions are solved by each teacher individually and often without taking into account the specific content of the subject and the real capabilities of the students. As the results of our experimental study showed, it is necessary to start teaching first-year students with "**instrumental activity**," in other words, equipping them with the "**tool**," without which it is impossible to meaningfully master the fundamentals of mathematical analysis. By the "tool" we mean **general educational actions** with the help of which the student can independently comprehend mathematical analysis.

As a result of our study, we concluded that the teaching of educational actions to 1st-year students is advisable to begin specifically with to begin specifically with the 1st year and precisely with the topics "**Real Numbers**," "**Functions**," "**Limit of a Sequence**."

These topics are superficially known to first-year students. It is precisely *superficially* known, as the study of the experience of teaching the beginnings of analysis in school shows that the assimilation of the basic concepts of mathematical analysis presents a particular difficulty for students. Therefore, there is a tendency toward a superficial study, in which the main attention is paid to developing the simplest calculation techniques to the detriment of their comprehension.

Based on this, the goals of studying the section "**Introduction to Analysis**" in the university were specified as follows:

1. To prepare the **primary conceptual apparatus** of mathematical analysis for the successful study of differential and integral calculus of functions of one variable (1st year), as well as subsequent topics of mathematical analysis.
2. To create conditions for the formation of certain **educational actions** in students, necessary for the study of mathematical analysis.
3. To prepare first-year students for **independent activity** when studying new sections of mathematical analysis and for the constant improvement of knowledge.

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Developing the basic provisions of the methodology for teaching educational actions to students when studying mathematical analysis in the university, we proceeded from the goals of studying mathematical analysis. Taking into account the specifics of the subject, which was discussed above, we identified **general educational actions** without which the assimilation of mathematical analysis is impossible. These include:

- **Analysis** (partitioning a whole object (method, idea, etc.) into parts), the internal essential properties of mathematical objects based on their lawful interrelations, etc.;
- **Synthesis** (the reverse transition from abstract provisions to mental restoration, i.e., to the concrete) based on analysis, etc.;
- **Comparison** (of mathematical objects, definitions, formulations of theorems, ideas of proof, methods for solving problems, algorithms of a class of problems, etc.);
- **Subsumption** under a concept and **derivation** of consequences;
- **Formulation** of mathematical propositions in a natural language;
- Actions for **finding solutions** to problems, ideas for proof;
- Actions for **working with theorems** of various types, etc.

For the formation of educational actions, and the organization of independent educational activity, a certain **means** is needed. As a means of forming the educational activity of students, we consider a set of problems and tasks for them. As an example, let's consider the following task:

Task 1.

1. Formulate the definition of an **even and odd function**. Present the graphs of these functions.
2. Investigate the parity and oddness of the following functions: $a)\ f(x)=x^3\cdot\frac{x-1}{x-1}$; б) $f(x)=5$; в) $f(x)=0$; g) $f(x)=\ln\frac{x^2-x}{x^2+x}$.
3. Give examples of functions that are both even and odd. How many such functions exist?
4. Prove, using the definition, that the **sum, difference, and product** of two even functions is an even function. Illustrate with concrete examples.
5. Compose an algorithm for proof using the definition of parity and oddness.
6. Are the following statements true: The sum (difference) of an even and an odd function is:

   a) an even function? b) an odd function?
7. Continue the following sentences to make them true:

a) The sum of two odd functions is a ...... function;

b) The product of an even and an odd function is a ...... function;

c) The product of two even functions is a ...... function;

d) The quotient of two even (odd, even and odd, odd and even) functions is a ...... function.

8. Do functions exist that have a domain of definition symmetric with respect to zero and are:

a) even (odd) and monotonically decreasing?

b) even (odd) and monotonically increasing?

c) even (odd) and positive?

d) even (odd) and non-positive?

e) even and constant?

f) odd and constant? Give examples.

9. Compare even and odd functions, paying attention to the even or odd number of extrema of these functions. Give examples.

10. Under what condition can any function f(x) be represented as the sum of an even and an odd function?

11. Formulate sufficient conditions for parity and oddness:

a) of a linear function $y = ax + b$;

b) of a quadratic function $y = ax^2 + bx + c$;

c) of a function $y = ax^3 + bx^2 + cx + d$;

d) of a fractional linear function $y = \frac{ax + b}{cx + d}$.

12. What function does not need to be investigated for parity and oddness if it is

known that it is **always neither even nor odd**? Give a specific example.

Let's analyze Task 1 from the point of view of **educational actions**. When performing the task, the student must:

1 (1) - **Recall** (read, find in lecture notes, ask the teacher or classmates, etc.) and formulate the definitions of even and odd functions; schematically represent (sketch) the graphs of even and odd functions (recall the graphs of known functions that have the property of parity or oddness); **compare** and note the essential differences: for an even function - symmetry with respect to the ordinate axis; for an odd function - symmetry with respect to the origin;

1 (2) - **Apply the definition** to the solution of specific problems (subsumption under a concept);

1 (3) - **Construct** (by analogy with 1(2)) examples of functions that have a specific property.

1 (4) - **Search for proof ideas**: - Outline a general proof scheme using the definition; - Conduct a general discussion using the definition, as in 1 (2).

1 (5) - **Formalize** the previous actions in the form of a general **algorithm**.

1 (6) - **Apply the proof algorithm** to a specific problem, possibly providing a counterexample.

1 (7) - **Be able to conduct reasoning** from the general algorithm and find the correct answer.

1 (8) - **Establish the relationship** between parity and oddness of a function and the property of monotonicity. (Students often do this task with the help of graphical interpretation and examples of specific functions).

1 (9) - **Establish the connection** between the parity and oddness of a function and the number of extrema points using **geometrical interpretation**. The problem is research-based, as one should consider the cases: a) the extrema points are on the ordinate axis and b) the extrema points are not on the ordinate axis.

1 (10) - A more general problem than 1 (7) and 1 (8), and generalizing the results of previous problems, students conclude that the function must be defined on some set T and that this set is symmetric with respect to zero.

1 (11) - Generalizing the results of solving previous problems, investigate known classes of functions, either by imposing conditions on the parameters a,b,c, and d and applying the definition, or by considering them as a composition of even and odd functions.

1 (12) - **Propose a hypothesis** about what the function structure should be if the domain of definition is an interval not symmetric with respect to zero, **test the hypothesis** - examples of concrete functions $y = lnx$, $y = a^x$.

CONCLUSION

The conducted analysis showed that teaching the initial sections of mathematical analysis based on the activity approach ensures the creation of an effective educational environment for first-year students. This approach is aimed not at passive assimilation of knowledge, but at their independent comprehension, analysis, and practical application in the process of performing learning activities.

The use of the **activity approach** contributes to the formation of intellectual competencies in students, including the ability to concretize abstract concepts, identify their interconnections, reason, draw conclusions, and conduct proof. Tasks aimed at studying the parity and non-parity of functions develop the logical, analytical, and research thinking of students.

The research results confirm the **high effectiveness of the activity approach** in the process of mastering mathematical analysis. This approach enhances motivation for independent knowledge acquisition, encourages students to search for new information, and contributes to the deepening of the content of the educational process. The presented methodological solutions ensure the continuity, consistency, and scientific nature of teaching mathematical analysis in higher education.

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