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ON THE SCIENTIFIC BASIS OF FORMING STUDENTS' LOGICAL COMPETENCE

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ABSTRACT

This article is devoted to the study of the scientific foundations of the formation of logical competence of students in mathematics lessons, which describe traditional and mathematical logic, the relationship between them. He was one of the first to develop a scientific understanding of the basic categories of logic, such as concept, judgment, and conclusion. It has also been proved by Aristotle that there are 19 types of correct conclusions in a special form. The constructed mathematical-logical model allows to study the forms of thinking, that is, the forms of thinking are reflected in the formulas in the logic of reasoning and predicate logic. That is, the same logical form can have different meanings. Just the study of form, the disregard for content, the study of the connections between these forms, is the view of logic as a science.

KEYWORDS: *Logical Competence, Intellectual, Mathematics, Traditional Logic, Mathematical Logic.*

INTRODUCTION

The process of teaching all subjects, especially mathematics, should be shaped on the basis of logical competencies, logical knowledge and logical skills. The school mathematics course has a great potential in the development of students' thinking skills, the formation of logical competence. However, research and observations on this topic show that this potential is not fully used. For example, N.Kh. Rozov [1], speaking about the science of logic in mathematics education, notes that the school mathematics course does not cover the whole course of logic, but focuses on the study of elements of mathematical logic, which is a special part of it. The author argues that the contribution of mathematics in the development of logical skills in students is that mathematics is inseparable from the mathematical foundations of logic, but that it is never emphasized, explained, developed.

Resolution of the Cabinet of Ministers No. 187 of April 6, 2017 approved the State Education Standard for General Secondary Education and the curriculum of subjects taught in grades 10-11, in particular, the curriculum of mathematics [2]. The program took into account the education of mathematics in developed countries and its development trends, and included in the content of mathematics education one of the new topics on the science of logic "Collections and logic." It is planned to study concepts such as collection, actions on collections; filler kit; feedback; denial, conjunction, and disjunction; logical equality; logical laws; implication, conversion, inversion, and counterpoint; predicates and quantifiers; laws of reasoning; paradoxes and sophisms in these topics and 19 hours are devoted to this. The above-mentioned state education standard, a textbook created in accordance with the program of mathematics [3], fully describes the content planned in the program, explains the newly introduced concepts, actions with the examples. However, it should be noted that the issues related to the development and consolidation of the acquired knowledge and skills on logic are not given in the following topics. This has a negative impact on the systematic formation of students' logical competencies. Therefore, there is a need to develop effective ways to develop logical competencies in schoolchildren, in particular, to develop a methodological framework for teaching them to use the knowledge and skills of logic specifically learned in the mathematics course in the study of mathematics and other sciences. To solve this problem, it is important to study the scientific basis for the formation of logical competencies in students.

The Main Findings and Results

This article is devoted to the study of the scientific basis for the formation of students' logical competence in mathematics lessons, which describes the traditional and mathematical logic, the relationship between them.

Logic as a science began with the work of Aristotle (384-322 BC), a student of Plato. Aristotle almost built a mathematical model of the human thought process. This model of his has served the development of European scientific civilization for more than 2,000 years. He was one of the first to develop a scientific understanding of the basic categories of logic, such as concept, judgment, and conclusion. It has also been proved by Aristotle that there are 19 types of correct conclusions in a special form. They are called Aristotle syllogisms. During 2000 years, logic developed on the basis of ideas and methods created by Aristotle. These ideas and methods are not only of historical significance in the present period, but are still in use today.

Even in ancient times, logic entered mathematics and turned it into a science of logic. From the time of the ancient Greeks, the term "mathematics" was synonymous with "proof" [4, p. 23].

Mathematics and logic have evolved over the centuries on the basis of close interactions. Moreover, their interaction has led to crises in these areas of knowledge, and through these interactions, these crises have been overcome, resulting in the effective and progressive development of these disciplines. These crises are due to the fact that the mathematical results accumulated during this period cannot be explained within the existing methods of reasoning. In order to solve the resulting delays, it was necessary to radically reconsider the general foundations and methodology of almost all mathematical theories and, of course, to analyze the logical methods of proof, the logical foundations of mathematical science. The development of mathematical science put forward more and more criteria for the solidity of mathematical proofs, which in turn led to the development of logic. At the same time, evolving logic has helped mathematicians find ways to get out of the deadlock that arises in logical reasoning.

The development of science and technology in European countries in the XVIII century, especially the development of mechanics and mathematics in connection with practice, paved the way for the emergence of a new direction - mathematical logic on the basis of traditional logic.

The German philosopher and mathematician G. Leibniz (1646-1716) developed a method of mathematical calculation, and applied it to logic. He was able to identify ways to reason logically by applying symbols to forms of thinking (perception, judgment, inference).

By the middle of the XIX century, mathematical logic was fully formed as an independent science, to which the English mathematician, logician J.Bul (1815-1864) and the German philosopher, mathematician G.Frege (1848-1925) made a significant contribution. In their works, the logical model of the thought process created by Aristotle was supplemented with mathematical content. On the one hand, logic applied mathematical methods in the study of the general structure of correct thinking, and at the same time was formed as a branch of mathematics. Logic entered the ranks of the mathematical sciences, and mathematical logic emerged. On the other hand, the subject of its study was the process of proving mathematical theorems, mathematical theories. Thus, logic became one of the real parts of mathematics, mathematical logic. In the twentieth century, conclusions were reached on the methods of thinking of mathematical logic that could not be proved using traditional logic. This applies to the axiomatic method, which is one of the most important, basic methods of mathematics, and the limits of its application. These scientific results were discovered by K. Gegel, A. Turing, A. Tarsky, A. Church, and they are among the greatest discoveries in the field of mathematics in the twentieth century.

In the second half of the twentieth century, unusually effective applications of mathematical logic were discovered. Mathematical logic, recognized as purely theoretical and abstract, had a strong influence on computers, their creation and operation. On the one hand, the methods of mathematical logic were used as a mathematical apparatus for computer practice, that is, for the creation of computers, for the construction of connection schemes. On the other hand, it became necessary to create software (applications) for computers.

The great practical importance of mathematical logic is that students are introduced to their understanding of the basics of mathematical logic in high school computer science and mathematics courses. In this case, logic is given by mathematical expressions. But its science of thinking, of reasoning, and of proof is not manifested. Hence, traditional logic should be used in shaping the logical competence of school students. However, logic cannot be imagined without its mathematical component.

The fundamental basis of traditional Aristotle logic is the famous Aristotle trinity, i.e., concept, judgment, conclusion. These trinities constitute the stages of the thinking process and they serve as the methodological basis for building a mathematical model of the thinking process. To interpret these categories in terms of mathematical logic, the two main sections of mathematical logic: the logic of reasoning and the logic of predicates are used.

The mathematics of logic begins with the passage of the subject of "concept" and continues with the subject of "judgment," and achieves great results in the passage of the subject of "conclusion."

The process of thinking begins with naming the things and events that surround us. These names (terms) refer to concepts, which in turn represent some class of objects of known character. Aristotle developed ideas on how to introduce concepts and how to classify them. It gives the scope of the concept, how to define the content of the concept, how to find them, how to identify them. From the point of view of mathematical logic, characters are one-place predicates: the set of characters representing its content is the resultant predicate, i.e., it is a conjunction of predicates. Finally, the concept size is the set of truth values of the resulting predicate. From this point on, modern set theory is involved in describing traditional logic using mathematical logic. Thus, concepts generalize knowledge about individual objects and events in the world around us.

The second stage of the thinking process is to study the connections among events, processes, and objects in the world around us, to express these connections in the form of judgments. A judgment is a statement that gives a certain judgment about an object or event. This fact can be used to determine whether a statement is true or false. The validity of an opinion in a commentary represents an important characteristic feature of that subject or event. Thus, any opinion will be either true or false, there can be no other case. 1 character is added to each true comment and 0 character is added to the false comment. Thus, in the 1st stage of the thinking process, we move away from the content of the judgment and leave for each judgment one characteristic of it - true or false. In this case we create a set of two elements {0; 1}.

Aristotle divides judgments into quantitative (general, specific, unit) and qualitative (affirmative, negative) classes. He also divides judgments into simple and complex judgments. A simple judgment is a judgment in which no related part of it is a judgment. A complex judgment can consist of several simple judgments. Thus the relationships between concepts are expressed in judgments.

From the point of view of mathematical logic, complex judgments will be more complex than the simple judgments made by Aristotle. This difference is seen in drawing conclusions from complex and simple judgments. Complex judgments are modeled through the logic of reasoning, the first part of mathematical logic, while simple reasoning is modeled through the logic of predicates.

Logically complex reasoning is formed from simple reasoning using conjunctions such as “but (not)”, “and”, “or”, “if”, “if”, “then”, “only and only”, “in this case”.

The next stage of the thinking process focuses on the essence of such conjunctions “but” is called negation of the action in which the conjunction participates and is denoted as $\rceil$, “and” the action represented by the conjunction is called conjunction, it is defined as $\wedge$, or the disjunction is matched to the conjunction and is defined as $\vee$, the implication operation corresponds to the conjunction "if", "if", "then" and is defined as $\rightarrow$. In this case, only and only in this case the equivalent of the connector corresponds, it is defined as $\leftrightarrow$.

These actions are called logical actions, and a truth table is created for each of them. As a result, we come to the following algebraic construction: a set of two elements and one unar given in it, and four binary algebraic operations $\rceil, \wedge, \vee, \rightarrow, \Leftrightarrow$. We define this construction as

$$B = < \{0,1\}, \rceil, \wedge, \vee, \rightarrow, \Leftrightarrow >$$

And we call it the algebra of considerations (Bul algebra).

Aristotle distinguishes between a set of simple judgments about the properties of things - categorical (or attributive) judgments. He divides them into those that belong to a particular thing (unit) and those that belong to a class of things (general), as well as those that affirm and deny them, respectively. The mathematical logic apparatus that models such judgments is called predicate logic.

Thus, in the first two stages of the thought process - the stage of forming concepts and judgments - human actions move from the material world to the realm of consciousness.

The third step in the thinking process is to draw conclusions. In general, drawing conclusions is an intellectual process expressed in judgments, in which a person acquires new knowledge. This knowledge is also expressed in the form of judgment. The initial judgments are called the conclusion condition, and the resulting judgments are called the conclusion result or outcome. Thus, with the help of conclusions, we grow our knowledge without directly referring to the things and phenomena of being, being able to discover the connections and relationships of that cannot be seen with the naked eye.

Aristotle was the first to draw attention not only to the content of the judgments, but also to the fact that they bring to new conclusions through the connections between them. Inference theory or proofs are taken as the culmination of traditional logic reasoning.

CONCLUSION

Thus deductive reasoning is the culmination of classical logic, in which a sequence of judgments is given. The constructed mathematical-logical model allows to study the forms of thinking, that is, the forms of thinking are reflected in the formulas in the logic of reasoning and predicate logic. That is, the same logical form can have different meanings. Just the study of form, the disregard for content, the study of the connections between these forms, is the view of logic as a science. Thus, in the formation of students' logical competence, we must rely on the achievements of traditional logic and mathematical logic, and use them.

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