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Scientific-Pedagogical Aspects of Logical Thinking

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Abstract: The article examines the scientific and pedagogical aspects of logical thinking. It highlights philosophical, psychological, and pedagogical foundations, and its role in the educational process. Modern pedagogical technologies such as problem-based learning, discussions, and case studies are analyzed. A comparative study of international experience and Uzbekistan's educational reforms is presented.

Keywords: logical thinking, education, pedagogical technology, cognitive development, competence.

21st century education has reached a new level in terms of its content and goals. Globalization processes, the rapid development of digital technologies, and the rapid obsolescence of knowledge require the education system not only to transmit information, but also to form in individuals the ability to think independently, analyze, and draw logical conclusions. Therefore, the development of logical thinking competence occupies a special place as one of the main trends of modern education. After all, logical thinking is an important cognitive function that regulates the cognitive process of a person and directs it to a goal.

International educational standards also pay great attention to this issue. In particular, the "Education 2030" program developed by the OECD lists critical and logical thinking as a primary competency among the basic skills for students. UNESCO's global recommendations in the field of education emphasize that "any education system, while ensuring the development of human capital, must also guide young people towards the ability to logically analyze and make responsible decisions". Also, in the results of international assessment programs - PISA (Programme for International Student Assessment), not only the level of knowledge of students is evaluated, but also their ability to logically analyze problems and process structured information as the main criterion.

The main goal of the article is to reveal the scientific basis of the concept of logical thinking in the educational system and to analyze the methodological aspects of its research. At the same time, the article highlights the essence of logical thinking in a combination of philosophical, psychological and pedagogical perspectives, and justifies its role in the educational process using the example of scientific research conducted in this area. In the history of human thought, creating the scientific foundations of logical thinking has been one of the most important tasks of philosophy. Logical thinking is formed as a system of rules governing not only the process of theoretical knowledge, but also practical activity. In this regard, great thinkers, great philosophers of the West and the East tried to reveal the deep essence of logic and thinking in their views.

Aristotle (4th century BC) scientifically substantiated logic as an independent science. His works "Organon" formed the theory of syllogistic. According to Aristotle, any knowledge arises

through the process of drawing conclusions, and conclusions must necessarily be based on a consistent logical chain. These ideas of Aristotle are also important from a pedagogical point of view: because he showed that in the process of education it is necessary to encourage the student not to memorize facts, but to come to consistent conclusions through thought. Thus, in Aristotle's pedagogy, logical thinking is the central criterion of the educational process.

In modern times, Rene Descartes (1596–1650) scientifically substantiated logical thinking through the method of rationalism. In his work "Discourse on Method", he put forward rules for "directing the mind in the right direction." According to Descartes, the reliability of knowledge is determined by its logical clarity. Therefore, he emphasized that any knowledge should be tested by doubt and accepted only that which is based on logical evidence. Descartes' formula "Cogito ergo sum" ("I think, therefore I am") went down in history as a universal criterion for determining the existence of human thought. From a pedagogical point of view, this idea shows the need to teach the student to think independently, doubt and find evidence.

I. Kant (1724-1804) analyzed logical thinking as a universal function of the human mind in his Critique of Pure Reason. According to him, thinking perceives reality through subjective forms, which means that the human mind actively participates in the structure of knowledge. Here Kant showed the logicality of thought and its subjective-objective coherence in the process of cognition. From a pedagogical point of view, Kant's views imply that in the educational process, the student should be seen not only as a receiver of external information, but also as an active subject in the creation of knowledge.

Hegel (1770–1831) explained logical thinking on a dialectical basis. In his work "Science of Logic", the theory was put forward that the thinking process moves through contradictions and rises to a higher level through synthesis. For Hegel, logical thinking is a process of constant development. This idea is also important in pedagogy: it is understood that in the process of educating a student, it is necessary to teach logical thinking not through static knowledge, but through the resolution of contradictory situations.

Eastern philosophy also deeply developed the scientific foundations of logical thinking. Al-Farabi (870–950) defined logic as "a means of protecting the mind from error," placing it above all other sciences. In his opinion, the validity of any science is determined by its logical basis.

Ibn Sina (980–1037) interpreted logical thinking in accordance with the natural laws of the human cognitive process. He deeply analyzed the forms of thought (imagination, affirmation, comparison) and determined their place in the human cognitive process. He also applied logic not only as a theoretical but also as a practical science, because logical thinking is also crucial in human life decisions.

Abu Rayhan al-Biruni (973–1048) saw logical thinking as a fundamental condition for the development of science. In his work "Qanun al-Mas'udi", he argued that knowledge about nature could be achieved through a combination of observation, experiment, and logical deduction. This idea is also very important for modern pedagogy: because it directs the student to create knowledge through experience, observation, and logical analysis, rather than through mere knowledge.

Thus, when we compare the views of Western and Eastern thinkers, we see that their common goal is the same: to regulate human thinking, to justify knowledge and to protect from erroneous thoughts. The differences are reflected in the methodological approach: Western philosophers focused more on theoretical and methodological systems, while Eastern thinkers sought to combine logic with practical life and science. Therefore, the combination of these two traditions is also important for modern education.

In modern philosophical research, the study of logical thinking has developed not only in traditional directions but also on new theoretical foundations. Formal logic and symbolic logic have also been scientifically strengthened as branches of logic.

Formal logic studies the general laws of human thought, that is, the system of rules that ensure the consistency of thinking. It regulates the processes of comparison, conclusion, generalization, denial and proof. This theory is important in education: it develops skills in a student such as understanding the connections between facts, expressing concepts coherently, and avoiding contradictions in thought. If logic has been considered the main criterion of human thinking since the time of Aristotle, then in modern education, formal logic also shapes students' ability to distinguish truth from error.

Symbolic logic, on the other hand, developed in the 20th century, allowing logical thinking to be expressed through mathematical symbols, formulas, and algorithms. This direction is closely related to modern education, as symbolic logic is a key tool in information technology and programming processes. Through symbolic logic, students acquire not only logical thinking, but also the algorithmic thinking necessary to function successfully in the digital world.

From the point of view of discussion, while formal logic is aimed at regulating human thought, symbolic logic allows for its application to technical and practical fields. If the first direction plays a key role in the formation of a general thinking culture in education, the second one serves to develop digital literacy and algorithmic thinking skills in students in the context of the modern information society.

In this regard, the harmonious application of these two theories is required in the formation of logical thinking in modern education. Formal logic provides the basic laws of thought, and symbolic logic provides their application in practical and numerical expression. Therefore, for the formation of perfect logical competence in the student, it is necessary to pay attention to the harmony of theoretical and practical logic in the educational process.

We know that one of the main directions of the science of psychology is the study of human thinking and its laws. The rationality of thinking has always been a central issue in the study of human thinking. In particular, the nature of logical thinking in the psychology of the 20th century was explained in different ways by different schools and scientists.

According to Vygotsky, thinking is a social process, the formation of which is closely related to language and communication. He interpreted the development of logical thinking as a cultural-historical process, that is, a person acquires the culture of thinking in connection with society. Based on this perspective, it is understood that the formation of a student's logical thinking in the educational process is not only an individual process, but is also closely linked to the social environment.

And Jean Piaget studied the thinking process from the point of view of ontogenetic development. In his theory of cognitive development, a child's thinking goes through certain stages: sensorimotor, preoperational, concrete operations, and formal operations. According to Piaget, logical thinking is formed at its highest stage, the formal operational stage. During this period, young people acquire the ability to think abstractly and reason logically.

Bloom, on the other hand, explained the thinking process through cognitive tasks in the educational process. His taxonomy shows the stages of knowledge, understanding, application, analysis, synthesis, and evaluation. In this direction, logical thinking is manifested at the highest levels - in the processes of analysis, synthesis, and evaluation. Therefore, Bloom's theory is an important criterion for educational methodology in the development of logical thinking.

When we look at the types of thinking, we can see that analytical thinking is characterized by the process of drawing conclusions based on existing facts, synthetic thinking is characterized by the process of combining different information, and creative thinking is characterized by the process of creating new ideas. Logical thought is the law-based type of thinking that governs them all. In this case, the main feature is the consistency, validity and non-contradiction of the conclusion. So, logical thinking is a factor that brings other types of thought into an expressive and meaningful form.

From the point of view of cognitive psychology, logical thinking is manifested in the processes of processing knowledge and performing logical operations. For example, a person remembers information (the simplest cognitive process), analyzes it, compares it, and summarizes it. In these processes, logical operations such as comparison, generalization, and determining cause and effect play a key role.

Logical thinking is of great importance in personal development. It strengthens memory processes, focuses attention, and creates the opportunity to clearly express thoughts in social interactions. At the same time, a person who can think logically also participates effectively in social relationships because he or she clearly expresses his or her own opinions and is able to analyze and draw conclusions from the opinions of others.

The gradual development of thinking in students is also shown as an important aspect in psychology. In the early stages, more concrete thinking prevails, while in the upper grades and higher education, abstract and logical thinking skills are developed. Therefore, the use of problem situations, questions and answers, creative tasks, and discussions in the educational process is the main pedagogical condition for forming students' logical thinking.

Thus, from the point of view of psychology, logical thinking is one of the highest stages in a person's cognitive development, which is formed in the educational process through a combination of various pedagogical methods and psychological factors.

The issue of logical thinking occupies a central place not only in philosophy and psychology, but also in pedagogy. Because the main goal of education is to equip a person with knowledge, skills, and competencies, as well as to form in him the ability to think independently, analyze, and draw logical conclusions. In pedagogical theories, logical thinking is considered an important tool in realizing the content and goals of education. From Jan Amos Comenius to modern pedagogical theories, it has been shown that the effectiveness of the learning process is closely related to the student's ability to think logically and critically. In this respect, logical thinking serves as the methodological foundation of education.

Logical thinking is defined as a separate competence in modern educational standards. For example, in the "Key Competences for Lifelong Learning" program adopted by the European Union, critical and logical thinking are among the key skills for the younger generation. The state educational standards adopted in the Republic of Uzbekistan also identify "the development of independent and logical thinking in students" as one of the priority tasks of education. This indicates the need to adapt the content and methods of the educational process to the demands of the times, that is, to focus not only on imparting knowledge, but also on forming a culture of thinking.

Pedagogical technologies that develop logical thinking play an important role in educational practice. In particular, problem-based learning develops the student not as a receiver of ready-made knowledge, but as a problem-solving subject. In this process, students develop logical thinking skills by participating in the processes of asking questions, making assumptions, proving, and disproving. Discussions and debates provide a clash of ideas, develop students' ability to defend their opinion, provide evidence, and provide logical refutation. The case-study method is focused on the analysis of real-life situations and forms the ability of students to understand causal relationships, compare solutions, and make logical decisions. Interactive methods (cluster, mental map, "brainstorming") make students active participants and develop the ability to distinguish logically based ideas from thoughts.

International experience also shows that modern education systems view logical thinking competence as a top priority. For example, in the Finnish education system, the main criterion is not just to provide students with knowledge, but also to teach them to use knowledge independently, analyze it, and think creatively. In Singapore, education is organized based on the “critical and inventive thinking” model, in which the abilities of logical analysis and creative ideation are harmoniously developed. In the Japanese experience, attention is paid to the culture

of “imagination” (yūkō na kangae) among students, that is, any knowledge is required to be logically substantiated through practice.

The educational reforms underway in Uzbekistan also place great emphasis on the competence of logical thinking. This is evidenced by the fact that state educational standards define competencies such as "the ability to think critically and logically" and "the ability to solve problem situations," and that interactive methods are widely used in updated textbooks and teaching aids.

Pedagogical analysis shows that logical thinking is a universal criterion of education. It underlies not only the content of knowledge, but also educational methods, technologies, and a system of general competencies. In the modern pedagogical process, it is possible to form students' logical thinking competence at a high level through the harmonious use of problem-based education, debate, case-study and interactive methods, as well as effective use of international and local experiences.

Various methods are used effectively in researching the phenomenon of logical thinking. First of all, the philosophical-analytical method is used to understand the nature and laws of human thinking. Through this method, logical thinking is explained in accordance with the laws of philosophy and logic. Based on this, the logical relationships, comparisons, and inferences in the human cognitive process are theoretically justified.

Secondly, psychodiagnostics methods serve to measure the manifestation of logical thinking in personal development. Through various tests, question-answer systems, and cognitive tasks, students' abilities to analyze, compare, and generalize are determined. Through these methods, it is possible to determine the level of logical thinking of a person and the stages of his development.

Thirdly, the method of pedagogical experiment is used to check the effectiveness of formation of logical thinking in the educational process. In this process, by introducing various interactive methods (problematic education, debates, case-study) into the educational process, it is observed how students' logical thinking skills are manifested.

When assessing logical thinking, clear criteria should be established. These include the extent to which the student controls cognitive processes, expresses logically based opinions in the question-and-answer process, and is able to consistently apply knowledge and skills in practice. For example, a student's ability to analyze information, identify cause-and-effect relationships, and propose a logical solution demonstrates his or her level of logical thinking.

At the same time, the comparative analysis method is also important in the study of logical thinking. While domestic research mainly uses traditional methodological approaches, foreign research is more often conducted in combination with cognitive psychology and modern pedagogical technologies. Through their comparative study, a combination of local traditions and international experiences can be ensured in the formation of logical thinking competence.

It is known from the above analysis that logical thinking as a universal competence of education is the main factor that ensures personal development and educational efficiency. It regulates human thinking, guides the cognitive process consistently and develops the student's ability to understand the truth and draw conclusions based on evidence.

When studying logical thinking, it is necessary to study philosophical, psychological, and pedagogical aspects in harmony. Philosophy reveals the general laws of human thought, psychology illuminates its aspects related to cognitive processes, and pedagogy forms it as a practical skill in the educational process. Therefore, the development of logical thinking competence in modern education should be carried out in harmony with these three areas.

The following practical recommendations are offered for the development of logical thinking in the educational process:

- wider use of interactive methods (problematic education, case-study, debates) in the course of the lesson, to form a culture of questioning among students, encouraging them to reach the truth through independent research and discussion;
- more introduction of elements of logical analysis in scientific and practical research, development of students' skills of making coherent conclusions and providing evidence.

In general, logical thinking serves as not only a theoretical but also a practical foundation of education, contributing to the holistic development of the student's personality. For its development, the effective use of scientifically based approaches and innovative pedagogical technologies is a requirement of today.

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