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DEVELOPING LOGICAL THINKING IN STUDENTS OF MILITARY-ACADEMIC LYCEUMS IN MATHEMATICS

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Abstract
This article focuses on the development of logical thinking skills among students studying at military-academic lyceums. It discusses the concept of logical thinking development, the origins of logic, the axioms of logical reasoning that underlie our worldview, tools to foster logical thinking, and other related topics in detail.

Keywords: Object, subject, mathematical speech, logic, induction, deduction, empirical roots of logical laws, mathematical formula, vector direction of time from past to future, cause-and-effect relationships, sequence, visual-imaginative thinking, verbal-logical thinking, visual-effective thinking.

Introduction

Modern educational standards have raised demands on the learning process, and current realities require new approaches to teaching. The rapid growth of information technologies elevates the learning process and transforms the relationship between teacher and student into a "subject-subject" interaction rather than the traditional "subject-object" model. The student is no longer merely an object influenced by the teacher but becomes a full-fledged participant in the pedagogical process.

It is known that mathematical speech is an integral part of general speech. Alongside other subjects, mathematical language plays an important role in

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enhancing children's vocabulary and speech skills. In math classes, mathematical speech serves as an important factor in developing logical thinking. To build a mathematical model of real-life processes, students must be able to express and mentally visualize these processes in language. Therefore, methods for developing students' logical imagination are studied in mathematics lessons.

When students are able to visualize an ongoing process and then express it in words, their mathematical language develops. Speech also improves when students articulate mathematical formulas in expressive verbal form.

Main Section

The development of logical thinking is essential for everyone, regardless of age. Logical reasoning helps individuals make decisions quickly, form logical chains, identify relationships between various objects, and predict outcomes in a short time. Additionally, one can analyze others' behavior and determine the causes behind their actions. This is not an innate gift but a skill developed through specific activities, games, and exercises.

Logic is not an inherent trait of human personality—we learn it throughout our lives. It is not something naturally close to us, but rather foreign; that's why people often avoid drawing logical conclusions, instead opting for what feels easier or more convenient. Yet without logic, humanity cannot function, as many laws of life are fundamentally based on it. A paradox? Yes—this multifaceted science is full of them.

How did logic emerge?

The roots of logical laws are empirical—meaning they stem from experimental understanding of the world: a person either created or witnessed an event and then observed its consequences. After multiple repetitions of causal situations, they memorized them and reached conclusions. Thus, logical laws, like those of other sciences, are derived from experience.

There are certain logical axioms that everyone must know. Deviating from them may indicate mental disorders. However, many logical laws can be twisted to suit one's purpose—just like in other sciences, errors and exceptions exist.

Let's look at the basic scientific foundations introduced into human life, the axioms that form the basis of our worldview:

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1. The vector direction of time from past to future, its linearity and irreversibility. From early childhood, people learn the concepts of "yesterday," "today," and "tomorrow," and begin to understand past, present, and future events as fixed and unchangeable.
2. Cause-and-effect relationships and their one-way directionality.
3. Logic describes small and large concepts and their compatibility, not just literally but also in abstract ways. It includes the adjacency and mutual replacement of concepts, and conversely, their incompatibility and inability to coexist simultaneously.

For example, a woman cannot be pregnant with a second child while already pregnant; a person cannot be alive and dead at the same time; a patient cannot feel healthy; water does not freeze at positive temperatures.

4. Induction and deduction:

Inductive reasoning moves from specific observations to general conclusions, relying on common features of various objects.

Deductive reasoning, on the contrary, moves from general principles to specific cases and is based on logical law.

Example: Deduction: If it rains, the grass gets wet. Induction: The grass is wet, the asphalt is wet, the roof of the house is wet—so it must have rained.

In deductive reasoning, the truth of the premise guarantees the truth of the conclusion. But if the conclusion doesn't match the premise, there's a separating factor: "It's raining, but the grass is dry." (The grass is under a canopy.)

In simple terms, deduction gives a 100% correct answer, while induction gives a likely conclusion with about 90% certainty—but it's subject to error. For example, the wetness could be due to dew or a broken sprinkler, not rain.

Induction generalizes repeated phenomena. If you throw a ball up, it falls. If it happens again and again, you conclude all thrown objects fall—this underpins the law of gravity. But we are in the realm of logic now, and inductive reasoning has flaws. What if you throw it and it sticks to a tree or lands on a shelf? In zero gravity, it wouldn't fall at all.

Hence, deduction is more accurate; induction only allows high-probability assumptions.

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5. Sequence. If we perform a series of actions in a specific order, we get the expected result. But if that order is disrupted, the outcome may differ or not occur at all. At the same time, some results don't depend on the sequence of actions. In short, this is referred to as an algorithm.

Logic is closely connected with other sciences. The rules mentioned above are based on laws of mathematics, physics, biology, and chemistry. But the understanding of relationships is the core of logical thinking. Everything around us has two sides—positive and negative. No phenomenon exists with only one aspect. The same applies to logic. Despite its apparent benefits, excessive reliance on logic can be harmful if misused.

Analysis and Results

Tools that help develop logical thinking include training and games. Logic can rightly be called the crown of human knowledge. It is a mental activity with its own goals, motives, operational functions, and results. It can be described in various ways: the highest level of information acquisition and processing, establishing cause-and-effect relationships between objects of reality, identifying specific characteristics of objects and events, forming ideas about them, and continuously building a set of concepts and notions to better understand the world.

Regardless of how it is defined, one thing is clear: the better a person's thinking, the more effectively they can interact with the world and others, learn, and comprehend events and truths. Thinking develops from birth, but life circumstances don't always support continuous development. Often, after reaching a certain level, progress slows down. Still, like many processes, thinking is something each of us can influence. In other words, everyone is capable—and this article discusses how to nurture that ability.

Before diving into the main material, let's briefly touch on the concept of thinking itself. According to experts, there are several primary types of thinking, most often studied and considered the most important:

1. Visually Creative Thinking
2. Verbal-Logical (Abstract) Thinking
3. Visual-Effective Thinking

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4. Visual-Imaginative Thinking

Visual-Imaginative Thinking and How to Develop It

Visual-imaginative thinking transforms reality into images, giving ordinary things new qualities. It involves solving problems and tasks visually, without direct manipulation. The brain is responsible for developing this ability. It should not be confused with imagination or fantasy—visual-imaginative thinking is based on real objects, actions, and processes.

Both adults and children can develop this type of thinking. Some effective exercises include:

Think about several people you interacted with today, and mentally visualize their clothes, shoes, hair, and appearance in detail.

Try describing the words "success," "wealth," and "beauty" using only two nouns, one adjective, and three verbs.

Verbal-Logical (Abstract) Thinking

Verbal-logical thinking is characterized by the ability to view a whole image and extract only the essential features, ignoring minor details that merely fill in the picture. This type of thinking has three forms:

Concept – grouping objects by their properties

Judgment – affirming or denying relationships or phenomena

Inference – drawing specific conclusions from multiple judgments

Everyone should develop verbal-logical thinking, especially in children from an early age, as it effectively trains memory, attention, and imagination. Try these exercises for yourself or your child:

Set a timer for 3 minutes and write down as many words as possible starting with "g," "sh," "h," and "z."

Take simple phrases like "What's for breakfast?", "Let's go to the movies," "come," and "there's a new test tomorrow," and read them backwards.

Use word groups like "sad, happy, slow, careful," "dog, cat, parrot, penguin," "Sergey, Anton, Kolya, Tsarev, Olga," and "triangle, square, board, images." Choose the word that doesn't belong in each group.

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Visual-Effective Thinking and Exercises to Develop It

Visual-effective thinking refers to solving mental problems by manipulating actual objects—based on real-life scenarios. It is considered the first method of processing acquired information. This type of thinking is most actively developed in children up to the age of 7, when they start combining, analyzing, and working with different objects.

In adults, this thinking is often associated with "manual intelligence"—the practical understanding of how objects in the world function and how to use them effectively. The brain is also responsible for developing this thinking style.

Conclusion

Every day, people rely on logic to solve problems. In general, forming and developing logical thinking helps avoid errors and is a crucial part of life experience. Logic is needed almost daily to solve various problems. It plays a role in scientific research, formal work, organization, and personal life. All of these areas are based on elements of logic. By developing logical thinking, people can solve other everyday problems more quickly and efficiently—for example, by distinguishing the primary from the secondary.

Everyone has the ability to process information—it is a natural function of the brain. The basic and secondary forms of logical thinking allow people to plan and regulate their behavior. It also enables them to draw correct conclusions and take appropriate actions.

In conclusion, logical thinking is a necessary skill that can be developed and taught. Logic is needed to reach the truth through the thinking process. Due to the brain's powerful activity, a certain scheme is activated that leads a person to their final goal. The result is achieved not through intuition, but through previously acquired knowledge. That is why logic is often called a science that allows conclusions to be drawn through the connection of multiple premises. The main task of logic is to synthesize existing pieces of information. As a result, a person gains true knowledge about the subject of their reasoning.

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