BG Pulse Journal USA
ISSN:1947-2536 http://www.bgpulseusa.com/index.php/bg
BG PULSE JOURNAL

DEVELOPMENT OF LOGICAL THINKING IN GENERAL EDUCATION SCHOOL STUDENTS

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https://doi.org/10.5281/zenodo.20491220

Abstract: This article highlights the theoretical foundations and practical methods of developing students' logical and creative thinking. Based on the views of **Alexander Romanovich Luria**, the relationship between thinking processes and brain activity is explained, with particular emphasis on the role of the prefrontal cortex. Furthermore, the significance of modern pedagogical methods—such as the **If–Then technique**, **Analysis Chain**, **Six Thinking Hats**, and the **Cluster Method**—in fostering students' critical, logical, and creative thinking skills is discussed.

Keywords: logical thinking, creative thinking, critical thinking, prefrontal cortex, pedagogical methods, If–Then technique, Analysis Chain, Six Thinking Hats, cluster method, interactive learning.

Introduction

Today, not only the education and upbringing of students but also the development of their logical reasoning and creative ideas has become an important responsibility for both teachers and parents. By monitoring students, engaging in individual activities, conducting conversations, and using questionnaires, educators and parents can identify students' abilities, interests, and levels of logical thinking. Currently, not only in developed countries but also in Uzbekistan, all necessary conditions have been created for teachers to work collaboratively with students and their parents.

A.R. Luria emphasized that "Logical thinking is not merely knowledge; it is the activity of neural networks in the brain" [1]. The **prefrontal cortex** (the frontal part of the brain) is responsible for analytical thinking, planning, recognizing cause-and-effect relationships, and drawing conclusions. This area develops rapidly between the ages of **10 and 14**, indicating that middle school is the most favorable period for the formation of logical thinking skills [2].

However, many developed countries begin fostering logical and creative development during the preschool years. Children are provided with various toys, and specialists observe which aspects attract their attention. Through such observations, educators can identify children's interests and potential talents, helping to guide them toward suitable future professions. The way children interact with toys and the features they focus on are carefully monitored. A correctly chosen profession can determine an individual's future and life path, making this an important initial step.

In the **United States** and the **United Kingdom**, philosophical questions are posed to children aged 6–12 years [3]. This approach helps assess their logical, critical, and moral reasoning skills. Educators observe how children respond, how much time they take to answer, and whether they can answer at all. In the **Finnish education system**, students are encouraged to answer questions during every lesson, and their ability to analyze independently is developed through motivation and encouragement [4].

Encouragement plays a crucial role in students' development and is considered a requirement of modern education. Motivation can take many forms, including gifts, grades, stickers, or simple verbal praise. Praise enhances a student's reputation among peers and helps increase self-confidence.

Today, schools utilize various techniques and didactic tools to develop students' logical thinking skills. These methods aim to improve reasoning abilities, analytical thinking, problem-solving skills, and independent decision-making, thereby preparing students for successful participation in academic and real-life situations.

"If-Then" Technique: "If these things happen, then what will happen?" — a type of question used to identify cause-and-effect relationships [5]. Today, this technique is also applied in school Tarbiya (Moral Education) textbooks. However, it is used in a slightly different way: students independently create and present their own endings to a story or narrative. In this approach, there are no incorrect answers because the story concludes according to the student's independent thinking and creativity, and different endings can later be compared. Teachers can apply this technique at the end of any topic, fairy tale, or story. Even if the story already has a completed ending, teachers may ask questions such as: "Could it have ended differently?", "What would happen if it ended this way?", "What consequences would follow?", or "Would it lead to a positive or negative outcome?" Students may be asked individually to explain the consequences. They can write their answers separately for the teacher to review, or they may respond orally. The method of implementation depends on the teacher's preference.

The next methodology is the **"Analysis Chain"** technique: deepening ideas by writing three or four conclusions that can be drawn from each fact or opinion [6]. This method is implemented somewhat differently. Students are encouraged to generate multiple conclusions. No response is considered incorrect; statements such as "Your answer is wrong," "This cannot be a conclusion," or "That is impossible" are avoided. All responses are either listened to or written down. Unlike the previous technique, this method requires students to think more extensively. They cannot complete the task by providing only one answer. Students are expected to write at least three conclusions, although they may write more if they wish. To encourage creative expression, teachers may ask students to present their conclusions using the cluster method. One advantage of this approach is that students simultaneously practice drawing conclusions while also learning another instructional method in depth. Additionally, they may create diagrams and visual representations, incorporating elements of artistic expression. As a result, this method promotes interdisciplinary integration.

The **"Six Thinking Hats"** method is one of the most well-known approaches for simultaneously developing students' logical, critical, and creative thinking skills. It was developed in 1986 by the British psychologist and inventor **Edward de Bono**. The central idea of the method is that people often mix emotions, facts, assumptions, and judgments together during the thinking process, which can lead to disorganized reasoning. To address this issue, de Bono proposed the idea of focusing on only one type of thinking at a time. Therefore, he introduced six different "thinking hats," each representing a specific mode of thinking.

Meanings of the Six Hats

Hat Color	Type of Thinking	Description
○ White Hat	Fact-based Thinking	Information, data, evidence, and facts. "What do we know?" "What information is needed?"
◍ Red Hat	Emotional Thinking	Feelings, intuition, and personal impressions. "I feel this way because…"
● Black Hat	Critical Thinking	Identifying risks and weaknesses. "What are the disadvantages of this idea?"

Hat Color	Type of Thinking	Description
Green Hat	Creative Thinking	New ideas, alternatives, and innovation. "Could there be another solution?"
Blue Hat	Managing Thinking	Organizing and controlling the process. "What conclusion have we reached?"
Yellow Hat	Optimistic Thinking	Identifying benefits and positive aspects. "How is this idea useful?"

How the Method Can Be Applied in Schools

First, a problem or issue is selected, and the class is divided into six groups, or students take turns using different colored hats. Each group presents ideas according to the thinking style represented by its assigned color, either orally or in written form. The White Hat groups collect and present information, the Black Hat groups identify possible risks and weaknesses, the Yellow Hat groups highlight benefits and positive aspects, the Green Hat groups propose creative solutions, the Red Hat groups express emotions and intuitions, and the Blue Hat groups summarize the overall conclusions.

Example of Classroom Application:

Topic: "Should Students Bring Mobile Phones to School or Not?"

The groups or stages operate as follows:

○ **White Hat:** "According to statistical data, 80% of students own a mobile phone."

● **Black Hat:** "Mobile phones can be distracting, reduce concentration, and waste valuable time."

Yellow Hat: "Mobile phones provide convenient access to online educational resources and learning materials."

Green Hat: "Special educational applications can be developed specifically for mobile phones."

Red Hat: "I am afraid that my phone might get lost."

Blue Hat: "Therefore, mobile phones can be beneficial for education, but they should be used responsibly and according to established rules."

This method is one of the most effective techniques for developing creative and logical thinking, especially among students in grades 5–9. Its main pedagogical significance lies in the fact that it:

- develops students' ability to view a problem, question, or idea from different perspectives;
- helps eliminate the habit of becoming fixed on a single viewpoint;
- promotes logical operations such as comparison, argumentation, and justification;
- most importantly, contributes to the formation of a culture of democratic thinking [7].

A thorough understanding and application of this method during lessons—by selecting questions or problems related to current or previously studied topics—can be highly effective for both teachers and students. It also helps prevent lessons from becoming monotonous and repetitive, while attracting students' attention through variety and engagement.

In addition, teachers may use the **Cluster Method**, which is widely known in educational practice. This method was developed by the American scholar **Gabriele Rico** in the 1980s. According to her theory, when chains of ideas are organized visually (through diagrams or mind maps), human thinking becomes deeper and logical connections are formed more effectively.

In the Cluster Method, information and ideas are presented in a branching structure originating from a central concept. This method simultaneously develops students' creative, logical, and analytical thinking skills, clearly demonstrates cause-and-effect relationships, and enables them to understand complex topics in a systematic manner [8].

Stages of Implementation

1. Select a central concept or idea.

For example: "Logical Thinking" or "Creative Thinking."

2. Identify and write the main branches extending from the center.

These may represent key aspects or directions, such as:

- Analysis
- Comparison
- Conclusion
- Evidence
- Problem

3. Add sub-ideas to each branch.

For example, under the branch **"Analysis,"** the following sub-ideas may be included:

- identifying facts;
- finding the main cause;
- analyzing evidence;
- examining the problem.

4. Draw connecting lines between the branches.

This allows students to visualize the logical relationships among ideas and better understand how different concepts are interconnected.

In the Cluster Method, students learn to organize and systematize ideas, reveal the internal logical structure of each topic, develop skills of analysis, classification, and generalization, and learn to express their thoughts visually. At the same time, creativity and critical thinking are developed in parallel. This method can be applied in various subjects such as native language, literature, history, biology, and even mathematics. It is particularly useful in lessons aimed at developing logical thinking, especially during the stages of topic analysis and idea planning.

The relationship between the Cluster Method and logical thinking lies in its ability to strengthen reasoning by helping students identify connections between ideas. It provides practice in cognitive operations such as analysis and synthesis and teaches learners structured thinking, which forms the foundation of logical reasoning.

The effective implementation and success of any teaching method in the classroom, its ability to engage students, enhance learning, and support thinking skills, are closely related to the teacher's professional competence and creativity. This requires continuous research, pedagogical mastery, and time. One of the main reasons why courses such as Creative Pedagogy or Creative Education are currently included in higher education curricula is precisely to address this need. Through these courses, students become familiar with modern and innovative teaching methods, learn how to apply them in practice, and gradually develop the necessary pedagogical skills. This serves as an important first step in their teaching careers and provides a foundation for avoiding excessive reliance on traditional teaching approaches in the future. Ultimately, the development of students' creative and logical thinking largely depends on the teacher's ability to create an effective learning environment.

Conclusion

In conclusion, the development of students' logical and creative thinking is one of the key objectives of modern education. In this process, it is important to take into account the characteristics of brain development, particularly the functioning and maturation of the prefrontal cortex.

The study demonstrated that the "If–Then" technique, the "Analysis Chain," the Six Thinking Hats method, and the Cluster Method are effective tools for helping students understand cause-and-effect relationships, draw independent conclusions, evaluate problems from different perspectives, and develop creative approaches to problem-solving.

Furthermore, the effective use of these methods depends directly on the teacher's professional competence, pedagogical approach, and ability to organize the learning process. As a result, the extensive application of interactive teaching methods enhances student engagement, broadens their thinking capacity, and contributes to the development of independent and critical thinkers.

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