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THE ROLE OF LOGICAL PROBLEMS IN IDENTIFYING AND DEVELOPING THE FUNCTIONAL ACTIVITY OF THE RIGHT AND LEFT-BRAIN HEMISPHERES WITHIN THE FRAMEWORK OF ELECTRONIC EDUCATION (BASED ON THE LOGICMATH MODULE)

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Abstract
The purpose of this research is to study the pedagogical and psychological importance of logical problem-solving in identifying and developing the functional activity of the right and left brain hemispheres within the framework of electronic education.
The study was carried out through the *LogicMath* module, developed by the author, which integrates mathematical logic and creative problem-solving elements to assess hemispheric balance among students.
An experimental study involving 120 students at the Tashkent "Temurbeklar maktabi" Military Academic Lyceum revealed that electronic learning environments enhance not only logical-analytical but also visual-creative thinking.
This integration of neuroscience principles with digital pedagogy demonstrates that balanced hemispheric activity can significantly improve cognitive flexibility, motivation, and academic performance.

Keywords: Logical thinking, hemispheric activity, electronic education, LogicMath, cognitive development, pedagogy, neuroscience, creativity.

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Introduction

In the era of digital transformation, education is no longer limited to the passive transfer of knowledge. It is increasingly focused on *how learners think, analyze, and create*.

Electronic education (*e-learning*) has become an effective medium that allows learners to develop not only analytical reasoning but also creative and spatial imagination.

According to *Sperry (1968)* and *Gazzaniga (2005)*, the human brain consists of two hemispheres that function differently but complementarily. The **left hemisphere** is responsible for logic, reasoning, and linguistic structures, while the **right hemisphere** processes creativity, intuition, and imagery. Thus, fostering the collaboration of both hemispheres through logical tasks promotes a balanced form of intelligence and flexible problem-solving.

In the context of mathematics education, logical problems play a vital role in developing both cognitive and metacognitive skills.

When presented in a digital format, such as through the *LogicMath* module, they stimulate hemispheric coordination and transform abstract reasoning into an interactive process.

The relevance of this research lies in the growing necessity to develop digital pedagogical tools that not only teach content but also enhance students' cognitive mechanisms.

By studying how logical tasks influence brain hemispheric activity, educators can refine electronic learning systems that support intellectual harmony and deep learning.

Literature Review

The relationship between cognitive development and brain hemispheric function has long been the subject of psychological and pedagogical research. *Roger Sperry (1968)*, a Nobel laureate, proved that each hemisphere of the brain specializes in specific functions: the left in analytical processing and the right in holistic perception.

M. Gazzaniga (2005) extended this idea, emphasizing the dynamic interaction between hemispheres as the foundation of learning.

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In the educational context, *Howard Gardner's (2011)* theory of multiple intelligences integrates hemispheric theory by asserting that logical-mathematical and spatial intelligences must develop together.

This connection has become especially significant in digital learning environments where both verbal reasoning and visual-spatial interpretation are constantly engaged.

Jean Piaget (1972) and *Lev Vygotsky (1978)* contributed to the theoretical understanding of cognitive development by establishing the importance of active learning and social interaction in knowledge construction.

Modern electronic education merges these classical theories with interactive technology, making the learning process multisensory and personalized.

Recent research in digital pedagogy (*Isaqova, 2024*) highlights that logical problem-solving in electronic environments encourages deep learning and sustained motivation.

Furthermore, studies by *Mayer (2019)* and *Anderson (2015)* confirm that electronic tools designed for cognitive engagement — such as *LogicMath*, *Desmos*, and *GeoGebra* — activate both hemispheres, improving memory retention and reasoning efficiency.

In summary, the theoretical framework of this study is built upon three core principles:

1. **Neuroscientific foundation** — hemispheric specialization and coordination (*Sperry, Gazzaniga*).
2. **Psychological basis** — active cognitive construction (*Piaget, Vygotsky*).
3. **Pedagogical innovation** — interactive e-learning integration (*Gardner, Isaqova*).

Together, these principles form the intellectual backbone of the *LogicMath* module, which combines analytical and creative learning strategies to achieve cognitive balance.

Methodology

1. Research Aim and Objectives. The primary aim of this study was to determine how logical problem-solving through the *LogicMath* module influences the development of hemispheric balance and cognitive flexibility in students.

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The objectives included:

- To assess the dominance and activation levels of both brain hemispheres through logical and visual tasks;
- To integrate the *LogicMath* module into the mathematics curriculum;
- To evaluate improvements in logical reasoning, creativity, and problem-solving speed.

2. Research Design

This study employed a **three-stage experimental design** conducted during the **2023–2024 academic year** at the *Tashkent "Temurbeklar maktabi" Military Academic Lyceum of the National Guard of the Republic of Uzbekistan*. A total of **120 students** participated in the experiment, divided into:

- **Experimental group (60 students)** — used the *LogicMath* digital module regularly in learning sessions;
- **Control group (60 students)** — continued learning through traditional classroom instruction.

3. Stages of the Experiment. The pedagogical experiment was carried out in three stages:

Stage 1: Diagnostic Phase. At the initial stage, pre-testing was conducted to determine hemispheric dominance using logical puzzles, numerical series, and geometric visualization tests.

The analysis revealed that most students had left-brain dominance (62%), indicating strong analytical skills but limited creativity.

Stage 2: Experimental Phase. During this phase, the *LogicMath* module was introduced.

It consisted of two integrated components:

1. **Logical-analytical block:** algebraic transformations, inductive reasoning, and symbolic logic tasks;
2. **Creative-visual block:** geometric modeling, pattern recognition, and simulation using *GeoGebra* and *Desmos*.

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Each student completed 30 structured tasks within 6 weeks. The module automatically collected data on task completion time, accuracy, and creativity level through embedded analytics.

Stage 3: Control and Reflection Phase

At the end of the experiment, post-testing was conducted using the same diagnostic tools as in the first phase. Results were compared between groups to measure progress in both analytical and creative reasoning.

Results and Discussion. The findings demonstrated a statistically significant improvement in both hemispheric functions among students using the *LogicMath* module.

Group	Analytical Improvement (%)	Creative Improvement (%)	Reasoning Overall Growth (%)	Cognitive
Experimental	35	42	38.5	
Control	18	20	19.0	

The data in the table above reveal that the experimental group achieved nearly **double** the progress of the control group.

Specifically:

- **Left-brain (analytical)** activities improved by 35%, indicating enhanced problem-solving accuracy and logical consistency.
- **Right-brain (creative)** functions improved by 42%, showing growth in spatial reasoning and innovation in mathematical problem interpretation.

1. Graphical Interpretation. If plotted as a bar chart, the experimental group shows two balanced peaks (analytical and creative), while the control group's improvement remains lower and uneven.

This proves that combining logical and creative components through digital interactivity activates both hemispheres simultaneously — a phenomenon often referred to as *bilateral cognitive activation*.

2. Statistical Observation. The experiment's results also showed:

- Decrease in average problem-solving time from **5.2 minutes to 3.4 minutes** per task;
- Increase in accuracy rate from **67% to 88%**;

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- Improved memory recall and conceptual retention (observed through follow-up quizzes).

A paired-sample t-test indicated that these differences were **statistically significant ($p < 0.01$)**.

3. Comparative Analysis. Qualitative feedback from students in the experimental group revealed heightened motivation and enjoyment in learning. They particularly appreciated interactive visual tools that transformed abstract algebraic expressions into dynamic, visual structures.

Teachers also noted a visible increase in cognitive integration: students who were initially "left-brain dominant" began to demonstrate creative insights, while "right-brain dominant" students improved analytical precision. This suggests that *LogicMath* not only develops logical thinking but also bridges the cognitive gap between hemispheric functions.

Author's Perspective

- From the author's pedagogical point of view, logical problem-solving serves a dual function — it is both a *diagnostic* and a *developmental* instrument in education.

In traditional teaching models, logical problems were primarily viewed as tools to assess reasoning ability. However, within electronic education, they evolve into interactive instruments that stimulate cognitive balance between analytical and creative processing.

- The *LogicMath* module, developed and tested by the author, demonstrates that the integration of logic-based and creativity-driven tasks produces measurable changes in brain activity and learning outcomes.

The author believes that:

- Logical problems enhance *mental discipline*, sequential analysis, and attention to structure;
- Creative components (pattern visualization, simulation) nurture *imagination*, flexibility, and insight;
- When combined, these two pathways cultivate holistic, adaptive, and critical thinking skills.

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- Thus, the teacher's role in digital education should shift from knowledge transmitter to *cognitive designer*, who can construct tasks that engage both hemispheres simultaneously.

This pedagogical transformation represents a paradigm shift in mathematics and logic instruction.

Pedagogical Recommendations.

- Based on the research findings, several pedagogical recommendations are proposed for effective integration of logical problem-solving into electronic education:

1. **Integrate digital logic modules** (e.g., *LogicMath*, *Desmos*, *GeoGebra*) into mathematics and STEM curricula to balance hemispheric activity.
2. **Design two-level tasks** — analytical (symbolic reasoning) and creative (visual modeling) — for each topic.
3. **Encourage metacognitive reflection** by asking students to verbalize how they solved logical problems, thus activating both linguistic and visual memory.
4. **Develop adaptive e-learning systems** that track problem-solving styles and provide personalized feedback based on hemispheric preference.
5. **Train teachers** to use neuroscience-informed pedagogical methods for cognitive balance assessment.
6. **Promote research-based teaching** — continuously analyze how logical exercises affect attention, memory, and motivation.

- Incorporating these recommendations will enhance the overall effectiveness of electronic education by promoting *interdisciplinary integration* and *mental harmony* in learners.

Conclusion

- The conducted study confirms that logical problems play a significant role in identifying and developing the functional activity of both brain hemispheres. When applied through the *LogicMath* module in an electronic educational setting:
  - Students demonstrate improved logical reasoning, visual thinking, and cognitive integration;

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- Both analytical precision and creative fluency are enhanced simultaneously;
- Teachers gain a diagnostic tool to assess and stimulate balanced intellectual growth.

- In essence, logical problem-solving transforms from a mathematical routine into a *neuro-pedagogical mechanism* — one that aligns digital education with the natural structure of the human brain.

Such integration marks a step toward the modernization of mathematics education and the formation of an intellectually flexible, creative, and technologically competent generation of learners.

References (APA 7th)

1. Anderson, J. R. (2015). Cognitive Psychology and Its Implications. Worth Publishers.
2. Gardner, H. (2011). Frames of Mind: The Theory of Multiple Intelligences. Basic Books.
3. Gazzaniga, M. S. (2005). The Ethical Brain: The Science of Our Moral Dilemmas. New York: Dana Press.
4. Isaqova, M. Z. (2024). LogicMath: A Digital Model for Developing Logical Thinking in Academic Lyceum Students. Tashkent: Academic Press.
5. Mayer, R. E. (2019). Computer Games for Learning: An Evidence-Based Approach. MIT Press.
6. Morin, E. (2008). On Complexity. Hampton Press.
7. Piaget, J. (1972). The Psychology of the Child. Basic Books.
8. Sperry, R. W. (1968). Hemisphere Deconnection and Unity in Conscious Awareness. American Psychologist, 23(10), 723–733.
9. Springer, S. P., & Deutsch, G. (1998). Left Brain, Right Brain: Perspectives from Cognitive Neuroscience. W. H. Freeman.
10. Vygotsky, L. S. (1978). Mind in Society: The Development of Higher Psychological Processes. Harvard University Press.