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ANALYSIS OF THE INFLUENCE OF MENTAL ARITHMETIC LESSONS ON THE INTELLECTUAL AND CREATIVE ABILITIES OF CHILDREN

Summary. *The article is devoted to an experimental study aimed at identifying the features of the influence of mental arithmetic classes on the mental and creative abilities of children aged 7–9. The relevance of the topic is determined by the growing interest in accelerated development programs that allow developing in younger students not only computational skills, but also creative thinking, auditory and visual memory, and reaction speed. The novelty of the study lies in the integrated approach, which highlights the dynamics of key indicators (auditory memory, arithmetic speed, and creativity indicators) and analyzes their relationship with the systematic practice of counting on an abacus. The work describes intermediate and final results, analyzes parent questionnaires, and conducts interviews with teachers. Particular attention is paid to monitoring children's fatigue and ability to come up with innovative solutions. The work aims to illustrate how parallel activation of the left and right hemispheres through mental arithmetic techniques affects the formation of cognitive interest. To achieve the goal, a comparative method, source analysis, and statistical data processing were used. The publications of researchers indicating the positive effect of interhemispheric interaction were studied. The conclusion describes the results of the experiment and the prospects for introducing mental arithmetic into school practice. The article will be useful for*

teachers, psychologists, and parents looking for innovative ways to develop children's intellectual resources.

Key words: *mental arithmetic, abacus, intelligence, creativity, imagination, auditory memory, experiment, primary school age, interhemispheric connections, pedagogical methods.*

Introduction. The modern education system is increasingly oriented toward methodologies that facilitate the accelerated development of various cognitive functions in young school-aged children. The relevance of this topic is explained by the growing demand for tools that promote the harmonious development of intellectual and creative abilities. One such tool is mental arithmetic training, which involves calculations on an abacus with a subsequent transition to imaginary operations.

The aim of this study is to determine how regular mental arithmetic practice influences the cognitive and creative characteristics of children and to assess the potential for integrating this methodology into everyday educational activities.

To achieve this objective, the following tasks were identified:

- Examine the dynamics of memory and arithmetic skill development through regular abacus practice.
- Assess changes in creativity levels and the ability to find unconventional solutions among children aged 7–9.
- Identify the pedagogical conditions under which mental arithmetic techniques yield the greatest effect on intellectual and creative development.

The scientific novelty of this study lies in the evaluation of a range of parameters, including auditory memory, calculation speed, and creativity level. Additionally, it provides a detailed analysis of how the activation of interhemispheric connections contributes to the formation of creative potential and cognitive initiative in young schoolchildren.

Materials and Methods. To substantiate the use of mental arithmetic for the development of children's intelligence and creativity, existing research findings were analyzed, including the work of A. Mauleshev [5], who proposed using unconventional forms of mental calculation to enhance preschoolers' motivation for learning; Yu.A. Novoselov [6], who described methodological approaches to brain development through soroban-based calculations; Yu.V. Skorobogatova [7], who investigated the effect of mind fitness techniques, including mental arithmetic, on cognitive processes. U. Treff [1] analyzed the relationship between numerical abilities and cognitive skills in young schoolchildren, concluding that the development of both components is essential for improving arithmetic performance. Z. Savcheva [2] examined the impact of mental arithmetic on children's intelligence and noted a positive trend in the development of their cognitive abilities. D. Liu [3] explored the "schematic" approach to teaching mental calculation and found that the use of visual schemes enhances both the speed and accuracy of calculations. A. K. Mynbaeva [4] investigated the formation of creative skills in schoolchildren within self-awareness lessons and concluded that creative tasks are necessary to stimulate imagination. E. Yauk [8] analyzed creative thinking in the process of solving mathematical problems and determined that flexibility and originality skills depend on students' foundational mathematical preparation.

The practical part of the study employed a comparative method, statistical data analysis, and a review of surveys and questionnaires completed by parents and teachers. To evaluate progress, psychological and pedagogical techniques were used to measure indicators of memory, calculation speed, creativity, and cognitive engagement in children. The obtained results were compared between the control and experimental groups, where the experimental group participated in abacus-based training while the control group followed a traditional educational curriculum.

Results. The study examined the level of mastery in mental arithmetic and the dynamics of cognitive and creative development in 118 children aged 7–9. The participants were divided into a control group and an experimental group (58 and 60 children, respectively), with observations conducted over one academic semester under identical instructional conditions.

Educators introducing students to mental arithmetic techniques followed a structured system of arithmetic training using an abacus. Children gradually learned to manipulate the beads, first physically and then mentally, by visualizing schematic representations of calculations. Interaction with visual numerical models was incorporated into the standard calculation program, which helped students maintain concentration and reinforced memory retention. Teachers maintained logs documenting changes in calculation accuracy, while psychologists monitored the children's cognitive processes and creative expressions.

A parental survey was conducted to assess the perceived impact of mental arithmetic on the development of creative problem-solving skills. Analysis of the questionnaires revealed that over 62 percent of respondents observed increased curiosity in their children and a greater willingness to explore unconventional solutions. This cognitive adaptability was reflected in their ability to formulate conclusions more quickly, display ingenuity in storytelling, and retain diverse types of information in memory.

At the initial stage of the experiment, children were introduced to the abacus structure and trained in transitioning to mental calculations, followed by memory training exercises. Table 1 presents the baseline indicators recorded before the start of the main study.

Table 1

Baseline indicator values in the groups (M±m) (Source: compiled by the author based on original research)

Research parameter	Experimental group (n=58)	Control group (n=60)
Auditory memory level (points)	25.13±1.20	24.90±1.18
Arithmetic calculation speed (problems/min)	11.72±0.95	12.03±0.91
Creativity index (points)	43.10±2.04	42.78±2.00

At the start of the experiment, there was no significant difference between the groups, indicating a comparable baseline level. Educators noted a consistent increase in attention span as students practiced abacus-based calculations, leading to the implementation of daily repetition exercises for specific arithmetic blocks. After two months, children in the experimental group were given tasks with varied numerical sets, along with auditory memory assessments. Table 2 presents the results of the interim testing.

Table 2

Interim assessment results (after 2 months) (Source: compiled by the author based on original research)

Parameter	Experimental group (n=58)	Control group (n=60)
Auditory memory level (points)	32.55±1.72	27.39±1.33
Arithmetic calculation speed (problems/min)	26.90±1.30	16.40±1.20
Number of original solutions (units)	5.28±0.96	3.75±0.74

The dynamics in the experimental group were more pronounced, aligning with the thesis that systematic practice in mental calculations over time leads to improved memory [5]. Most children demonstrated the ability to maintain a high

problem-solving pace, whereas participants in the control group largely remained at their initial levels.

After six months of systematic abacus-based calculations, a significant increase in creativity was observed among a large portion of the participants. Children increasingly applied unconventional approaches to solving story problems and adapted more quickly to numerical workloads. The final analysis is presented in Table 3.

Table 3

Final data after six months of training (Source: compiled by the author based on original research)

Parameter	Experimental group (n=58)	Control group (n=60)
Auditory memory level (points)	38.64±1.90	30.27±1.42
Arithmetic calculation speed (problems/min)	43.10±1.85	21.14±1.25
Creativity index (points)	56.00±2.17	46.03±1.95

Specialists indicate that increasing the volume of proactive abacus training enhances performance across diverse student categories. With regular training, children demonstrate higher speed in perception and greater accuracy in calculations [6]. The experimental group outperformed the control group in nearly all aspects, with a more noticeable contrast among students who consistently attended additional sessions and completed visually guided arithmetic exercises at home.

Discussion. The study revealed that children aged 7–9, while mastering abacus-based calculations, demonstrated progress in calculation speed, short-term memory, and the ability to find non-trivial solutions. These findings align with data suggesting that training in mental arithmetic improves the quality of mathematical knowledge and enhances working memory in young schoolchildren

[1]. Moreover, participants in this study exhibited not only increased computational accuracy but also greater originality in problem-solving, which corresponds with results indicating that targeted training in early school years leads to improved intelligence levels and readiness for productive thinking [2].

The study placed particular emphasis on combining visual and tactile engagement with the abacus, which correlates with an approach that advocates the use of "schemes" in arithmetic instruction, focusing on repetitive exercises and meaningful reinforcement [3]. In the control group, which did not practice abacus-based calculations, performance improvements were moderate, whereas the experimental group demonstrated accelerated development of auditory and visual memory, along with increased readiness for solving complex problems. The integration of interactive methods into lessons aligns with experimental findings showing that creative exercises in the classroom foster imagination and independent reasoning [4].

The most pronounced improvement in problem-solving flexibility was observed among students who consistently attended abacus training. Participants with higher initial cognitive abilities displayed significant adaptability in selecting arithmetic operations, which corresponds with findings that children with strong mathematical skills exhibit fluid reasoning and a variety of strategies, although originality in solutions may sometimes be lacking [8]. Students with an average starting level in mathematics showed progress in calculation speed but required more time to develop a stable skill. Those with lower initial results needed extended learning periods and experienced difficulties in independently transferring mental calculation skills. These observations are consistent with existing evidence suggesting that systematic practice and reliance on specialized methodologies can enhance computational efficiency and encourage a creative approach to numerical problem-solving [1; 3].

To assess intellectual performance in the groups, a comprehensive set of tests was used, including tasks for short-term numerical sequence recall, auditory

memory assessment, and logical sequence construction. The average score in the experimental group increased by 27.53% by the end of the experiment, compared to 12.18% in the control group. Children who practiced mental arithmetic began processing tasks more quickly, accurately recalled numbers in both forward and reverse order, and navigated problem scenarios more effectively. Participants in this study demonstrated precisely this effect: when presented with dictated numbers, they efficiently reconstructed sequences in both direct and reverse order.

The assessment of creative abilities was conducted using well-established psycho pedagogical methodologies, both verbal and non-verbal. For instance, tasks included generating story continuations and creating unique drawings from template shapes. The creativity index was calculated based on flexibility, originality, and fluency of ideas. The average score in the experimental group increased from 43.17 before the study to 56.02 after, indicating a significant improvement. In contrast, the control group's scores ranged from 42.11 to 46.09. The specific contribution of mental arithmetic to creativity development was confirmed by statistical data analysis ($p < 0.05$).

A separate analysis focused on problem-solving abilities requiring unconventional approaches in mathematical tasks. Teachers presented children with short logical problems that required ingenuity. The experimental group demonstrated a higher frequency of original solutions (65.4%), while creative findings were observed less frequently in the control group (approximately 38.7%). This effect was reinforced by participants' own remarks, as they reported reduced anxiety when working with multi-digit numbers or complex combinations.

Positive changes were also observed in overall classroom engagement. Many children became more confident in raising their hands and initiating discussions in group settings. According to teachers, approximately 53% of children in the experimental group took the initiative more frequently in project

work, whereas this behavior was observed in only 27% of the control group. Similar findings were documented in another study, which noted that systematic mental arithmetic practice enhances concentration and psychological resilience [7]. Collectively, these developments reflected an increased interest in creative activities.

Throughout the experiment, phased observations were conducted to assess student fatigue, specifically measuring the time required for cognitive recovery after intensive mental exertion. After three months of systematic abacus exercises, the duration of effective concentration increased by approximately 35% compared to the initial stage, whereas the control group showed only a 14% improvement. This indicates a higher level of self-regulation development in students practicing sensory-motor manipulations with abacus beads. According to experts, the specific hand movements combined with simultaneous mental visualization of numbers channel cognitive energy and stimulate children's imagination [5]. The cumulative results of fatigue observations confirmed that the integration of parallel visual, auditory, and tactile stimuli influences children's cognitive endurance.

In addition to tests and observations, discussions were conducted with teachers. The majority noted that children practicing mental arithmetic exhibited noticeable concentration in other subjects. Approximately 46% of educators also observed additional benefits for musical or artistic achievements. These opinions align with the idea that visualizing numbers and engaging both hemispheres of the brain form a foundation for the overall development of creative abilities. After six months of training, teachers highlighted an accelerated perception of large volumes of information, which facilitated students' preparation for tests and enabled more productive use of lesson time.

Psychologists analyzing statistical results emphasized the correlation between training intensity and significant changes in performance. More frequent sessions (at least three hours per week) were associated with the highest growth

in cognitive and creative potential, while absences led to delays in forming automated skills. In contrast, one-time consultations did not produce similar effects, even in cases of high motivation. This finding confirms the importance of systematic practice in mastering mental arithmetic on the abacus.

The use of supplementary tasks such as tables, picture-based lotto, rhythmic exercises, and auditory number reading further enhanced positive outcomes. Students who initially struggled with arithmetic operations began to show progress after adjustments in instructional methods, including a combination of abacus demonstrations, flashcards, and exercises linking numbers to appropriate visual representations. According to students, such varied activities helped maintain their interest. Other studies have reported similar findings, indicating that when children physically manipulate the abacus beads, they learn arithmetic operations significantly more effectively than through traditional methods. Reformulating exercises served as an additional stimulus, helping students overcome recurring mistakes.

Some students in the experimental group also participated in dance or art classes. These students exhibited enhanced spatial imagination and cognitive flexibility, likely due to increased involvement of the right hemisphere. Such parallel learning contributed to greater resilience to mental workloads and unlocked additional cognitive potential.

When analyzing the study results, factors such as students' initial intellectual level and family environment were considered. Half of the experimental group participants had arithmetic skills at or below the average level at the start of the study. After six months, 74% of this subgroup had reached at least a confident proficiency level. In contrast, only 39% of the control group achieved a similar improvement. Statistical comparisons confirmed a consistent trend across different locations where the training was conducted.

Thus, a series of observations in the experimental group revealed significant progress in several areas: auditory and visual memory, creativity,

intellectual performance, reaction speed, and communicative activity. In the control group, changes were less pronounced, which aligns with findings on the benefits of multisensory learning and the simultaneous engagement of logical and visual processing structures in the brain. It was noted that students who entirely avoided mental arithmetic training were less likely to demonstrate speed and accuracy in calculations. Most of them also showed little inclination toward independent problem-solving or creative exploration.

Conclusion. The conducted study confirmed that regular mental arithmetic training significantly improves key cognitive parameters, including auditory and visual memory, calculation speed and accuracy, and creativity. After six months of practice, a portion of students who initially demonstrated average or low performance showed substantial progress, indicating the versatility of this method.

The following conclusions were drawn based on the study objectives:

- Systematic abacus exercises contributed to the development of rapid numerical information processing skills and enhanced the ability to retain extended numerical sequences in memory.
- A positive dynamic in creative potential was identified, associated with improved imagination and an increased tendency to seek unconventional solutions.
- The most significant results were achieved when regular training incorporated both logical and visual processing structures in the brain, along with active support from teachers and parents, which reinforced skill retention.

Thus, mental arithmetic can be effectively integrated into educational curricula or supplementary learning programs, providing children with expanded opportunities to develop their intellectual and creative potential.

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