UDC 37.378
IRSTI 14.23.17
https://doi.org/10.48371/PEDS.2025.78.3.037

PEDAGOGICAL CONDITIONS FOR THE FORMATION OF ALGORITHMIC SKILLS IN PRESCHOOL CHILDREN IN THE PROCESS OF TEACHING THE BASICS OF MATHEMATICS

Azimbayeva D.[1], Kyyakbayeva U.[2], *Aitpayeva A.[3]
[1,2,*3] Abai Kazakh National Pedagogical University, Almaty, Kazakhstan

Abstract. In contemporary society, fostering algorithmic abilities in preschool children is regarded as an increasingly significant yet insufficiently studied issue. A key characteristic of preschool age lies in the fact that children encounter most knowledge and experiences for the first time, while their personal background is too limited to provide a reliable foundation for learning. In the early stages of learning, mastering elementary algorithmic operations, viewed as generalized ways of acting, becomes a prerequisite for advancing to more complex forms of knowledge.

This article examines the current state of the problem related to the development of algorithmic abilities in preschool children. Drawing on an analysis of psychological, pedagogical, and methodological studies addressing this topic, the authors propose a model for teaching the fundamentals of mathematics aimed at strengthening algorithmic abilities in preschoolers. The effectiveness of this model is confirmed through the use of specific tools designed to build algorithmic skills, including task-based games, games with incomplete action structures, quest activities, rule-based games, and integrated tasks.

Key words: algorithmic abilities, senior preschool children, teaching aids, games, conditions for the formation of algorithmic skills, teaching model, the process of teaching the basics of mathematics

Introduction

The issue of establishing pedagogical conditions that support the development of algorithmic abilities in senior preschool children during the process of learning the fundamentals of mathematics occupies a significant place in contemporary pedagogical theory and practice, Properly organized conditions in this area are a key factor influencing not only children's cognitive growth, but also their physical, psychological, and social progress. Within the education system of Kazakhstan, one of the central objectives is to raise the quality of preschool upbringing and instruction while simultaneously creating favorable environments that promote children's all-round development.

The Law of the Republic of Kazakhstan "Concerning Education" [1], the National Mandatory Standard for Preschool Upbringing and Education [2], along with additional normative documents governing preschool education, all emphasize the importance of providing a supportive environment for the comprehensive growth of children, These documents collectively underline the necessity of creating conditions that ensure the effective development of each child in preschool institutions.

Among the methodological challenges of preschool pedagogy, the task of cultivating algorithmic abilities remains one of the least investigated, The concept of algorithmic abilities itself is infrequently used and lacks a single, universally accepted definition. It is most often encountered in relation to mathematics and computer science (A.B.Kolmogorov [3], V.A.Krutetsky [4], N.B.Istomina [5], A.A.Stolyar [5], G.E.Sycheva [6], and others), Research into the development of algorithmic thinking, abilities, and culture in children of various ages has been conducted by A.V.Goryachev [7], L.V.Voronina, E.V.Korotaeva [8], J.A.Kadirov [9], A.A.Stolyar [10], S.D.Yazvinskaya [11], T.Havlaskova [12], K.Meterbaeva [13], E.A.Utyumova [14], among others.

A closer examination demonstrates that algorithmic approaches have universal applications, extending beyond mathematics and computer science into virtually every sphere of human activity. In this context, abilities in algorithmic thinking acquire special significance as they enhance the developmental impact of education. They help children learn to decompose complex tasks into elementary steps, organize these steps into a coherent system, plan their activities systematically, follow prescribed rules, articulate their actions using appropriate language, and creatively adapt familiar algorithms in line with their own abilities and interests.

For this reason, teachers must employ advanced professional competencies to structure learning activities effectively, considering both the needs and interests of children while introducing them to the foundations of mathematics.

Research in this field makes it possible to view algorithmic skills from two distinct perspectives. On the one hand, they function as learning abilities - the capacity to master mental actions, rapidly assimilate knowledge, acquire skills, and adopt strategies for action. On the other hand, they can also be seen as creative abilities, enabling children to reconfigure familiar algorithms, devise original approaches to solving problems, and generate outcomes that are personally meaningful. This dual-level framework is also reflected in the works of many psychologists and mathematicians.

According to the national report "Accessible Quality Education for Everyone" prepared by the Ministry of Education of the Republic of Kazakhstan, Organizing pedagogical conditions that promote the development of algorithmic abilities in older preschoolers through mathematics teaching is key for ensuring their holistic growth, both individually and socially.

The effectiveness of creating pedagogical conditions for developing algorithmic abilities in preschoolers is determined by two essential factors: the professional preparedness of teachers and the active participation of children in educational processes. Preschool institutions are designed to provide a safe and stimulating environment that supports growth and development, while also enabling educators to design programs that correspond to the individual needs of every child. From the standpoint of a personality-oriented approach, many researchers emphasize that algorithmic skills allow children to successfully handle cognitive challenges by applying mastered generalized methods of action (algorithms) [14]; to creatively adapt these algorithms in line with their own abilities, inclinations, and interests; to independently choose learning strategies [9]; and to select problem-solving methods based on efficiency and rationality while building confidence in their capabilities [9].

Since preschoolers are exposed to most knowledge for the first time and have minimal personal experience, their learning must begin with simple algorithms treated as common action patterns, which form the base for mastering later educational tasks.

Psychologists and educators note that mastering a defined sequence of actions is essential for children, since any form of activity initially requires technical skills and basic competencies. Only after these are acquired can children achieve original and meaningful outcomes. Abilities reveal themselves in practice, and their analysis should be conducted by considering which psychological characteristics are most conducive to mastering the required activities, E.V.Bondarevskaya emphasizes that personality viability under modern conditions is formed by two components: acquired algorithms and readiness for their modification, i,e,, creativity.

A number of researchers also point out that the development of algorithmic abilities in preschool children is closely related to the general intellectual development of the child, as it stimulates memory, attention, imagination, and the ability to analyze and compare. The acquisition of algorithms at this age not only prepares children for the study of mathematics at school but also serves as a foundation for forming independence in decision-making, perseverance in achieving goals, and flexibility in finding alternative solutions. Thus, algorithmic abilities can be regarded as a universal quality that ensures readiness for learning across various domains and promotes the successful adaptation of the child to the requirements of modern education.

Analysis of psychological, pedagogical, and methodological research by L.V.Voronina and A.A.Stolyar has allowed clarification of the concept of algorithmic abilities. These are defined as the capacity to set goals, plan activities, follow rules or patterns, implement and apply algorithms, correct actions directed toward results, transfer established algorithms to new situations or activities, and explain algorithmic operations in language that is comprehensible to others.

Synthesizing the findings of researchers such as A.V.Beloshista, A.V.Goryachev, T.I.Erofeeva, M.P.Lapchik, Z.A.Mikhailova, S.E.Tsareva, and S.D.Yazvinskaya has made it possible to outline the structural components of algorithmic skills that can and should be developed in preschool children through mathematics instruction:

Cognitive component: the ability to follow an algorithm and apply instructions in solving mathematical tasks; the ability to perform algorithms of mathematical operations such as counting, measuring, and sequencing; the ability to use studied algorithms to solve similar problems; and the ability to employ visual models (schemes) that represent the sequence of algorithmic steps. Communicative component: the ability to cooperate with peers and adults while executing or constructing algorithms in mathematical problem-solving; the ability to articulate algorithmic actions using clear and appropriate language; and the ability to justify one's actions when composing or performing an algorithm.

Regulatory component: the ability to set goals for upcoming activities; to identify and correct errors in an algorithm independently or with guidance; to evaluate outcomes against objectives; and to exercise monitoring, self- monitoring, and correction when creating or implementing algorithms in mathematics.

The theoretical foundations for forming algorithmic abilities developed by A.K.Aitpayeva, A.B.Akpayeva, L.A.Lebedeva, and S.N.Zhienbaeva support the assertion that preschool age represents a sensitive period for cultivating these abilities through mathematical material.

The contributions of these scholars significantly informed our study in identifying the need to enhance pedagogical conditions for the development of algorithmic abilities in older preschoolers during mathematics instruction. Based on an analysis of scientific and methodological literature, we identified several key principles.

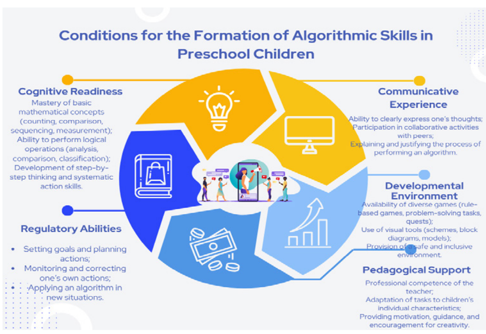

Fig.1 Conditions for the Formation of Algorithmic Skills in Preschool Children

The formation of algorithmic skills in preschool children is a complex pedagogical and psychological process that requires the integration of several interrelated conditions. These conditions ensure not only the acquisition of mathematical knowledge but also the development of a child's cognitive flexibility, communicative competence, self-regulation, and capacity for creative problem-solving.

Cognitive readiness is the foundation upon which algorithmic skills are built. At this stage, children must acquire basic mathematical concepts such as counting, comparison, sequencing, and measurement. Equally important is the development of logical operations—analysis, comparison, and classification—which allow children to structure information meaningfully. Through systematic exercises, children strengthen step-by-step thinking, enabling them to follow algorithms consciously and reproduce them in new contexts. Cognitive readiness therefore creates the intellectual basis for understanding the essence of algorithms and for applying them in practice.

Algorithmic abilities cannot fully develop in isolation. A key pedagogical condition is the child's active communicative interaction with peers and adults. Participation in collaborative games, group problem-solving, and pair work fosters the ability to express thoughts clearly, explain the logic of actions, and justify solutions. This communicative component not only enhances verbal reasoning but also promotes social adaptation. As children articulate their reasoning processes, they internalize algorithmic operations more effectively and learn to transfer them into verbal, symbolic, and practical forms.

Self-regulation plays a decisive role in consolidating algorithmic skills. Children must learn to set goals, plan their actions, and monitor and adjust their behavior in accordance with the requirements of a given task. Techniques such as graphical dictation, sequential pictures, and step-by-step modeling encourage the development of goal-directed behavior. Importantly, the ability to evaluate outcomes against set objectives ensures that children do not merely imitate algorithms but consciously understand their structure. Regulatory abilities thus cultivate independence, perseverance, and responsibility, preparing children for the challenges of schooling.

The quality of the developmental environment is a significant determinant in shaping algorithmic abilities. An effective environment provides children with diverse opportunities to engage in rule-based games, problem-solving tasks, and quests. Visual aids, including schemes, block diagrams, and models, are essential for representing the structure of algorithms in accessible forms. Furthermore, a safe and inclusive environment ensures that all children, regardless of individual characteristics or special needs, can participate equally in algorithmic activities. By enriching the environment with sensory stimuli, constructive play materials, and digital tools, educators foster conditions conducive to experimentation, creativity, and discovery.

Finally, the effectiveness of all other conditions depends largely on the professional competence of the teacher. Pedagogical support entails adapting tasks to children's developmental needs, differentiating the level of complexity, and motivating learners through encouragement and guidance. Teachers must not only instruct but also act as facilitators, creating situations in which children can explore, test, and refine their algorithmic reasoning. Moreover, the integration of innovative teaching methods—problem-based learning, heuristic conversation, and project-based activities—reinforces the child's ability to generalize and creatively apply algorithms in new

Taken together, these five conditions form a holistic framework for the development of algorithmic skills in preschool children. Cognitive readiness ensures the intellectual foundation, communicative experience enhances collaborative learning, regulatory abilities establish self-control, the developmental environment provides resources and opportunities, and pedagogical support guarantees guidance and professional structuring of the process. The synergy of these factors makes it possible to cultivate algorithmic thinking as both a cognitive and creative ability, thereby preparing children for successful adaptation to the demands of modern education and society.

To structure the process of mathematics education with a focus on algorithmic ability formation in preschool children, a model was developed (Fig, 1) consisting of five interconnected blocks:

Target block – specifies the focus of mathematics teaching methodology on developing algorithmic skills in preschoolers.

Methodological block – reflects the key approaches and principles guiding the construction of methodology.

Content block – outlines the subject matter and content at each stage of mathematics instruction methodology.

Procedural block – incorporates the main tools, forms, and methods applied both in teacher–child interaction and peer collaboration to foster algorithmic skills.

Result block – provides instruments for monitoring and evaluating the extent of algorithmic skill development in children.

This model is grounded in the theoretical and methodological principles of the personality-oriented, activity-based, and integrative approaches. Drawing on the analysis and generalization of didactic principles of content formation (consistency, accessibility, advanced learning, and continuity), along with the unique characteristics of preschool education, we formulated three methodological principles. These principles shape both the structure of mathematics content and the organization of the educational process aimed at cultivating algorithmic skills in preschoolers:

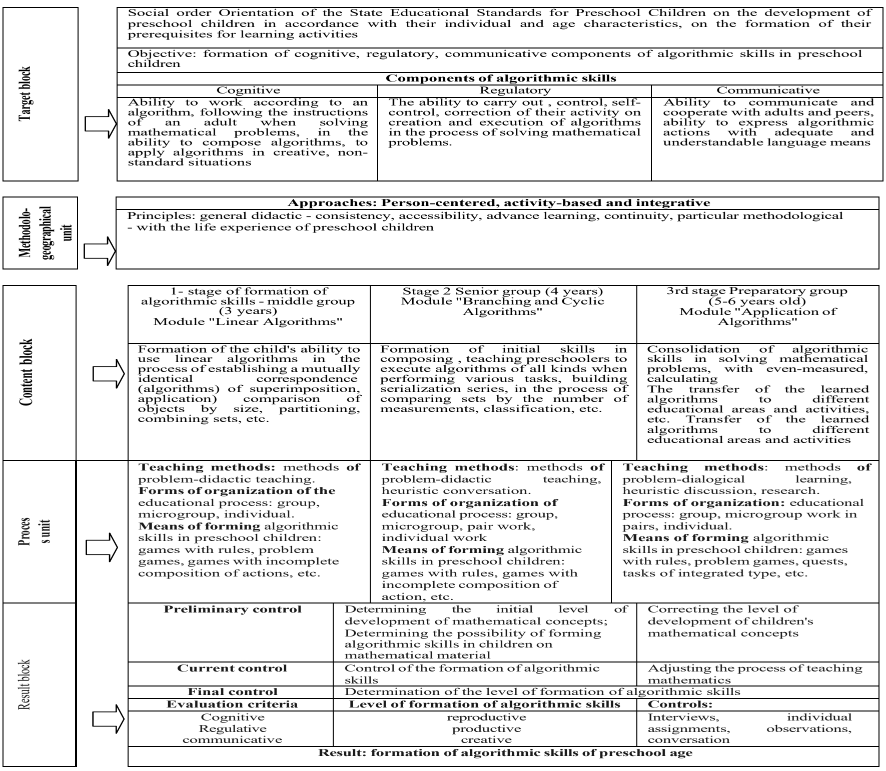

Fig. 2. Model of teaching mathematics with the aim of developing algorithmic skills in preschool children

1. The principle of generalization implies highlighting the main objective that underlies the construction of the teaching material.

2. The principle of phasing stipulates the necessity of stage-by-stage formation of algorithmic skills in the process of learning mathematics, which requires the transition from the execution and creation of sequential algorithms to cyclic and branching ones in the development of quantitative, numerical, geometric, spatial, temporal, and magnitude representations.

3. The principle of linking algorithmic activity in the process of teaching mathematics with the life experience of preschool children implies the purposeful inclusion of tasks that link mathematical objects and concepts under study with the surrounding life.

The analysis of the structure of algorithmic skills and in accordance with the requirements of the State Standards of Education for Children's Education to the content of the educational program allowed us to justify the following requirements:

1. Learning tools that are used in the educational process and in children's independent activities should create a developing subject-space environment to ensure the algorithmic activity of preschoolers.

2. Learning tools should condition the learning of the mathematical material being studied in the process of performing or creating an algorithm to achieve a goal in a game.

3. The content of the game, game task should be adequate to the age capabilities of children and the algorithmic skills being formed.

4. Teaching aids used for learning a new algorithm by preschoolers should contain a complete indicative basis of actions for its assimilation, application in new conditions and types of children's activities.

This study introduces the concept of " the instructional basis for algorithmic actions", which means the orienting basis of actions in the process of executing, composing and transforming algorithms when solving mathematical problems.

It has been revealed that training in the implementation of simple sequential procedures should be based on the orientation basis of the third type, in accordance with the theory of phased formation of mental actions of P.Y.Galperin, N.F.Talyzina, Under the guidance of the tutor, new algorithms are systematically taught with division into stages (steps), allocation of reference actions and conditions for their correct execution. As the algorithm is mastered, the share of children's independent activity in applying the algorithm increases.

Materials and Methods

In the course of the study we identified and tested various means of developing algorithmic abilities in preschool children, including problem games which are based on the creation of a problematic situation, games with an incomplete action structure where part of the necessary steps to achieve the goal is deliberately omitted, quests that require children to search for the final solution starting from an initial idea and goal using a branching conditional algorithm, and games with rules that rely on a structured system of requirements and conditions forming the basis of the game content. The analysis carried out in the research shows that the development of algorithmic skills must take place within an organized educational process structured in three sequential modules.

The first module, referred to as linear algorithms, corresponds to the stage of early preschool education and is aimed at children of about three years of age. At this level the main task is to develop the ability to perform linear algorithms when solving simple mathematical problems, to retain the goal of the activity, to monitor and adjust one's own actions with the assistance of an adult, and to explain the execution of a linear algorithm in accessible language. The basic mathematical structures studied at this stage include simple rules of comparison and superimposition, basic counting, elementary comparison of sizes and the construction of ordered series with up to five objects. Instruction is organized through problem-dialogic methods which allow children to participate in the invention of new knowledge and to form an elementary understanding of sequences of actions.

The second stage, devoted to conditional and iterative algorithms, addresses senior preschoolers and emphasizes building skills for creating and applying more advanced algorithmic patterns. At this stage children are expected to learn how to compose algorithms of different kinds and represent them with the help of flowcharts. The mathematical structures studied here include the construction of series in ascending or descending order with five to ten items, indirect comparison of objects by means of a conditional measure, as well as the use of logical methods of classification and comparison. In addition to problem-dialogic techniques, The heuristic dialogue technique is applied to help children step by step reveal algorithmic processes and detect consistent patterns while solving problems.

In the third module, preschoolers in the preparatory class focus on applying algorithms, with intended to strengthen and extend the algorithmic understanding accumulated during previous phases of learning. Here children study mathematical structures in the form of algorithms for solving simple arithmetic problems, algorithms for weighing objects by hand, and algorithms for measuring quantities with conventional and improvised measuring devices. The main task of this module is to expand the scope of employment of algorithms, to transfer acquired skills to various educational areas, and to integrate them through practical activity. Repeated application of the studied sequences of actions to similar tasks fosters the development of the ability to establish analogies and forms the prerequisites for school learning. At this stage, the teacher uses problem games, games with rules, and games with incomplete action structures, while gradually increasing the share of independent work performed by children. In addition to problem-dialogic and heuristic methods, the research method is actively applied, which encourages children to discover new knowledge independently and to create their own algorithms when solving mathematical problems.

The process of forming cognitive, regulatory, and communicative components of algorithmic abilities within mathematics teaching is organized in four stages: goal-setting, planning, implementation, and reflection. The goal-setting stage includes the creation of psychological readiness for play activity, verification of preparedness for the lesson, and establishing the connection of the current activity with prior experience. The planning stage involves analyzing the situation, presenting the material in a problem form through dialogue, discussing possible solutions and hypotheses for overcoming the difficulty. The implementation stage consists in continuing the game situation, where children apply new algorithms to solve mathematical tasks, taking into account conditions that emerged in the previous phase. The reflection stage requires children to compare their results with a standard model, to engage in self-control and self-assessment, and to make corrections when necessary, with the teacher demonstrating the standard to guide the evaluation.

Considering the identified structure of algorithmic abilities and the content of mathematics education in preschool organizations, the study defined levels, indicators, and criteria for assessing the development of these skills. Three levels were distinguished:

reproductive, productive, and creative. At the reproductive level, children demonstrate the ability to use acquired algorithms and logical operations in familiar situations, while the independent construction of algorithms is possible only with some assistance from the teacher. At the productive level, children are able to apply algorithms more independently, to create their own solutions for mathematical tasks, and to perform successfully in standard situations. At the creative level, preschoolers are capable of applying algorithms flexibly in both typical and non-standard situations, independently devising algorithms for problem-solving, and showing initiative in generating new solutions.

The results obtained in the course of the experiment confirm that the application of the proposed methodology of mathematics teaching ensures the formation of algorithmic abilities in preschool children and contributes to the growth of their mathematical knowledge. Moreover, the systematic use of this approach stimulates cognitive activity, enhances independence, and prepares children for successful learning at school.

Results and Discussion

A special methodology aimed at developing algorithmic abilities in preschool children was designed and tested within the framework of a pedagogical experiment. A total of 211 children participated in the study: 105 children in the control group and 106 children in the experimental group.

The control group was taught according to the traditional state curriculum, while the experimental group was introduced to the new methodology. The methodology incorporated problem-based games, rule-based games, quests, tasks with incomplete action structures, as well as integrated activities.

As a result of the experiment, the algorithmic abilities of children were analyzed across three key components: **cognitive, communicative, and regulatory**.

Table 1 – Comparative Indicators of the Development Levels of Algorithmic Abilities

Components	Levels	Control group (n=105)	Experimental group (n=106)	Difference
Cognitive (mathematical concepts, logical operations, block diagrams)	Low	40%	28%	-12%
	Medium	42%	40%	-2%
	High	18%	32%	+14%
Communicative (tasks by J. Piaget, G.A. Tsukerman)	Low	39%	29%	-10%
	Medium	46%	42%	-4%
	High	15%	29%	+14%
Regulatory (methods of A.L. Wenger, D.B. Elkonin, E.K. Varkhova)	Low	39%	33%	-6%
	Medium	44%	36%	-8%
	High	17%	31%	+14%
Overall level	High	16%	31%	+15%

The proportion of children who reached the high level in the experimental group increased by 14–15% across all components. This demonstrates that the methodology had a direct impact on children’s algorithmic thinking, execution of logical operations, and abilities to plan and regulate actions.

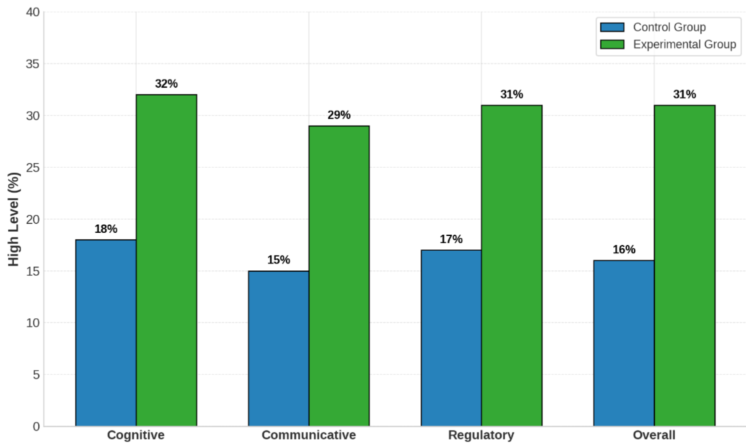

Fig. 3. – Comparative Indicators of the Development Levels of Algorithmic Abilities

To verify the reliability of the results, the Pearson correlation coefficient and p-values were calculated.

Table 2 – Statistical Characteristics of the Experiment Results

Components	**Mean value (control)**	**Mean value (experimental)**	**Standard deviation**	**Pearson (r)**	**p-value**	**Interpretation**
Cognitive	0.58	0.71	±0.12	0.81	0.013	Difference statistically significant
Communicative	0.54	0.68	±0.11	0.76	0.019	Clear development of communicative skills
Regulatory	0.55	0.70	±0.13	0.82	0.011	Improvement in self-regulation abilities
Overall index	0.56	0.70	±0.12	0.80	0.014	Confirms methodology effectiveness

Since all p-values were less than 0.05, the differences are statistically significant. This proves that the progress observed in the experimental group was not random.

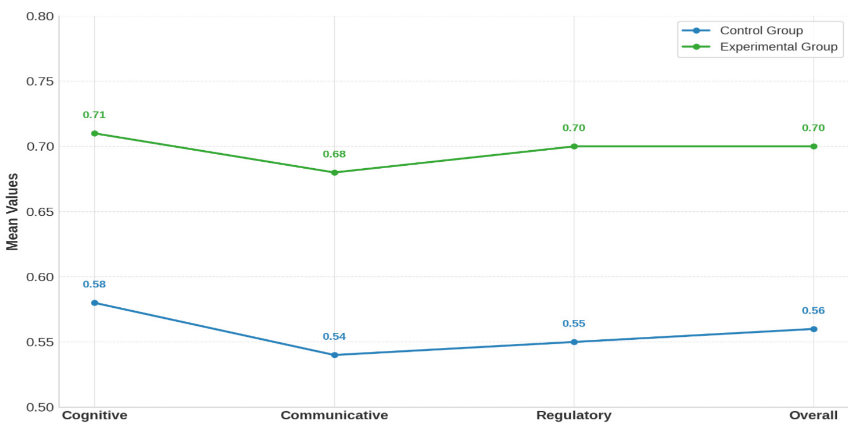

Fig 4. – Statistical Characteristics of the Experiment Results

The analysis of the experimental results showed that the new methodology had a clear and measurable effect on the development of algorithmic abilities in preschool children. The comparative indicators between the control and experimental groups confirmed significant differences in development levels. These differences were both statistically significant ($p < 0.05$) and pedagogically meaningful.

1. Interpretation of the Cognitive Component

The cognitive component was defined by children's mastery of mathematical concepts, ability to perform logical operations, and competence in constructing block diagrams. In the experimental group, this indicator improved considerably: the proportion of children at a high level reached 32%, which is 14% higher than in the control group.

These results allow us to make several conclusions:

- Firstly, children's abstract thinking ability was strengthened. They not only repeated ready-made algorithms but also constructed their own solutions to new tasks.
- Secondly, flexibility in logical thinking increased. Children learned to perform operations such as counting, comparing, and ordering in sequence.
- Thirdly, the increase in cognitive development corresponds with L.S. Vygotsky's concept of the zone of proximal development: play-based methods expanded children's potential and enabled them to master more complex concepts.

The growth of this indicator highlights the effectiveness of problem-based games and quests, which transformed the child from a passive learner into an active problem-solver.

2. Interpretation of the Communicative Component

The communicative component was measured by the children's ability to apply logical relations in communication and to express their thoughts in a structured manner. In the experimental group, the high level reached 29%, compared to only 15% in the control group.

This demonstrates the following aspects:

- Children's ability to engage in dialogue improved. They learned to act together, compare opinions, and reach common solutions.
- J. Piaget's tasks ("left/right," "brothers and sisters") and G.A. Tsukerman's "Mittens" activity enhanced the children's ability to verbalize logical reasoning.
- Growth in the communicative component facilitated children's social adaptation, encouraging them to cooperate with peers and actively participate in group activities.

Moreover, communicative development is of particular importance in inclusive education. By interacting, children learned to respect equality, to listen to others, and to provide mutual support.

3. Interpretation of the Regulatory Component

The regulatory component included children's ability to plan actions, self-monitor, and correct errors. This indicator also improved significantly in the experimental group: 31% reached a high level, compared to only 17% in the control group.

The differences clearly demonstrate children's readiness for learning activity:

- They learned to set goals and determine step-by-step paths to achieve them.
- A.L. Wenger's "Pattern and Guideline" method and D.B. Elkonin's "Graphic Dictation" task helped children regulate their activities.
- The "Sequential Pictures" task (E.K. Varkhova, N.V. Dyatko, E.V. Sazonova) enabled children to construct and consistently reproduce a logical sequence of events.

The development of regulatory abilities is critically important for preschool children, as it ensures their psychological and intellectual readiness for school.

4. General Interpretation

Overall, the experimental group showed a 14–15% increase across all components of algorithmic abilities. This difference reflects not only quantitative growth but also qualitative improvements:

- Children's cognitive activity increased;
- Communication skills and cultural interaction were enhanced;
- Self-regulation and planning abilities were strengthened.

Statistical analysis (Pearson r = 0.80, $p < 0.05$) confirmed that the differences between the groups were not random but resulted from the introduction of the new methodology. This provides a scientifically grounded validation of the methodology's effectiveness.

The results of the study prove that the newly developed methodology is effective in fostering algorithmic abilities in preschool children.

- Compared with the control group, the proportion of children at a high level increased by 14–15% in the experimental group.
- Improvements were recorded across all three components: cognitive, communicative, and regulatory.
- Statistical analysis confirmed the reliability and significance of the differences.
- The methodology promoted not only intellectual growth but also social and personal development, making it relevant for use in inclusive education environments.

Thus, the experiment demonstrated that the methodology can serve as a powerful tool for developing algorithmic abilities, logical reasoning, and self-regulation in preschool children, while also preparing them for successful transition to formal schooling.

Conclusion

The conducted research was based on the analysis of philosophical, psychological, and pedagogical literature, which made it possible to clarify the concept, structure, and importance of algorithmic abilities, as well as to consider the category of time from philosophical, natural science, psychological, and pedagogical perspectives. In domestic pedagogy, the issue of algorithmic abilities remains insufficiently studied and is most often addressed in mathematics and computer science, where even in these fields there is no single precise definition of the concept, In preschool pedagogy and psychology, attention has traditionally been focused on familiarizing children with the category of time, the peculiarities of its perception, ways of orientation in temporal sequences, the development of a sense of time, and the understanding of succession of events, with particular emphasis on introducing systems of measures.

Modern pedagogy continues to search for effective ways to improve the conditions of personal development in children and poses before researchers and practitioners the task of advancing the concept of personality-oriented education. Such education requires the construction of content directed at the development of the child's inner world, the formation of individual experience, the assimilation of cultural means of interaction with reality, social adaptation, and confidence in one's own abilities, In this context, algorithmic abilities act as an essential condition for successful achievement of educational tasks in line with individual traits, aptitudes, and interests, as well as a means of enabling children to choose their own learning paths and to feel secure in their skills and potential.

1. On the basis of the conducted analysis of psychological, pedagogical, scientific, and methodological literature, as well as normative documents and dissertation studies

related to preschool mathematics education, the concept of algorithmic abilities was defined and its structure clarified, including cognitive, regulatory, and communicative components.

2. According to the identified structure, three levels of development were distinguished reproductive, productive, and creative, with corresponding indicators and criteria.

3. A model of mathematics teaching aimed at developing algorithmic abilities in preschool children was constructed, comprising target, methodological, content, procedural, and result components. This model was grounded in the principles of personality-oriented, activity-based, and integrative approaches, as well as in general didactic principles such as consistency, accessibility, continuity, and advancement, and specific methodological principles such as generalization, staging, and the connection between algorithmic activity and children's everyday experiences.

4. On the basis of the model, a methodology was developed and substantiated that provides for a transition from mastering and creating simple linear algorithms to working with cyclic and branching types.

5. A set of teaching tools, including games and tasks, was designed to be used both in organized learning activities and in independent work, with the aim of gradually increasing the share of children's independence in constructing and transforming algorithms. This contributes to the systematic development of the cognitive, regulatory, and communicative aspects of algorithmic abilities.

6. The pedagogical experiment confirmed the presence of differences between the control and experimental groups in the levels of algorithmic ability formation achieved during mathematics teaching. The results clearly demonstrate the effectiveness of the proposed methodology, supporting the view that purposeful organization of the educational process significantly enhances the development of algorithmic skills in preschool children.

REFERENCES

[1] Закон «Об образовании» Республики Казахстан, –Астана, 2007, –№ 319-III. Режим доступа: URL: https://adilet,zan,kz/rus/docs/Z070000319 [Дата обращения: 9.05.2025].

[2] Государственный общеобязательный стандарт дошкольного воспитания и обучения. – Астана, 2022, –№348. Режим доступа: URL: https://adilet,zan,kz/rus/docs/V2200029031 [Дата обращения: 13.05.2025].

[3] Колмогоров А.Н., Драгалин А.Г. Введение в математическую логику, –М,: Изд-во Моск. ун-та. 1982. –238 с.

[4] Крутецкий В.А. Психология математических способностей школьников / под ред. Н.И.Чуприковой. –М,: Изд-во НПО. 1998. –418 с.

[5] Столяр А.А. Формирование элементарных математических представлений у дошкольников, –М.: Просвещение, 1988. –303 с.

[6] Сычева Г.Е. Формирование элементарных математических представлений у дошкольников, –М.: Книголюб, 2004. –64 с.

[7] Горячев А.В. Ключ Н.В. Все по полочкам: метод. рекомендации к курсу информатики для дошкольников. –М,: Баласс. 1999, –64 с. Режим доступа: URL: https://www,labirint,ru/books/41808/ [Дата обращения: 14.06.2025].

[8] Voronina L.V., Sergeeva N.N., & Utyumova E.A. Development of algorithm skills in preschool children // Procedia –Social and Behavioral Sciences, –2016. – Vol. 233. –P, 155–159. DOI: https://doi,org/10,1016/j,sbspro,2016,10,176.

[9] Kadirov J,A, Stages of developing algorithmic skills in educational game activities // European Scholar Journal, –2021, –Vol. 2, No, 10. –P. 120–122, – ISSN 2660-5562. Режим доступа: URL: https://media,neliti,com/media/publications/400736-none-ce72e79d,pdf [Дата обращения: 10.07.2025].

[10] Формирование элементарных математических представлений у дошкольников: учеб, пособие для пед, ин-тов / Р.Л.Березина [и др,]; под ред, А.А.Столяра. –М.:Просвещение, 2018. –303 с.

[11] Язвинская С.Д. Педагогические условия развития алгоритмических способностей детей старшего дошкольного возраста в процессе познания категории времени: дис. канд. пед. наук. –Ставрополь, 2009. –202 с. Режим доступа: URL: https://www,dissercat,com/content/pedagogicheskie-usloviya-razvitiya-algoritmicheskikh-sposobnostei-detei-starshego-doshkolnog Дата обращения: 15.07.2025].

[12] Havlásková T, Homanová Z, Kostolányová K,&Barteček, Z,Methodology for developing algorithmic thinking in pre-school education // European Conference on e-Learning, –Kidmore End, 2019, DOI: 10,34190/EEL,19,027, Режим доступа: URL: https://www,proquest,com/openview/593465c748f61b6f2b180839708217a6/1?pq-origsite=gscholar&cbl=1796419 [Дата обращения: 15.07.2025].

[13] Метербаева К. Геймификация арқылы мектеп жасына дейінгі балалардың көшбасшылық қасиеттерін қалыптастыру//Абылай хан атындағы Қазақ халықаралық қатынастар және әлем тілдері университетінің хабаршысы, «Педагогикалық ғылымдар» сериясы. –2024. –№ 4 (75). –617– 634 б, DOI: https://doi,org/10,48371/PEDS,2024,75,4,037.

[14] Утюмова Е.А. Условия формирования алгоритмических умений у детей дошкольного возраста // Педагогическое образование в России. –2016, –№ 3. –С, 94–99. Режим доступа: URL: https://cyberleninka,ru/article/n/usloviya- formirovaniya-algoritmicheskih-umeniy-u-detey-doshkolnogo-vozrasta/viewer [Дата обращения: 10.08.2025].

REFERENCES

[1], Zakon «Ob obrazovanii» Respubliki Kazakhstan (Law of the Republic of Kazakhstan "On Education"), – Astana, 2007. – No, 319-III, Rezhim dostupa: URL: https://adilet,zan,kz/rus/docs/Z070000319__. [Data obrashcheniya: 09.05.2025], [in Rus]

[2] Gosudarstvennyi obshcheobiazatelnyi standart doshkol'nogo vospitaniia i obucheniia (State obligatory standard of preschool education and training), – Astana, 2022, –No, 348, Rezhim dostupa: URL: https://adilet,zan,kz/rus/docs/V2200029031, [Data obrashcheniya: 13.05.2025]. [in Rus]

[3] Kolmogorov A.N., Dragalin A.G. Vvedenie v matematicheskuiu logiku (Introduction to mathematical logic) .–Moscow: Moscow University Press, 1982, – 238 s. [in Rus]

[4] Krutetskii V.A. Psikhologiia matematicheskikh sposobnostei shkol'nikov (Psychology of mathematical abilities of schoolchildren) / pod. red. N.I.Chuprikovoi. – Moscow: NPO. Publishing House, 1998, –418 s. [in Rus]

[5] Stolyar A.A. Formirovanie elementarnykh matematicheskikh predstavlenii u doshkol'nikov (Development of basic mathematical notions among preschoolers). – Moscow: Prosveshchenie, 1988. –303 s. [in Rus]

[6] Sycheva G.E. Formirovanie elementarnykh matematicheskikh predstavlenii u doshkol'nikov (Formation of elementary mathematical concepts in preschool children). –Moscow: Knigoliub, 2004, –64 s. [in Rus]

[7] Goryachev A.V., Kliuch N.V. Vse po polochkam: metodicheskie rekomendatsii k kursu informatiki dlia doshkol'nikov (Everything in order: methodological recommendations for informatics for preschoolers), –Moscow: Balass, 1999. –64 s. Rezhim dostupa: URL:https://www,labirint,ru/books/41808/, [Data obrashcheniya: 14,06,2025]. [in Rus]

[8] Voronina L.V. Sergeeva N.N. Utyumova E.A. Development of algorithm skills in preschool children // Procedia –Social and Behavioral Sciences, –2016, – Vol, 233, –P, 155–159, DOI: https://doi,org/10,1016/j,sbspro,2016,10,176, [in Eng]

[9] Kadirov J.A. Stages of developing algorithmic skills in educational game activities // European Scholar Journal, – 2021, – Vol. 2. No.10. – P. 120–122. ISSN 2660-5562. Rezhim dostupa: URL: https://media,neliti,com/media/publications/400736-none-ce72e79d,pdf, [Data obrashcheniya: 10.07.2025] [in Eng]

[10] Berezina R.L., Stolyar A.A, i dr. Formirovanie elementarnykh matematicheskikh predstavlenii u doshkol'nikov: uchebnoe posobie dlia pedagogicheskikh institutov (Formation of elementary mathematical concepts in preschool children: textbook for pedagogical institutes) / pod red. A.A.Stoliara, – Moscow: Prosveshchenie, 2018. –303 s. [in Rus]

[11] Yazvinskaya S.D. Pedagogicheskie usloviia razvitiia algoritmicheskikh sposobnostei detei starshego doshkol'nogo vozrasta v protsesse poznaniia kategorii vremeni (Pedagogical conditions for the development of algorithmic abilities of older preschool children in the process of cognition of the category of time): dis kand, Ped, nauk, Stavropol, 2009. – 202 s, Rezhim dostupa: URL: https://www,dissercat,com/content/pedagogicheskie-usloviya-razvitiya- algoritmicheskikh-sposobnostei-detei-starshego-doshkolnog, [Data obrashcheniya: 15,07,2025]. [in Rus]

[12] Havlásková T., Homanová Z., Kostolányová K., Barteček Z. Methodology for developing algorithmic thinking in pre-school education // European Conference on e-Learning (ECEL 2019). – Kidmore End. UK. 2019, DOI: https://doi,org/10,34190/EEL,19,027. [in Eng]

[13] Meterbaeva K. Geimifikatsiia arqyly mektep zhasyna deiingi balalardyn köşbasshylyq qasietterin qalyptastyru //Izvestiia Kazakhskogo universiteta mezhdunarodnykh otnoshenii i mirovykh iazykov imeni Abilai Khana. Seriia

«Pedagogikalyk gylymdar», –2024, –№ 4 (75), –S. 617–634, DOI: https://doi,org/10,48371/PEDS,2024,75,4,037. [Data obrashcheniya: 15.07.2025]. [in Kaz]

[14] Utyumova E.A. Usloviia formirovaniia algoritmicheskikh umenii u detei doshkol'nogo vozrasta (Conditions for the formation of algorithmic skills in preschool children) // Pedagogicheskoe obrazovanie v Rossii, –2016. –№ 3. –S. 94–99. Rezhim dostupa: URL: https://cyberleninka,ru/article/n/usloviya- formirovaniya-algoritmicheskih-umeniy-u-detey-doshkolnogo-vozrasta/viewer, [Data obrashcheniya: 10,08,2025]. [in Rus]

МАТЕМАТИКА НЕГІЗДЕРІН ОҚЫТУ ҮДЕРІСІНДЕ МЕКТЕП ЖАСЫНА ДЕЙІНГІ БАЛАЛАРДЫҢ АЛГОРИТМДІК ДАҒДЫЛАРЫН ҚАЛЫПТАСТЫРУДЫҢ ПЕДАГОГИКАЛЫҚ ШАРТТАРЫ

Азимбаева Д.К.[1], Кыякбаева У.К.[2] , *Айтпаева А.К.[3]
[1,2,*3] Абай атындағы Қазақ ұлттық педагогикалық университеті,
Алматы, Қазақстан

Андатпа. Қазіргі қоғамда мектеп жасына дейінгі балалардың алгоритмдік дағдыларын дамыту өзекті және аз қарастырылған мәселеге айналуда, Мектепке дейінгі жастың маңызды ерекшелігі -бала көп нәрсені бірінші рет меңгереді, оның өзіндік субъективті тәжірибесі өте елеусіз және оқудың бастапқы нүктесі ретінде қызмет етумен шектеледі. Демек, оқытудың алғашқы кезеңдерінде әрекеттің жалпыланған әдістері ретінде қарапайым алгоритмдерді меңгеру сәйкес әрекетті табысты меңгерудің қажетті шарты болып табылады.

Мақалада авторлар мектеп жасына дейінгі балалардың алгоритмдік дағдыларын дамыту мәселесінің жай-күйіне талдау жасайды. Зерттеу мәселесі бойынша психологиялық-педагогикалық және әдістемелік еңбектерді талдау негізінде мектеп жасына дейінгі балалардың алгоритмдік дағдыларын дамыту мақсатында математиканы оқыту моделі жасалды және оның тиімділігі алгоритмдік дағдыларды дамыту құралдарын (проблемалық ойындар, әрекет құрылымы толық емес ойындар, квест ойындары, ережелері бар ойындар, кіріктірілген тапсырмалар) қолдану арқылы негізделді.

Тірек сөздер: алгоритмдік дағдылар, мектепке дейінгі ересек жастағы балалар, оқыту құралдары, ойындар, алгоритмдік дағдыларды қалыптастыру шарттары, оқыту моделі, математика негіздерін оқыту процесі

ПЕДАГОГИЧЕСКИЕ УСЛОВИЯ ФОРМИРОВАНИЯ АЛГОРИТМИЧЕСКИХ НАВЫКОВ У ДЕТЕЙ ДОШКОЛЬНОГО ВОЗРАСТА В ПРОЦЕССЕ ОБУЧЕНИЯ ОСНОВАМ МАТЕМАТИКИ

Азимбаева Д.К.[1], Кыякбаева У.К.[2], *Айтпаева А.К.[3]
[1,2,*3] Казахский национальный педагогический университет имени Абая, Алматы, Казахстан

Аннотация. В современном обществе развитие алгоритмических навыков у детей дошкольного возраста становится актуальной и наимение разработанной проблемой. Важной отличительной особенностью дошкольного возраста является то, что многое ребенок познает впервые, его собственный субъектный опыт очень незначителен и ограничен, чтобы служить отправным пунктом в обучении. Следовательно, овладение на первых ступенях обучения простейшими алгоритмами, как обобщенными способами действий является необходимым условием успешного освоения соответствующей деятельности.

В статье авторы проанализировали состояние проблемы формирования алгоритмических навыков у детей дошкольного возраста. На основе анализа психолого-педагогических и методических работ по проблеме исследования разработана модель обучения основам математики с целью формирования алгоритмических умений у детей дошкольного возраста и обоснованно доказана ее эффективность за счет использования средств формирования алгоритмических навыков (игры-задачи, игры с неполной структурой действия, игры-квесты, игры с правилами, задания интегрированного типа).

Ключевые слова: алгоритмические навыки, дети старшего дошкольного возраста, средства обучения, игры, условия формирования алгоритмических навыков, модель обучения, процесс обучения основам математики

Received / Статья поступила / Мақала түсті: 26.04.2025.
Accepted: / Принята к публикации /Жариялауға қабылданды 26.09.2025.

Information about the authors:

Azimbayeva Dariga - master of science, doctoral student of Abai Kazakh National Pedagogical University, Almaty, Kazakhstan, dariga40@mail.ru, https://orcid,org/0009-0007-4057-2205

Kyyakbayeva Ulbossyn -candidate of Pedagogical Sciences, Associate Professor of Abai Kazakh National Pedagogical University, Almaty, Kazakhstan, email: kyakbaeva@mail.ru, https://orcid,org/0009-0003-5579-9788

Aitpayeva Almagul- candidate of Pedagogical Sciences, Professor of Abai Kazakh National Pedagogical University, Almaty, Kazakhstan, email: alma- arujan@mail.ru, https://orcid,org/0000-0002-9351-6553

Авторлар туралы мәліметтер:

Азимбаева Дарига Куановна - педагогика ғылымдарының магистрі, Абай атындағы Қазақ ұлттық педагогикалық университетінің докторанты, Алматы, Қазақстан, email: dariga40@mail.ru, https://orcid,org/0009-0007-4057-2205

Кыякбаева Улбосын Козыбаевна - педагогика ғылымдарының кандидаты, қауымдастырылған профессор, Абай атындағы Қазақ ұлттық педагогикалық университеті, Алматы, Қазақстан, email: kyakbaeva@mail.ru, https://orcid,org/0009-0003-5579- 9788

Айтпаева Алмагуль Карекбаевна - педагогика ғылымдарының кандидаты, профессор, Абай атындағы Қазақ ұлттық педагогикалық университеті, Алматы, Қазақстан, email: alma-arujan@mail.ru, https://orcid,org/0000-0002-9351-6553

Информация об авторах:

Азимбаева Дарига Куановна - магистр педагогических наук, докторант Казахского национального педагогического университета имени Абая, Алматы, Казахстан, email: dariga40@mail.ru, https://orcid,org/0009-0007-4057-2205

Кыякбаева Улбосын Козыбаевна - кандидат педагогических наук, ассоциированный профессор Казахского национального педагогического университета имени Абая, Алматы, Казахстан, email: kyakbaeva@mail.ru, https://orcid,org/0009-0003-5579-9788

Айтпаева Алмагуль Карекбаевна - кандидат педагогических наук, профессор Казахского национального педагогического университета имени Абая, Алматы, Казахстан, email: alma-arujan@mail.ru, https://orcid,org/0000-0002-9351-6553