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**INNOVATIVE EDUCATIONAL TECHNOLOGIES IN THE
PREPARATION OF CHILDREN FOR SCHOOL**

**ABSTRACT
of a dissertation**

for awarding the educational and scientific degree of "doctor"

**Doctoral program: Preschool pedagogy
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The dissertation work was discussed and directed for public defense at the extended council of the "*Preschool and Primary Education*" department at the Faculty of Pedagogy at the "Konstantin Preslavsky" University of Shumen.

The dissertation work, developed in three chapters, has a volume of 223 standard pages - 205 main text and 16 pages of appendices. It is illustrated with 14 tables, 63 figures and 18 diagrams. The numbering of the figures and tables in the abstract follows the dissertation work. The literature used includes 84 information sources in Bulgarian and foreign languages.

The public defense of the dissertation work will take place on March 10, 2026 at 11 a.m. in room 211 of the Faculty of Pedagogy of the "Konstantin Preslavsky" University of Shumen or online if necessary.

The materials for the defense are available in the "*Development of the academic staff*" department of "Konstantin Preslavsky" University of Shumen, Rectorate, floor 1, room 107 and on the university's website.

INTRODUCTION

The preparation and readiness of children for school is an important and multifaceted topic, the purpose of which is to create conditions in kindergarten for mastering knowledge, skills and attitudes that will serve as a basis for successfully dealing with school material and the new environment.

School readiness is a term used to describe practically the overall outcome of preschool education.

According to the provision of Art. 35, para. 3 and para. 5 of Ordinance No. 5/ 03.06.2016 on preschool education "the readiness of the child for school is regulated briefly, in two aspects - the time for diagnosis of school readiness is determined and its content is formulated: 1. within 14 days before the end of school time, the teacher of the relevant group determines the readiness of the children who will enter the first grade in the next school year; 2. the readiness of the child for school takes into account the physical, cognitive, linguistic, social and emotional development.

The interpretation of school readiness is closely related to the requirement that an equally prepared group of children attend school. This is not about children having equal opportunities, but about children whose communication skills, attitudes towards learning, integration and compliance with school requirements have already been formed. Children should: have mastered a certain behavioral pattern; have mastered basic moral norms directly relevant to the relationship with other children and with older people; have acquired a minimum vocabulary necessary for communication in the school environment; have acquired the necessary knowledge and skills for learning content; have the necessary information about basic hygiene habits and how to take care of themselves and protect their personal health, their lives and the lives of other children" [Hristova, 2023].

At the same time, modern children are growing up with new information technologies - they are a part of education and a natural companion in their everyday life. The role of the teacher in preschool education is to form in them hygienic and routine habits for handling modern technologies, as well as to direct them to their use not only for entertainment, but also for educational purposes.

In relation to this, the need arose to study the possibilities of innovative technologies for the preparation of children from the fourth age

group with the aims of full absorption of the program content and the sustainability of knowledge and the formation of competences and determining the relevance of the issues considered in the dissertation work.

The object of the study is the education of children from the fourth age group in kindergarten.

Subject of the study – the process of competence formation (predictor of children's readiness for school) through the use of innovative educational technologies.

The purpose of the present study is to investigate the possibilities of innovative educational technologies for the preparation of children from the fourth age group for school in the direction of full absorption of the program content and the sustainability of knowledge and formation of competences.

Research hypothesis:

If innovative educational technologies are used in the educational process in the fourth age group of kindergarten, it will help to increase the efficiency of knowledge acquisition and the formation of competencies which are a prerequisite for school readiness.

The selected topic of the dissertation "*Innovative educational technologies in preparing children for school*", related to the application of innovative educational technologies in the fourth age group, proves that they successfully become an effective method of organization for active and creative work of children. Moreover, their use contributes to the acquisition of knowledge in an interesting and non-traditional way, resulting in a higher level of school readiness.

CHAPTER ONE: THEORETICAL ANALYSIS AND STATEMENT OF THE PROBLEM

The first chapter of the dissertation, divided into three main paragraphs, presents the following most important aspects of the study of theoretical sources and their analysis:

Paragraph 1.1. presents the transition between the two educational institutions - kindergarten and school.

Education is a process that unifies the practices of training, upbringing and socialization of children in kindergartens, in the sense of Art. 3, para. 1 of the Preschool and School Education Act.

In Art. 55 of the Law for Preschool and School Education (LPSE) states that "*preschool education lays the foundations for lifelong learning by ensuring the physical, cognitive, linguistic, spiritual-moral, social, emotional and creative development of children, taking into account the importance of play in the process of pedagogical interaction*". In practice, this means that preschool education provides conditions for early childhood development and preparation of children for school.

According to Ordinance No. 5/2016, pedagogical interaction in preschool education "*takes place in an environment for learning through play, which is age-appropriate and guarantees the overall development of the child, as well as opportunities to protect its physical and mental health*" [Ordinance No. 5, Art. 3].

Pedagogical interaction is considered as a process oriented towards achieving expected results related to the overall development of the child, within which the main participants are the teacher and the child. In accordance with Ordinance No. 5/03.06.2016, teachers plan and alternate the forms of pedagogical interaction and organize the daily regime in the group so as to provide conditions for optimal pedagogical impact and support the development of each child.

Art. 69, para. 1 of the LPSE states that "preschool education creates *conditions for the overall development of the child's personality and the acquisition of a set of competences - knowledge, skills and attitudes* necessary for the child's successful transition to school education. Such a statement proves the conscious understanding of the role of kindergartens for the socialization of children and their full preparation for school, or that

everything that will follow in school education is largely laid down by quality preschool education." [Hristova, 2023].

Preschool education is implemented within the framework of a program system that is a key component of the kindergarten's development strategy. *The program system* should provide conditions for ***the acquisition of competences*** in all educational areas, taking into account the specifics of the kindergarten, the interests, opportunities and age characteristics of the children.

Paragraph 1.1.1. examines the educational fields - predecessors of the study subjects.

The organization of the pedagogical interaction on the mastery of the educational content in kindergarten is carried out in the presence of a playing environment, conditions and time for learning through game activity to achieve the competencies.

The competences that the children of the fourth age group must acquire are contained as *expected results in the educational directions and the cores to them*, which also determine the framework of the educational content for each educational direction (**see Appendix No. 1**).

According to the ordinance, the activities of the educational fields are subordinated to the goal of ensuring a happy childhood for every child, as well as building motivation and confidence in its own capabilities.

In accordance with the normative framework, *the educational directions and their specifics*, on which the forms of pedagogical interaction are carried out, are specified.

Educational directions determine the educational content that children master. Through the activities carried out during the formation of competences, the basis of readiness for school is laid.

Paragraph 1.2. represents children's readiness for school

Children's readiness for school is understood as a standard of physical, intellectual, social and emotional development that they must have before entering school.

Paragraph 1.2.1. School readiness

"Successful learning at school requires personal development of the child, expressed in relation to the school, to learning, to the teacher, to itself. This implies the development of the social motives of behavior that determine the internal positions of the student. There is a need for motivation.

The emergence and birth of self-esteem are a prerequisite for effective schooling.

While preschool education focuses on the development towards school preparation through play (competencies such as knowledge, skills and attitudes), Art. 75 of the LPSE states that school preparation is the next step, which builds through subjects and modules leading to competences for the next stages, being guided by State Educational Standards (SES), defining the objectives, content and requirements for learning outcomes.

The requirements for the educational program are several - to fix the learning content, facts, concepts; distinguish basic from additional knowledge; basic knowledge to be developed thoroughly and comprehensively; to include instructions for teachers. In the initial stage of the educational degree, the entertaining nature of the educational process continues to be a necessity. The use of various didactic games continues, which attract the interest and attention of young first-graders and help them in the transition to the future steps of the educational system.

The key competences under Art. 77 of the LPSE are leading in education. The general educational preparation covers the following groups of key competences:

1. *Competencies in the field of the Bulgarian language;*
2. *Communication skills in foreign languages;*
3. *Mathematical competence and basic competences in the field of natural sciences and technologies;*
4. *Digital competence;*
5. *Study skills;*
6. *Social and civic competences;*
7. *Initiative and entrepreneurship;*
8. *Cultural competence and skills for expression through creativity;*
9. *Skills to support sustainable development and for a healthy lifestyle and sports.*

Preparation for school implies reaching a certain level, ensuring the transition to new mental and personal formations, necessary for the formation of new needs and motives as well as for the development of new abilities. In recent years, education has been more oriented towards the formation of the so-called "soft skills" or life skills than to intellectual achievements [Bizhkov, 1999].

The spheres of school readiness are conventionally distinguished. In general, it is accepted that school readiness is a construct of a complex nature, which has eight determinants:

- *Cognitive development of the child;*
- *Physical development of the child;*
- *Emotional development of the child;*
- *Social development of the child;*
- *Family environment;*
- *Cultural interests;*
- *Kindergarten;*
- *Contacts with other children* [Bakhchevanova – Georgieva, Georgieva, Karadimitrova, 2014].

In general, each of the eight determinants is built upon in the process of the child's growth and development, and educational institutions - kindergarten and school - are directly related to this.

Paragraph 1.2.2. Types of readiness

Bakhchevanova - Georgieva, Georgieva and Karadimitrova determine that the construct of psychological readiness for starting school contains the following components:

- **Personal readiness** - is expressed in the readiness of the child to accept the new social position - to be a student with certain rights and obligations. It includes the child's attitude to the school, to the learning activity, to the teachers and to himself. Personal readiness also includes a certain level of motivation for learning activities and emotional resilience.

- **Intellectual readiness** - implies the presence of a certain stock of specific knowledge and abilities in the child: differentiated perception; analytical thinking (ability to determine the main signs and connections between phenomena, reproduction of a pattern); rational approach to reality (weakened role of fantasy); logical memorization; interest in obtaining new knowledge and making efforts for it; development of fine motor skills of the hand.

- **Social-psychological readiness** - includes the presence of such qualities in children, thanks to which they could communicate with other children and teachers. At school, the child joins a team where everyone is busy with common affairs, and he must have enough flexible ways to establish relationships with other children, act together with them, give way

and defend himself. In other words, socio-psychological readiness implies the development of the child's need for communication and the ability to obey the interests and customs of the children's group [Bahchevanova – Georgieva, Georgieva, Karadimitrova, 2014].

The socio-psychological preparation for school requires, along with the formation of visual thinking, the mastery of mental operations and creative imagination, necessary for the development of the student's educational activity, to develop qualities related to the moral-volitional and motivational sphere of the child's personality. Often this motivation is provoked by the teacher, who must intrigue the child and attract his interest to the activity on the given educational content.

According to S. Lazarova, "cognitive interest is aimed at knowledge, at obtaining, mastering and applying knowledge related to a given educational content" [Lazarova, Ivanova, 2017:45].

The creation of an emotional atmosphere in the learning process helps to activate the students, to develop their knowledge and strengthen their interest and helps to develop a number of qualities - activity, purposefulness, striving to achieve the set goals.

The assimilation of the learning material and the easier passage of the first graders through the transition between the two educational institutions kindergarten - school depends precisely on their readiness, social and personal responsibility based on the model established in the kindergarten and the future contact between teacher-parent-student. In this way, the learning activity at school will be carried out more easily. They need a smoother transition, stronger motivation, greater support from parents, understanding and tolerance from teachers, because the child must have a positive attitude towards school in order to learn effectively.

In this regard, preschool teachers are constantly faced with the question of searching for innovative methods of communication in the process of learning the educational content.

In **paragraph 1.3.** innovative educational technologies in kindergarten are considered

Innovative educational technologies are "not just a tool for diversifying and supplementing the educational process, but a necessity dictated by the dynamically developed social development. Adding something new to the already existing (definition of the adjective innovative

in the interpretive dictionary) is a permanent process (or should be) in education. Introducing innovations are a priority in the work of the teacher, who realizes both global and specific goals and seeks ways to increase efficiency. It adapts the educational content to achieve certain results, applies various forms and means to include each child and develop his potential, seeks individual and differentiated approaches to rethinking priorities. Thus, the change that implies **innovation** (from the Latin *novatio*) in education is aimed at the three components: *education, upbringing and socialization*" [Kyurkchiyska, 2022].

Years ago, M. Andreev shared that "the adaptation of education to the information age is not expressed by a simple action to modernize the learning space, but requires a complete change of the content, methods and goals of the educational system. It is expressed in a complete educational reform, including a change in human thinking" [Andreev, 1986].

Ya. Totseva, defines "innovation" as a generalized concept for all significant (rational and useful) innovations in the business activity of people, which aim to bring a given object of activity from one state to another desired state. Innovation is not just change. It is a change in the sense of producing something new. This means that it is not enough to remove something for innovation to occur. It is necessary to apply a new way, a new method, new rules, or a new technical means to be able to say that there is an innovation. An innovation can be a product, a process, a position or a paradigm. Innovation is a purposeful, planned and controlled change, through which organizational and content problems are solved in various areas of human practice, and through pedagogical innovation, organizational and content problems of education are solved in a certain educational area (individual classroom, kindergarten, classroom, school, educational region, educational system). Innovation is synonymous with innovation or novelty" [Totseva, 2012:5-6].

According to P. Petrov, "the closest concept to innovation is novation, which has all its characteristics with the exception of the characteristic of introduction, i.e. the lack of verified novelty" [Petrov, 2017:29].

For the purposes of this dissertation, innovative educational technologies are understood as the use of new technologies that favor the process of competence formation.

We know that for modern children, play is often synonymous with computer, tablet, laptop, because they associate it with their favorite computer games. In this regard, it can be said that information technology is the new face of education. Among them, the so-called computer group (information, multimedia, Internet, dialog, conference, remote, etc.) dominates for now. Through these technologies, thinking develops and ensures the acquisition of a set of competencies - knowledge, skills and attitudes, necessary for the child's successful transition to school education, as claimed by Ch. Sotirov and I. Stoyanova [Sotirov, Stoyanova, 2018:167].

According to R. Papancheva, L. Parijkova and others. "the future is in the hands of the Alpha generation - those born after the year 2010. The Alpha generation is expected to be the most transformative to date. Alpha people interact with a touchscreen from a very early age. In 2017, the European Commission published *Digital competences 2.0 - A Digital Competence Framework*. One of the main areas of digital competence is: Information and data literacy: being able to articulate information needs, to find and extract digital data, information and content, and to assess the significance of the source and its content, and to store, manage and organize digital data, information and content" [Papancheva, Parijkova et al., 2018].

This confirms the need to develop digital literacy from preschool age. **Digital literacy** is a term adapted to the digital competences that children and adults need to acquire through **digital technologies**.

At its core, digital literacy is about working with information and developing lifelong learning skills. In Ordinance No. 5 of 03.06.2016, there is no educational direction "**Information technologies**" and, accordingly, there are no State educational standards for the acquisition of digital competences in kindergarten. These competences are formed through the work in the other educational fields when searching and processing information.

Prerequisites for the acquisition of digital competences and continuity between the state educational standards in the preschool education system and in the school education system are rather observed. In the "**Construction and Technologies**" educational direction, attention is drawn to the fact that children should form their skills in information technology from kindergarten. This setting in this direction is that one of the common goals is creating opportunities for the initial development of digital competence: **to**

create conditions for initial familiarization with information and communication technologies.

In the educational core of *Technology*, towards the expected results, already in the second age group, children must have an idea about the devices for information and communication - television, audio devices, etc.; in the third age group, to distinguish the devices for information and communication - telephones, in the fourth age group, the child knows different possibilities of communication and information devices.

Through the use of ICT in learning, social interactions are not merely supportive but an essential component in cognitive development. In a software environment, knowledge is mastered permanently and functionally, it is offered in a practical and social context close to children's lives, and learning is characterized by awareness of intentions and conscious motivation [Kyrkchiyska, 2017].

The need to use information and communication technologies in preschool age is aimed at improving the quality of education, as well as increasing the child's motivation for active thinking, so that he can develop his creative abilities, search and find non-standard solutions in life.

The realization of the educational goals - *building active creative and independent individuals with a high degree of intellectual development* - requires the use of such forms of training that guarantee the assimilation and interpretation of the program content in the educational areas which stimulate thinking activity.

By integrating information and communication technologies in the education of children in various educational fields, the aim is to:

- create an interactive environment that allows freedom of choice and expression of each child;
- develop skills for working with computer systems and software and communication skills in an environment of active team cooperation;
- expand opportunities for social interaction and collaborative work;
- create an environment of respect for individual differences, needs and interests of children [Boneva, Tsankov and Damyanov, 2008].

"The kindergarten, where the child spends eight hours at a time, must offer many stimulating choices if we expect it to remain involved and engaged in the activities offered. In this sense, information technology makes the group room more complex and interesting for children. The presence of a

computer and an interactive board, as well as their proper use, offer another opportunity for them. Since the children in the group are at different levels of social development, they have different preferences when it comes to collective activity - some prefer collective creative games, others - to draw and play independently, others - to listen to fairy tales" [Fakirska, 2012].

"Through information technology, opportunities are given to the child to sit alone and play in partnership with the computer, play together with friends or work in a group. Children usually play and talk in a circle of friends, in cooperation with others or in project activities. The computer can also be used to encourage their growth or to have a conversation among peers about their activities. The computer is the discreet friend of children, because it does not get angry when they are wrong, but only gives them a sign, prompts them when they have difficulty and encourages them with each successful attempt. Finally, the computer in the study room offers a new direction for building the child's individuality and for using the child's capacity. The child who does not succeed in taking on and performing roles in creative games, who has problems with motor coordination and therefore is not a particularly desirable partner of the group, can become the computer "expert". Using the computer can be the child's own preferred means of activity" [Fakirska, 2012].

In addition to the familiar traditional teaching methods, other methods of integrating ICT are used successfully, such as:

- **supporting method** – technologies are used for increased precision in presenting the educational content; by using utilities or software products, such as those developed by publishing houses "Izkustva", "Prosveta", "Klet Bulgaria", etc. and helps to increase children's security and self-confidence;

- **a method of research and control** - technologies help the child to explore, research, experiment and build solutions; simulation software packages enable children to experiment with virtual environments that represent real life in real and digital environments. The publishing houses offer a software package collection of didactic computer games in the educational fields of *Bulgarian language and literature, Mathematics, Environment, Fine arts, Construction and technologies.*

- **guiding method** – the information is presented to the children at an appropriate level and pace, giving the opportunity to receive feedback on the progress in learning; modern technology makes it possible for children to

engage in new forms of creative design and production by combining different means into one product.

The use of these methods can stimulate and sustain children's interest in ways that traditional methods cannot, and promote self-directed, child-centered learning.

Children should be placed in the role of active users, not passive observers of what is presented on the screen. That is why the selection of software solutions for work is of utmost importance. On the one hand, they must enable the realization of the educational task by direction, and on the other hand, they must be easy enough for students to learn.

When using activities related to ICT in the pedagogical situation, the teacher sets a task for the children to perform, supports its implementation in a certain time, analyzes what has been done up to a certain stage, compares and summarizes what the children have done, or in other words, the teacher helps *to increase the efficiency of knowledge acquisition and competence formation.*

The educational technologies proposed in the dissertation are aimed at supporting:

- ***the cognitive development of the child*** - by maintaining the motivation for knowledge; support of children's curiosity, development of cognitive interests, formation of cognitive actions, development of mental processes - perception, thinking, memory, imagination, and related characteristics. Through them, the development of free will is stimulated as an element of the child's preparation for school;

- ***language development*** - by enriching the speech and improving the related speech as an objective prerequisite for developing the forms of communication and knowledge of the world. The child's speech at this age is not so situationally dependent and is aimed at describing and interpreting relationships, as well as in the course of game activity, daily activities for the child, as well as when recreating literary works;

- ***spiritual and moral development*** - by nurturing a respectful attitude towards different community groups, by educating the child in the values of the Bulgarian cultural model;

• **social development** - through opportunities to develop the child's communication and interactions with other children and with adults by stimulating the child's independence and readiness for joint activity;

• **emotional development** - by stimulating the child's emotional responsiveness, unfolding children's experiences in the activities, and creating conditions for children's well-being. Relations of sympathy and antipathy are also manifested. This is the age when the first lasting feelings and relationships arise. Therefore, it is important that children are supported in information technology games when they have not won. In these situations, the child must learn to accept his loss and save his drive for success for a later stage;

• **creative development** - through the formation of an aesthetic attitude towards the world around the child and the realization of independent creative activity. It begins to notice the beauty of the world around it - the natural environment or creative products of other people's activities. Children do not have established criteria for beauty, but they are particularly sensitive to the perception of beauty and thus build their ideas about it.

The achievement of high levels of the specified types of development is carried out with the innovative educational technologies used for the purposes of the dissertation, presented in fig. 1.

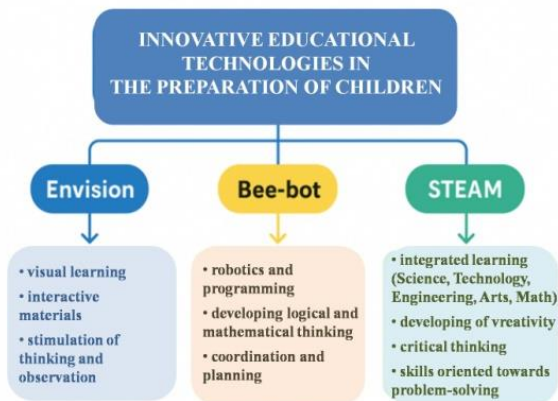


Fig. No. 1. *Innovative educational technologies in preparing children for school*

Paragraph 1.3.1. Envision: a multi-mouse technology in kindergarten

"The idea of sharing a computer by attaching several mice is not at all new. A similar possibility existed even in Windows 98, where it was envisaged that a parent or teacher could teach a child how to use a computer. Around 2000, the first software for education appeared – KidPad. It was based on the possibility of children drawing together, creating their own drawing books. However, its use was limited to the versions of Windows 98 and Windows 2000. With the release of Windows XP and DirectX9 things are changing. The seamless use of multiple mice becomes possible. New independent projects are emerging, which are mainly aimed at using multiple mice in PC games like MAME and CPNMouse" [Dafcheva, 2010].

Envision multi-mouse technology is a learning system where all children in the group have mice connected to the teacher's computer.



Fig. No. 5. Administrative module for situation creation by Envision

Source: <https://envision.nimero.com/bg>

"What is shown on the computer display is projected onto a white screen in front of the children. The mouse cursor of each participant is visualized on the screen with a different color and image. The children use their mice to perform tasks and give the correct answer to questions posed in a different way. Some technologies record the results of each child automatically and rank them after completing the task, others give a percentage of the answers. The tasks given to the children are not limited to choosing one of several the answer, and in grouping images by category; writing the correct answer with a virtual keyboard; indicating the correct

place on an image, and other things that make teaching diverse and rich in possibilities" [Koleva: 2012].

Envision is an innovative approach to improve the communication environment in pedagogical situations to achieve better achievements in children's educational fields.

The place of multi-mouse technologies in the scheme of the pedagogical situation is in the microframe in the course of the game, which consists of separate pedagogical activities, which in turn are characterized by forms, methods and didactic means. This is exactly where multi-mouse technology comes in – as a didactic tool and form. As a static screen – it visualizes, as a screen-question it is an individual or collective work.

The positive emotions after each situation with *Envision* are a charge for meaningful further work and a motive for additional work with children to stimulate their successful readiness for school.

The teacher's role is to create a balance between the three main components throughout the learning process and to monitor their specific application.

The purpose of the technologies used is *to support the learning process in order to bring about a change in the activities of the children in the group to increase their knowledge, skills and abilities, as a guarantee for a successful transition to school.*

The greatest advantage of multi-mouse technologies is considered to be that they allow children to learn through play.

Paragraph 1.3.2. Technology with Bee-bot robotic toys in kindergarten

Bee-Bot is a fun and engaging robotic toy that has been awarded the most impressive hardware for kindergarten and younger primary school students at Bett 2006 (UK) - the largest trade fair for educational technology products.

It is based on Lego principles and allows children to program the robot's journey in a square grid.

The design of the toy is adapted to its potential users - children and is shaped like a yellow bee with black stripes. However, this design is not unalterable. It can be modified by using special plastic covers and adding additional elements - paper antennas, fabric wings, etc.



Fig. No. 21. *Plastic clothing for programmable toys*

Source <https://innovateconsult.net/>

The toy also has a small connector for carrying toys or other moving devices in its back.

"Programming the Bee-Bot involves several types of complex movements:

- ✓ moving a certain number of "steps";
- ✓ reaching a certain goal from a specific beginning;
- ✓ delete the memory;
- ✓ programming new moves from the point of reaching a previous move.

Two sides of tasks can be distinguished when working with Bee-Bot, which are in direct and immediate relation with each other:

- technical (programming) – include the movement of the robot in different directions to reach the specified goal;
- didactic - to reach, through the movement of the bee, an answer to a given task" [Ilieva - Dabova, 2015]

Paragraph 1.3.3. STE(A)M technology in kindergarten

The implementation of STEM literacy in education from kindergarten should help children build an understanding of the world around them through experimentation, exploration and fun games through which they will feel like little and real explorers.

STEM is an acronym of the first letters of the English words for *science, technology, engineering* and *maths*. It is a learning technology that seeks to inspire children to grow in science and technology and learn together

instead of separately. Applied methods for practicing new knowledge are also an important element. Thus, through STEM education, children are given the opportunity to build a complete picture of the world in which they live.

“STEM encompasses the *four principles* identified as key to 21st century education: creativity, collaboration, critical thinking and communication.



Fig. No. 26. *Logo of STEAM*

STEAM offers a real opportunity and in a fun way for children to play and learn to master new knowledge about the surrounding world, as well as to experiment in the form of play and practical activities in kindergarten.

This is why more and more kindergartens in Bulgaria have started to introduce different aspects/fields of STEAM into their daily organization. Undoubtedly, this process will not stop soon, and it does not need to, because today's children are tomorrow's successful people in the world of science, technology, engineering, mathematics and the arts.

Both the Envision multi-mouse system and the Bee-bot robotic toys, as well as the use of STEAM learning in kindergarten, are innovations in the context of searching and discovering effective ways to form competences.

Conclusions:

1. The inclusion of innovative educational technologies is appropriate, both in basic and additional forms of pedagogical interaction.
2. Although the innovation is not limited to the use of information and communication technologies, they are predominant in the experimental work carried out.
3. Kindergarten cannot stay away from the introduction of STEAM education.

The creation of a suitable educational environment, the use of adequate methods and approaches to work are a guarantee for the successful use of innovative educational technologies. All this corresponds to the professional skills of the preschool teacher, who is a researcher and innovator.

CHAPTER TWO: RESEARCH DESIGN

The second chapter of the dissertation consists of two paragraphs:

Paragraph 2.1. present the organization of the study by determining:

The object of the study is the education of children from the fourth age group in kindergarten.

Subject of the study – the process of competence formation (a prerequisite for children's readiness for school) through the use of innovative educational technologies.

The purpose of the present study is to investigate the possibilities of innovative educational technologies for the preparation of children from the fourth age group for school in the direction of full absorption of the program content and the sustainability of knowledge and formation of competences.

The goal is specified in the **following tasks**:

1. To make a theoretical overview of the specialized literature regarding:

- ✓ the essence of innovative technologies and the resulting specifics in the learning process in kindergarten;
- ✓ research and analysis of concepts addressing issues related to innovative educational technologies and school readiness.

2. To develop an experimental technology for the application of innovative educational technologies in various educational fields;

3. To determine a system of criteria and indicators for proving/rejecting the hypothesis;

4. To analyze the results and formulate conclusions and recommendations about the children's readiness for school through the use of innovative educational technologies in kindergarten.

Taking into account the purpose and subject of the study, the following working **hypothesis of the study** is formulated:

If innovative educational technologies are used in the educational process in the fourth age group of kindergarten, it will help to increase the efficiency of knowledge acquisition and the formation of competencies that are a predictor of school readiness.

In order to realize the goal, to fulfill the tasks and to prove (reject) the hypothesis, the following **methods** of scientific research are used in the work process:

1. **Theoretical analysis** of the researched problem - study of literary sources, normative documents and pedagogical experience.

2. **Pedagogical monitoring** of the existing practice in preschool education - implemented in basic and additional forms in the educational fields.

3. **Pedagogical experiment** - with the application of innovative educational technologies in the educational fields.

4. **Diagnostic procedures** for tracking the achievements of children in the fourth age group - entry and exit level.

5. **Mathematical-statistical methods**: Descriptive analysis, Variation analysis (with Student's t-test at the level of statistical significance $p \leq 0.05$), ANOVA (at the level of significance $p \leq 0.05$), comparative and graphic analysis, used to process the obtained results of the conducted experiment.

In the period February 2022 - September 2023, the following are determined: the thematic orientation, the research objectives and the resulting tasks, the statement of the scientific problem of the experiment; research of literary sources (electronic and paper), formulation of a working hypothesis, the subject and object of the research, which have already presented themselves.

During this period, the research contingent is also clarified, criteria and indicators are determined, which are presented in the following paragraphs.

In paragraph 2.2.1. the study contingent is presented

The sample of the study included a total of 123 children from the fourth age group. The choice of this age group is purposeful, since it is during the last year of preschool education that school readiness is formed - a set of knowledge, skills and attitudes that ensure a smooth transition to primary school.

The selection of kindergartens was made from different settlements, namely: regional town, town-municipal center and village. This is important for conducting the research, due to the different opportunities of kindergartens to use innovative educational technologies corresponding to ICT. In order to ensure a better representativeness of the sample, the study

was conducted in settlements of different sizes, both in the experimental group and in the control group.

The experimental group consists of 61 children from the "Konche Vihrogonche" kindergarten, city of Shumen; "Prolet" kindergarten, town of Novi Pazar; "Snezhanka" kindergarten, Ivanski village.

In the control group, the number of children was 62 from: "Golden Fish" kindergarten, town of Shumen, district Shumen; "Kitka" kindergarten, town of Novi Pazar, Shumen district, "Slaveiche" kindergarten, Salmanovo village, Shumen district.

All children are 6-7 years old. The gender distribution is homogeneous (50.8% girls and 49.2% boys). 52% of the participants in the experimental training are bilingual, and for 48% the Bulgarian language is their mother tongue.

The sample thus formed can be defined as representative, as it reflects real differences between educational institutions depending on their location, resources provided and linguistic and cultural context.

Paragraph 2.1.2. specifies criteria and indicators

The criteria and indicators on which they are broken down correspond to the types of children's readiness for school and the key competences specified in the regulations.

Criterion I: Language and Speaking Skills

Indicator 1 (I1): Active participation in dialogic communication and demonstrates a culture of verbal communication.

Indicator 2 (I2): Understands the difference between a word and a sentence.

Indicator 3 (I3): Determines the number of sounds in words.

Indicator 4 (I4): Composes orally a short descriptive text.

Indicator 5 (I5): Understands the main plot in a variety of familiar texts.

Criterion II: Mathematical skills

Indicator 1 (II1): Counting and relating quantity.

Indicator 2 (II2): Defines spatial relations through "above", "below", "behind", "in front", "between".

Indicator 3 (II3): Finding the place of an omitted object in a serial line.

Indicator 4 (II4): Orientation in two-dimensional space on a square grid.

Indicator 5 (I5): Distinguishes and names geometric figures.

Criterion III: Social Skills

Indicator 1 (I1): Expresses his right of choice and initiative among others.

Indicator 2 (I2): Recognizes professions from different fields and their importance in people's lives.

Indicator 3 (I3): Names personal, official and national holidays, local customs and traditions.

Indicator 4 (I4): Understands the difference between role-playing and real-life relationships.

Indicator 5 (I5): There are ideas about the school – classroom, furniture, teaching aids that the student needs.

Criterion IV: Gross and fine motor skills

Indicator 1 (I1): Control hand-eye coordination.

Indicator 2 (I2): Demonstrate initial graphics skills.

Indicator 3 (I3): Recognition and naming of graphic signs of some printed letters related to the names of familiar persons and objects.

Indicator 4 (I4): Planning the sequence of actions and the use of different materials and techniques when performing visual tasks independently.

Indicator 5 (I5): Activity in mobile and competitive games.

Criterion V: Digital skills

Indicator 1 (I1): Has an idea of the role of technology in toys with batteries, lights, sound, computers and others.

Indicator 2 (I2): Knows individual capabilities of communication and information devices.

Indicator 3 (I3): Has an idea of the purpose of some electronic and electrical devices and the safety rules for their use.

Indicator 4 (I4): Participation in a small common project in the kindergarten.

Indicator 5 (I5): Work in a software environment (Electronic resources of publishing houses, etc.)

Paragraph 2.2. describes the experimental work

Experimental work goes through three stages: ascertaining, training and concluding.

2.2.1. Ascertaining (first) stage

The ascertaining stage of the experimental work was carried out in September 2023. An entry diagnostic is conducted, which establishes the level of the children according to each criterion at the entrance to the experiment. This time coincides with the beginning of the school year in the fourth group. For the purposes of the experimental work, a diagnostic toolkit was developed and presented in an electronic book, which contains worksheets with 25 tasks, in accordance with the requirements of the ZPAO from a set of competencies (knowledge, skills and attitudes), defined as expected results in Ordinance No. 5 on preschool education.



Fig. 27. *Electronic book - diagnostic toolkit*

There are an equal number of tasks for each area of competence, also described in table 1.

Table 1.

№ of task	CRITERIA	COMPETENCY FIELD
1–5	LANGUAGE AND SPEAKING SKILLS	BULGARIAN LANGUAGE AND LITERATURE
6–10	MATHEMATICAL SKILLS	MATHEMATICS
11–15	SOCIAL SKILLS	ENVIRONMENT
16–20	GROSS AND FINE MOTOR SKILLS	BULGARIAN LANGUAGE AND LITERATURE, PHYSICAL EDUCATION, FINE ART
21–25	DIGITAL SKILLS	DESIGN AND TECHNOLOGY

Evaluation procedure:

Achievement results are reported using a point system.

Each criterion carries a maximum of 15 points (5 tasks × 3 points), and the entire toolkit bears a maximum of 75 points.

By registering the children's answers in an *individual card for the results of tracking the achievements* (see Appendix No. 5) as correct and incorrect, quantitative results are obtained and on this basis the degree of development is specified as follows:

- Low, indexed with a value of 1 (one point):
The child does not cope with the task.
- Average, indexed with a value of 2 (two points):
The child copes with help.
- High, indexed with value 3 (three points):
The child copes independently.

Tasks No. 1 to No. 5 correspond to the expected results of the *Bulgarian language and literature* education and refer to *Criterion I: Language and speaking skills*.

The focus is on the language development, speech competence and communicative readiness of children for school.

Tasks No. 6 to No. 10 correspond to the expected results of the educational field *Mathematics* and refer to *Criterion II: Mathematical Skills*.

The goal is to trace the formation of elementary mathematical concepts and abilities to solve cognitive tasks.

Tasks from No. 11 to No. 15 refer to *Criterion III: Social Skills* and correspond to the educational direction *Environment*.

The degree of social adaptability, interaction skills and the formation of positive attitudes towards the school environment are measured.

Tasks No. 16 to No. 20 refer to *Criterion IV: Gross and Fine Skills* and correspond to the educational direction "*Bulgarian Language and Literature*", "*Physical Education*", and "*Fine Art*".

The readiness to write, the development of motor skills and coordination are tracked.

Tasks #21 to #25 meet the requirements for the development of initial digital competences in the context of *Design and Technology* and relate to *Criterion V: Digital Skills*

The aim is to assess children's ability to use digital media as a tool for play and learning, research and communication.

2.2.2. Educational (second) stage

For the purposes of the educational experiment, an innovative pedagogical technology was developed, on the basis of which the following activities are implemented:

- Application of innovative educational technologies in various educational areas – *Envision*, *Bee-bot*, *STEAM* activities and electronic resources of educational book publishers;
- Carrying out pedagogical situations with an emphasis on the game, experimental and research approach;
- Integration of digital means in daily pedagogical practice through an interactive board and multimedia materials;
- Tracking the dynamics of children's achievements through ongoing observations and intermediate checks.

30 topics were developed and adapted in the educational fields with the application of innovative educational technologies in the experimental group:

With Envision technology, the topics are: *"What's where?"; "My Family"; "Fruits and vegetables who do not eat"; "Let's go to the rink"; "Winter Riddles"; "Count to ten"; "I play with sounds and syllables"; "It's dangerous on the street"; "Musical Riddles".*

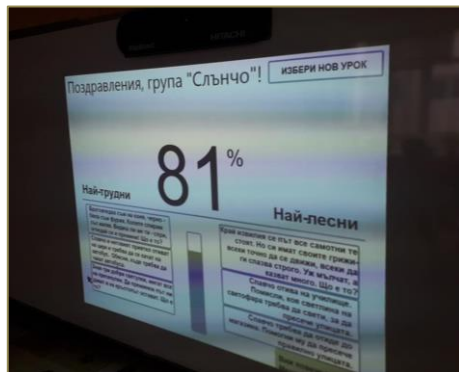


Fig. No. 58.

Fragment of topic No. 27. "It's dangerous on the street"

With Bee-bot technology: "Games with geometric shapes"; "Golden Autumn"; "Seasons"; "What I want to become"; "Fairy magic"; "I play and count to five"; "At home and on the street"; "Who pollutes and destroys nature"; "Domestic animals"; "Chain of sounds."



Fig. No. 40.

Fragment of topic No. 9. "Seasons"

With STEAM technology: "I've already grown up"; "Autumn Treasures"; "I paint with paints from nature"; "Let's send autumn"; "On the Trail of the Dwarves", "The Hour of the Code"; "I play with sounds and letters"; "My Street"; "Spring palette"; "Life in the city (in the village)"; "Favorite fairy-tale characters".



Fig. No. 38.

Fragment of topic No. 7. "Autumn Treasures"

2.2.3. The final stage is accompanied by a diagnostic procedure, which takes place in the month of May 2024 at the end of the school year in the experimental and control groups. The tasks are similar to those from the first stage of the study. They report the competences formed in both groups of children after conducting the training experiment.

The results of the conducted research and their analysis are presented in the third chapter.

CHAPTER THREE: ANALYSIS OF THE RESULTS OF THE CONDUCTED RESEARCH

To achieve the objectives of the study, a two-stage, nested sample was drawn. At the first stage, a sample is taken not from individually selected groups according to their list in the general population, but entire nests of units (selection of kindergartens). Then, at the second stage, random statistical units (groups, children) are determined in the selected nests, which form the sample.

The analysis of the results in the dissertation is presented through the summarized results of the study of incoming and outgoing diagnostics.

The children's skills are checked before the experiment is conducted and afterwards, using the system of criteria and indicators presented in the second chapter to prove/disprove the hypothesis.

An analysis of the results of the ascertainment experiment is presented in **paragraph 3.1.1.**

The ascertaining stage of the experimental work was realized at the beginning of the academic year 2023/2024. An incoming diagnosis was carried out, which established the level of the children according to each criterion for their readiness for school and the key competences specified in the regulations.

The input diagnostics serves as a baseline point of comparison, by which the effectiveness of the application of innovative educational technologies is evaluated in the last closing stage.

The children were offered 25 diagnostic tasks, distributed according to five criteria: *Language and speech skills, Mathematical skills, Social skills,*

Gross and fine motor skills and Digital skills, each criterion including five indicators (I1–I5).

The evaluation is established by a three-level scale (1 – low, 2 – medium, 3 – high level), which allows quantitative processing of the results and application of statistical methods.

Numerical characteristics – mean, standard deviation, variance, standard error and coefficient of variation – were calculated.

The results of the incoming diagnostics by criteria are presented in tables and diagrams.

Table № 3

CRITERIUM I – LANGUAGE AND SPEAKING SKILLS INITIAL DIAGNOSTICS					
Group	average value	standard deviation	dispersion	standard error	variation coefficient
EG	1.767	0.314	0.098	0.040	17.8%
CG	1.687	0.315	0.099	0.040	18.7%

The mean values for EG and CG are very close, which shows that the children have similar language and speech skills. Standard deviations in both groups (0.31) and coefficients of variation (17-18%) indicate a similar dispersion of individual achievements. Differences are minimal and fall within normal variability, with no outliers.

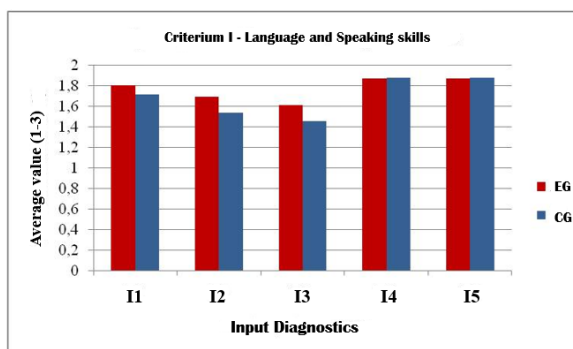


Diagram No. 1. Results of input diagnostics – Criterion I

The diagram represents the average values of EG and CG of the obtained results on the indicators of *Criterion I: Language and speaking skills*.

According to I1: *Active participation in dialogic communication and demonstrates a culture of verbal communication*, the children from EG (1.80) get involved more actively and talk about their families.

According to I2: *Understands the difference between a word and a sentence* and I3: *Determines the number of sounds in words*, EG has slightly higher results, but the values for CG are close. The differences are small - from 0.14 to 0.16.

According to I4: *Composes a short descriptive text orally* and I5: *Understands the main plot in various familiar texts*, the two groups achieve exactly the same average values (1.87), which show an equivalent level in these indicators.

The data confirm that they are almost the same in both groups - EG and CG at the beginning of the experiment, without significant differences, neither in the individual indicators, nor in the overall result according to criteria.

When conducting the diagnostics, it is established that the children have an average level of achievement, which is a prerequisite for having a good basis for working on language, speech and literacy preparation. They have the skills to participate in dialogue. Orally compose a short descriptive text. They tell a short story with the help of the teacher using assigned reference words. They distinguish a sentence from a text.

Table No. 4 presents the data for the second criterion: *Mathematical skills*.

Table № 4

CRITERION II – MATHEMATICS SKILLS INPUT DIAGNOSTICS					
group	average value	standard deviation	dispersion	standard error	variation coefficient
EG	1.836	0.311	0.097	0.040	16.9%
CG	1.832	0.316	0.099	0.040	17.2%

Here, too, the average values of EG and CG are practically identical, which proves that at the threshold of the fourth group they have the same mathematical skills. Standard deviations reflect good variability.

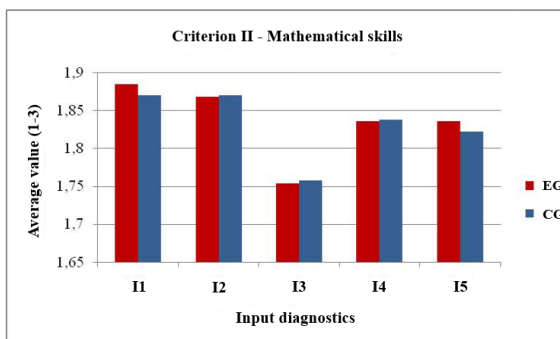


Diagram No. 2. Results of input diagnostics – Criterion II

According to I1: *Counting and relating the quantity* EG shows a slight advantage (1.86) compared to CG (1.82). The difference is minimal.

According to I2: *Determines spatial relations by "above", "under", "behind", "in front", "between"*, I3: *Finds the place of an omitted object in a serial line*, and I4: *Orientation in two-dimensional space* on a square grid again calculate the values between the two groups, with differences varying within the limits of 0.02-0.05 points.

According to I5: *Differentiates and names geometric shapes*, the results are almost identical, which testifies to an even mastery of the basic geometric concepts at the beginning of the experiment.

The data confirm that the mathematical readiness of the children in both groups is practically the same and the achievements guarantee success in mathematics situations during the school year.

Table No. 5 describes the data for the next criterion - *Social skills*:

Table № 5

CRITERION III – SOCIAL SKILLS					
INPUT DIAGNOSTICS					
Group	average value	standard deviation	dispersion	standard error	variation coefficient
EG	1.895	0.252	0.063	0.032	13.3%
CG	1.923	0.203	0.041	0.026	10.5%

With this criterion, the difference is again small (0.028) at the average value, with CG showing a minimally higher result than EG.

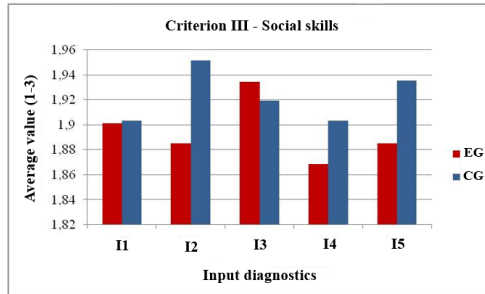


Diagram No. 3. Results of input diagnostics – Criterion III

On I1: *Expresses his right to choose and initiative among others*, EG shows a minimal lower value than CG (1.88 vs 1.93), but the difference is statistically insignificant.

Indicators I2: *Recognizes professions from different fields and their importance in people's lives*, I3: *Names personal, official and national holidays, local customs and traditions* and I4: *Understands the difference between role-playing and real relationships* demonstrate almost identical values between groups. Again, it is confirmed that social skills in both groups are close.

According to I5: *There are ideas about the school - classroom, furniture, teaching aids needed by the student* - EG and CG achieve the same result, which is an indicator of forming a desire to enter school by creating motives for readiness for school.

Table No. 6 reflects the data for the next criterion - *Gross and fine motor skills*:

Table № 6

CRITERION IV – GROSS AND FINE MOTOR SKILLS INPUT DIAGNOSTICS					
Group	average value	standard deviation	dispersion	standard error	variation coefficient
EG	1.895	0.252	0.063	0.032	13.3%
CG	1.935	0.210	0.044	0.027	10.9%

The difference in results is very small (0.04) and does not indicate structural differences. Children's motor skills develop relatively evenly, and this is also evident from the variability.

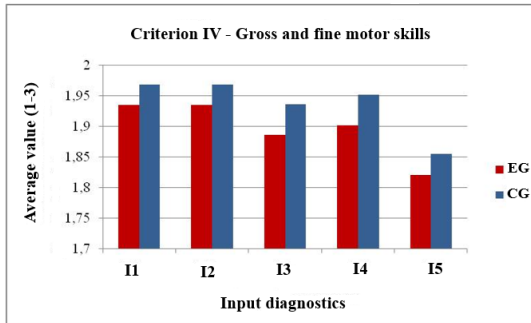


Diagram No. 4. Results of the input diagnostics – Criterion IV

In I1: *Controlling hand-eye coordination* and I2: *Demonstrating initial graphic skills*, the results show a difference of less than 0.05 points, which means practically identical data for both groups. The average values are also almost equal.

In I3: *Recognizing and naming graphic signs of some printed letters* and I4: *Planning the sequence of actions and the use of different materials and techniques*, very close results are again observed, which show a similar level of mastery of elementary gross and fine motor skills.

In I5: *Showing activity in mobile and competitive games*, EG and CG also demonstrate the same levels, which confirm homogeneity between the groups.

The results of the indicators of both groups are equivalent.

In **Table No. 7**, the data for the last criterion – *Digital skills* are reflected:

Table № 7

CRITERION V – DIGITAL SKILLS INPUT DIAGNOSTICS					
Group	average value	standard deviation	dispersion	standard error	variation coefficient
EG	1.630	0.247	0.061	0.032	15.2%
CG	1.561	0.229	0.052	0.029	14.6%

Here, the values for both groups are low. The differences are small and indicate that the children have little experience working with an interactive whiteboard, digital devices, and software games.

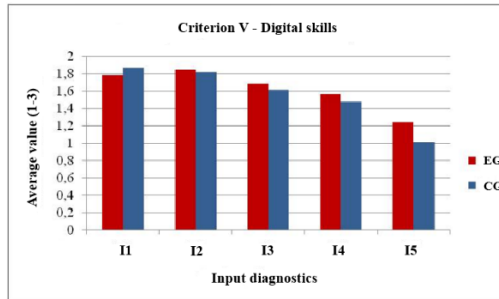


Diagram No. 5. Results of the input diagnostics – Criterion V

The diagram shows that for I1: Has an idea of the role of technology in toys with batteries, lights, sound, computers and others and I2: Knows individual capabilities of communication and information devices, the two groups achieve similar results, with the CG having a slight increase (difference of about 0.05).

For I3: Has an idea of the purpose of some electronic and electrical devices and the safety rules for their use and I4: Participation in a small joint project in kindergarten, the data also show minimal differences, without a structural trend.

For I5: Work in a software environment, the values are lowest in both groups, since the skills are highly dependent on the educational environment in kindergarten, as well as on the conditions and environment in the family.

Diagram No. 6 represents the integral comparison between the experimental and control groups for all criteria from the incoming diagnostics.

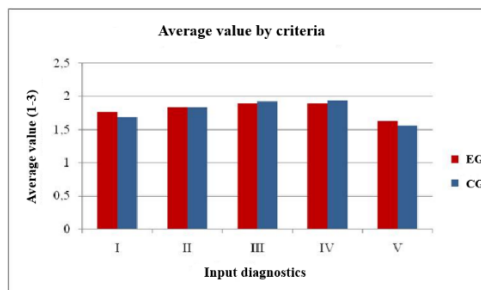


Diagram No. 6. General diagram of input diagnostics by all criteria

The closest results are for **Criterion II: Mathematical skills**, **Criterion III: Social skills** and **Criterion IV: Gross and fine motor skills**, where the mean values are almost the same. (< 0.03). This shows that children from the EG and CG before the experiment have the same skills.

For **Criterion I: Language and speech skills** and **Criterion V: Digital skills**, minimal differences are observed, but they fall within the limits of natural age variability and do not reach the thresholds for statistical significance. This is an important argument in favor of the equivalence between the two groups before the experiment.

In summary, the diagram shows a lack of clearly expressed trends that would put one of the groups in a more favorable initial position. The results confirm: the even distribution of skills, the validity of the experimental design, which requires homogeneity of the groups before pedagogical impact.

In order to confirm this visual assessment, an additional statistical test was performed using Student's t-test for independent samples. In accordance with the objectives of the experiment, the following hypotheses were formulated:

✓ **Null hypothesis (H₀):** there are no statistically significant differences in the mean values of EG and CG at the entrance to the experiment for all criteria.

✓ **Alternative hypothesis (H₁):** there are statistically significant differences between the two groups.

The choice of the t-test is determined by the specifics of the study:

- The sample is of a sufficiently large volume. (N = 123 children);
- The variances of the two groups are comparable;
- The groups are independent, since different children are examined under the same conditions.

A standard significance level of $\alpha = 0.05$ is assumed. For each criterion, an empirical t-stability was calculated, which was compared with the critical value t-cr at this significance level.

The results of the t-test, with mean values and standard deviations according to the criteria, are presented in **Table No. 8**:

Table No. 8

Results of Student's t-test for independent samples

GROUPS	N	X	S	t_{em}	P
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<i>EG I</i>	61	1.77	0.31	1.412	0.1606
<i>CG I</i>	62	1.69	0.31	-	-
<i>EG II</i>	61	1.84	0.31	0.067	0.9464
<i>CG II</i>	62	1.83	0.32	-	-
<i>EG III</i>	61	1.90	0.25	-0.666	0.5066
<i>CG III</i>	62	1.92	0.20	-	-
<i>EG IV</i>	61	1.90	0.25	-0.964	0.3368
<i>CG IV</i>	62	1.94	0.21	-	-
<i>EG V</i>	61	1.63	0.25	1.588	0.1148
<i>CG V</i>	62	1.56	0.23	-	-

The lack of statistically significant differences between the EG and the CG ($p > 0.05$ for all criteria) confirms that the two samples are equivalent in terms of competence levels.

Therefore, it can be concluded that the EG and the CG begin the experiment from a statistically homogeneous level of preparation for school in terms of language, mathematics, social, motor and digital skills.

Paragraph 3.1.2. Analysis of the results of the final experiment

The output diagnostics was conducted in May, at the end of the school year, in parallel with the EG and the CG. It includes 25 diagnostic tasks, constructed in accordance with the criteria and indicators for tracking children's achievements in the exit diagnostics. The tasks are completely analogous in structure and content to the entry diagnostics.

In this way, methodological comparability between the two stages is guaranteed and the possibility of reliable measurement of the change that occurred as a result of the pedagogical experiment is provided.

The assessment is carried out using a three-point scale (1 – 3 points), similar to that used in the ascertaining stage. The application of the same scale at both stages validly allows for the natural development of children's skills and provides conditions for quantitative analysis of the dynamics of achievements.

The main characteristics of the result are summarized in tables 8 – 12. These indicators allow:

- accurate comparison between groups on each criterion;
- tracking the degree and direction of the changes that have occurred;
- isolating the effect when using innovative educational technologies –

Envision multi-mouse system, **Bee-bot robotic toys** and **STE(A)M** approach.

Table № 9

CRITERION I – LANGUAGE AND SPEAKING SKILLS OUTPUT DIAGNOSTICS					
group	average value	standard deviation	Dispersion	standard error	variation coefficient
EG	2.28	0.390	0.152	0.049	17.1%
CG	1.99	0.262	0.068	0.033	13.1%

The table shows that the mean value is significantly higher in the EG (2.28) compared to the CG (1.99).

The standard deviation is higher in the EG (0.39) compared to the CG (0.26), which means a wider distribution of achievements and a larger proportion of children reaching a high level.

The reduced variability in the EG indicates a more stable and even development, while the data in the CG are around the low level. This is the first strong indicator of the effect of **Envision** and **STE(A)M** on communicative competence. The results demonstrate a strong positive effect on language and speech skills precisely in the EG.

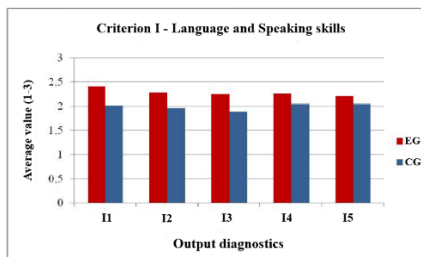


Diagram No. 7. Results of the output diagnostics – Criterion I

The diagram for *Criterion I: Language and speaking skills* illustrates the distribution of the average values for the five indicators. In all indicators, the EG demonstrates an advantage over the CG.

The largest difference is registered in I1: *Active participation in dialogical communication* (EG–2.40; CG– 2.01), which is an indicator of higher activity, with a very good basis for working on speech development.

For I2: *Understands the difference between a word and a sentence* and I3: *Determining the number of sounds in a word*, the EG shows (2.28–2.24), and the CG (1.95–1.88), which indicates a better developed language culture.

For I4: *Composes a short descriptive text orally* and I5: *Understands the main plot in various familiar texts*, the differences are more moderate, but again higher in the EG (2.26 and 2.20), and in the CG (2.05 and 2.05).

Here, the results show that after the pedagogical experiment, children from the experimental group demonstrate a higher level of language and speech skills.

Table № 10

CRITERION II – MATHEMATICS SKILLS OUTPUT DIAGNOSTICS					
group	average value	standard deviation	Dispersion	standard error	variation coefficient
EG	2.22	0.395	0.156	0.050	17.84%
CG	2.04	0.220	0.048	0.028	10.81%

In Table No. 10, the average value in the EG (2.22) exceeds the one in the CG (2.04), which shows a clear progress in the mathematical skills of the children included in the experiment.

The standard deviation in the EG (0.395) is higher than that in the CG (0.220), i.e. some of the children in the EG have moved to higher levels of achievement, while the results in the CG are around the average level.

The coefficient of variation $V\% = 17.84$ in the EG and 10.81 in the CG confirms the more dynamic variable in the experimental group.

The data analysis shows that the EG (2.22) shows higher results than the CG (2.04) in terms of mathematical skills.

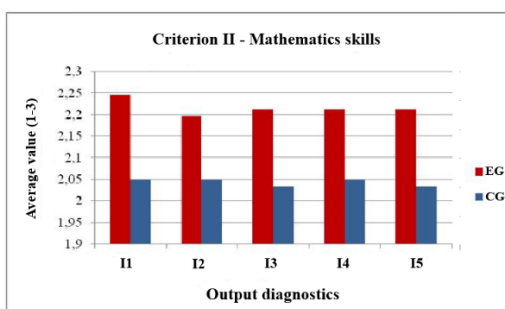


Diagram No. 8. Results of the output diagnostics – Criterion II

In all indicators of *Criterion II: Mathematical skills*, the average values of the EG are higher than those of the CG.

The advantage is most clearly expressed in I1: *Counting and correlating quantity* - the EG (2.25) surpasses the CG (2.05), which indicates a more stable mastery of mathematical knowledge.

In I2: *Determines spatial relationships through "above", "under", "behind", "in front", "between"*, I3: *Finds the place of a missed object in a serial row*, I4: *Orients in two-dimensional space using a square grid* and I5: *Distinguishes and names geometric figures*, the values are very close within each indicator, but higher in the EG (2.20–2.21) compared to the CG (2.03–2.05). This means that the EG children reach a high level of achievement, while in the CG an average level of achievement prevails.

Table № 11

CRITERION III – SOCIAL SKILLS OUTPUT DIAGNOSTICS					
group	average value	standard deviation	dispersion	standard error	variation coefficient
EG	2.34	0.374	0.140	0.047	16.01%
CG	2.03	0.225	0.050	0.028	11.07%

The data from Table 11 shows the strongest progress precisely in *Criterion III*. The average value in the EG (2.34) significantly exceeds that in the CG (2.03).

The increased values of the standard deviation and the coefficient of variation in the EG show that a large part of them have reached high levels of social skills, while in the CG the results are around the average level.

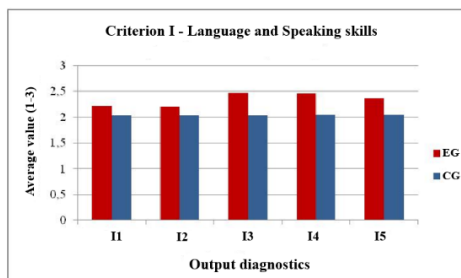


Diagram No. 9. Results of the output diagnostics – Criterion III

The diagram shows that one of the strongest effects of the pedagogical experiment is observed for *Criterion III: Social skills*. The average values for EG vary from 2.21 to 2.48, while for CG go around 2.03–2.05.

For I1: *Expresses his right to choose and initiative among others* and I2: *Recognizes professions from different fields*, EG has moderate but stable results (EG: 2.21–2.20; CG: 2.03), which indicates better orientation in the social environment and recognizes different professions.

The most distinct differences are for I3: *Names holidays, local customs and traditions* and I4: *Understands the difference between role and real relationships*. Here EG reaches (2.48) and (2.46) as opposed to (2.03–2.05) for CG.

In I5: *Has ideas about the school*, the advantage is also in favor of EG (2.36 versus 2.05).

Table № 12

CRITERION IV – GROSS AND FINE MOTOR SKILLS OUTPUT DIAGNOSTICS					
group	average value	standard deviation	dispersion	standard error	variation coefficient
EG	2.24	0.393	0.155	0.050	17.54%
CG	2.05	0.223	0.049	0.028	10.87%

The data in Table № 12 show that the average value of the EG (2.24) is higher than that of the CG (2.05). This ensures better formation of coordination, graphomotor and motor skills as a result of the inclusion of motor-game and manipulative activities in the experimental environment.

The higher coefficient of variation in the EG (17.54) indicates that some of the children have reached a high level, while the result in the CG remains around the average (10.87).

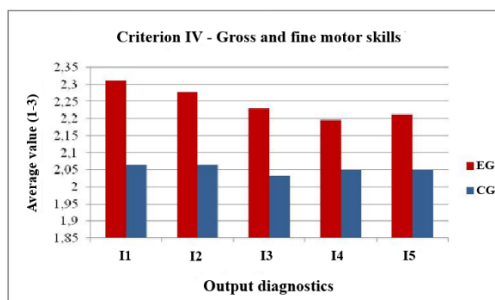


Diagram No. 10. Results of the output diagnostics – Criterion IV

In *Criterion IV: Gross and fine skills*, the EG also demonstrated higher average values for all indicators (2.20–2.31), compared to the CG (2.03–2.06).

In I1: *Controls hand-eye coordination* and I2: *Demonstrates initial graphic skills*, the EG has a clear advantage (2.31 and 2.28) over the CG (2.06 and 2.06), which indicates better results in fine skills and motor readiness.

In I3: *Recognizing and naming graphic signs of some printed letters related to the names of familiar people and objects*, I4: *Planning the sequence of actions and using different materials* and I5: *Showing activity in mobile and competitive games*, the average values of the EG range between (2.20 and 2.23), while in the CG they remain around (2.03–2.05).

Although the differences are not as large as in social and digital skills, the data show better results in motor and graphic tasks in the experimental group.

Table № 13

CRITERION V – DIGITAL SKILLS OUTPUT DIAGNOSTICS					
group	average value	standard deviation	dispersion	standard error	variation coefficient
EG	2.32	0.404	0.163	0.05172	17.43%
CG	1.84	0.298	0.088	0.037888	16.22%

The table represents the pronounced difference between the two groups. The mean value of the EG (2.32) significantly exceeds that of the CG (1.84). This is the largest measured effect in the entire experiment.

The standard deviation for the EG (0.404) shows a wider dispersion, due to the fact that many children have moved to a high level. For the CG (0.298) the dispersion is lower, which suggests limited progress and weaker dynamics.

The coefficient of variation for the EG ($V\% = 17.43\%$) is significantly higher, which reflects better pedagogical work. For the CG ($V\% = 16.22\%$) the variability is mainly due to individual differences, and not to the pedagogical impact.

This criterion is the strongest indicator of the effectiveness of the applied innovative educational technologies.

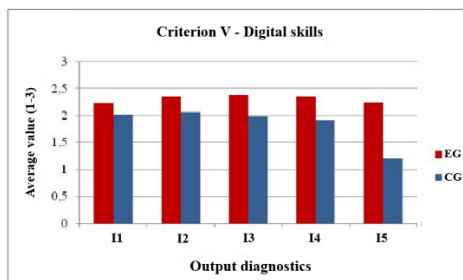


Diagram No. 11. Results of the output diagnostics – Criterion V

The average values for EG on all indicators are significantly higher (2.23–2.39), while for CG they range between (1.21 and 2.06).

On I1: *Has an idea about the role of technology* EG (2.23) higher results than CG (2.02), but the difference is greater on the following indicators.

On I2: *Knows individual capabilities of communication and information devices* and I4: *Participation in a small joint project in kindergarten* EG reaches (2.36) compared to (2.06 and 1.92) for CG.

This shows that in the control group a significant part of the children remain at a low level on these indicators, while in EG the average and high levels prevail.

The biggest difference is on I3: *Has an idea about the purpose of some electronic and electrical devices* and I5: *Work in a software environment*.

In I3 EG reaches (2.39), while CG remains at (1.98). At I5 the difference is particularly significant – (2.25) compared to (1.21). This means that a significant proportion of children in the control group remain at a low level on this indicator, while in the EG average and high achievements prevail.

The data show that digital skills are the area in which the effect of the *Envision multi-mouse technology, the Bee-Bot robotic toys and the STE(A)M approach is most clearly and categorically manifested.*

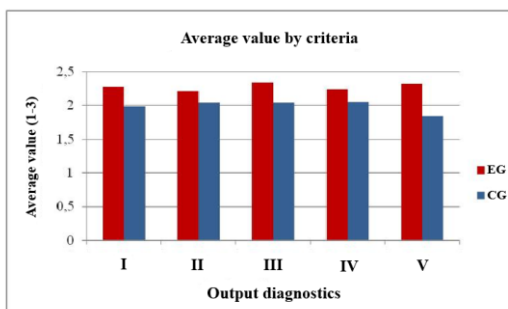


Diagram No. 12. General diagram of the output diagnostics by all criteria

The general diagram, reflecting the average values for five criteria for the output diagnostics, shows a clearly expressed and structurally consistent trend: EG shows higher results than CG on all criteria, with the differences being both numerically distinct and pedagogically significant.

This trend testifies to the effectiveness of the innovative educational technologies applied in the course of the pedagogical experiment.

The average values of EG vary in the interval (2.22–2.34) and show a steady transition to a high level of achievements.

In contrast, the results of CG are in the range (1.84–2.06), which outlines a predominantly average level.

The largest differences are in:

Criterion V: Digital skills – EG reaches (2.32), and CG barely (1.84). This is the largest difference and shows that innovative educational technologies have an extremely high transformative effect on digital competence.

Criterion III: Social Skills – EG: 2.34, CG: 2.04. Here, the results achieved by pedagogical interactions, compatible tasks and STE(A)M activities lead to visible changes in self-regulation, interaction and social activity.

These values not only exceed the result of the input diagnostics, but also show a qualitatively different profile of the groups at the end of the experiment.

Table No. 14**Results of Student's t-test for independent samples**

GROUP	N	X	S	t_{em}	P
EG I	61	2.28	0.39	4.85	0,001
CG I	62	1.99	0.26	-	-
EG II	61	2.22	0.40	3.13	0.002
CG II	62	2.04	0.22	-	-
EG III	61	2.34	0.38	5.38	0.001
CG III	62	2.04	0.23	-	-
EG IV	61	2.25	0.39	3.47	0.001
CG IV	62	2.05	0.22	-	-
EG V	61	2.32	0.40	7.51	0.001
CG V	62	1.84	0.30	-	-

In order to determine whether the reported differences in the achievements between the experimental and control groups of the exit diagnostics are statistically significant and not due to natural age dynamics, student's t-test for independent samples was applied.

In accordance with the objectives of the study, the following hypotheses were formulated:

Null hypothesis (H₀): *there are no statistically significant differences in the mean values according to the research criteria of the exit diagnostics between the EG and the CG.*

Alternative hypothesis (H₁): *there are statistically significant differences between the EG and the CG according to the research criteria of the exit diagnostics.*

The standard significance level $\alpha = 0.05$ is assumed, and the critical value of the t-test for approximately 121 degrees of freedom is $t\text{-cr} \approx 1.98$. The decision to accept or reject the null hypothesis is based on the following rule:

- if $|t_{emp}| > t\text{-cr}$ and $p < \alpha \rightarrow H_0$ is rejected, H_1 is accepted \rightarrow there is a statistically significant difference between the EG and the CG;
- if $|t_{emp}| \leq t\text{-cr}$ and $p \geq \alpha \rightarrow H_0$ is accepted, H_1 is rejected \rightarrow there is no statistically significant difference.

The data presented in Table 13 show that for all criteria the empirical values of the t-criterion exceed the critical value $t\text{-cr} = 1.98$, and the obtained

p-values are less than $\alpha = 0.05$. This means that the null hypothesis (H_0) is rejected for all criteria and the alternative hypothesis (H_1) is accepted: between the experimental and control groups at the output stage there are statistically significant differences in achievements on all the criteria studied.

The highest t-stabilities are registered in:

- **Criterion V: Digital skills** ($t_{\text{emp}} = 7.51$; $p < 0.001$) and
- **Criterion III: Social skills** ($t_{\text{emp}} = 5.38$; $p < 0.001$), which shows that between these two criteria the effect of innovative educational technologies is the strongest and most clearly expressed.

Significant differences are also observed in:

- **Criterion I: Language and speech skills** ($t_{\text{emp}} = 4.85$; $p < 0.001$);
- **Criterion IV: Gross and fine motor skills** ($t_{\text{emp}} = 3.47$; $p \approx 0.001$);
- **Criterion II: Mathematical skills** ($t_{\text{emp}} = 3.13$; $p \approx 0.002$).

In all cases, the mean values of the experimental group are statistically and pedagogically higher than those of the control group, which indicates a real qualitative increase in achievements as a result of the pedagogical experiment.

In summary, the results of the t-test for the output diagnostics unequivocally confirm that the innovative educational environment (*Envision* multi-mouse technology, *Bee-Bot* robotic players and the *STE(A)M* approach) has a statistically significant and pedagogically significant effect on the effectiveness of the key competencies of children in the experimental group.

In addition to the analysis of the mean values and statistical differences between the groups, the distribution of high achievements is of particular importance for the results.

High achievements are the most stable indicator of qualitative mastery of competencies and reflect the real degree of mastery of the skills set in the state educational standards.

The data from the output diagnostics show a clear shift of a large part of the children in the experimental group to a high level, while in the control group the retention of the average level prevails and only a limited number of children moved to the high level.

The summarized conclusions are:

- Experimental group (EG): a significant part of the children achieved a high level in many indicators - between 28% and 45% depending on the criterion;

- Control group (CG): the share of children with high achievements is significantly lower - between 3% and 12%, with high results practically absent in some indicators (especially in digital skills).

The highest relative share of high achievements in the EG is observed in:

- **Criterion V: Digital skills**, where high achievements are dominant (for example, in I3 and I5);

- **Criterion III: Social skills**, especially in I3 and I4, where more than a third of the children reach the maximum level;

- **Criterion I: Language and speech skills**, where over 30% of children achieve high results, especially in I1 and I4.

In contrast, in the control group: high achievements are scarce in most indicators; the distribution is around the average level.

Analysis of high achievements shows that:

1. The experimental group not only increases the average results, but also qualitatively transforms the structure of achievements, with a significant part of them reaching *high competence* in all criteria.

2. The control group retains the natural age dynamics, but does not show a leap towards high achievements - there is no qualitative transition.

3. The most pronounced effect is in digital and social skills, which directly corresponds to the nature of the technologies used:

Envision - increased interactivity and cooperation;

Bee-Bot - logical thinking, spatial orientation, regulation;

STE(A)M - teamwork, creative problem solving, design.

The high achievements confirm the effect of the innovative educational environment, regardless of the results of the control group, which serves as a strong evidence of the effectiveness of the experiment.

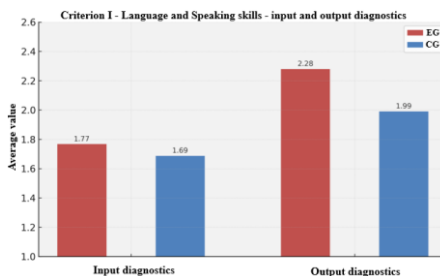


Diagram No. 13. Comparative diagram of the results under Criterion I

The comparison between the input and output diagnostics for **Criterion I: Language and speech skills** shows a clear distinction between the two groups at the end of the experiment.

In the EG, the average value increased from (1.77) to (2.28), which represents significant progress and a transition from an average to a high level in language and speech skills.

The most intense increase was in the indicators related to dialogical communication and creating an oral text.

In the CG, the increase was significantly smaller – from (1.69) to (1.99). The obtained value is at the average level.

The difference between the EG and the CG at the output (0.29 points) is pedagogically significant: It reflects a qualitatively higher degree of language readiness in the EG children who participated in the pedagogical situations with interactive resources of the publishing houses, tasks on an interactive board and game situations in the Educational Direction – Bulgarian Language and Literature.

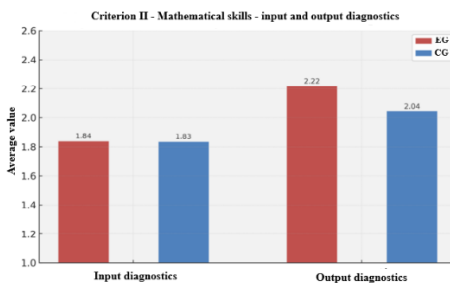


Diagram No. 14. Comparative diagram of the results under Criterion II

Comparison of the results of the input and output diagnostics according to **Criterion II: Mathematical skills** shows a clearly more favorable dynamics in the experimental group compared to the control group.

At the input, the two groups start from practically identical positions – the average value in the EG is (1.84), and in the CG it is (1.83), i.e. the math skills are equal and are in the zone of average achievements on the three-point scale.

At the exit of the pedagogical experiment, a clear divergence of the results is observed. In the EG, the average value increases (2.22), which means a transition to a sustainable predominance of average to high achievements. In the CG, the increase is weaker - (2.04).

The difference between the groups at the output (0.18 points) reflects a real improvement in counting, quantitative relations, spatial orientation and work in two-dimensional space in the EG children.

In the EG, mathematical skills are developed in the context of game situations with Bee-Bot robotic toys, square grid tasks, activities related to the STE(A)M approach, as well as work in a digital environment that requires seriation, orientation and logical thinking.

This probably explains the greater jump in achievements, while in the CG, where the educational environment is mainly based on traditional methods, progress remains limited to the natural development of already available basic concepts.

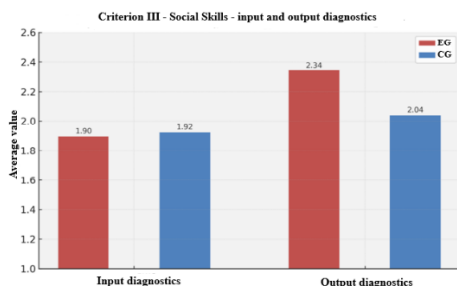


Diagram No. 15. Comparative diagram of the results under Criterion III

Criterion III: Social skills registered one of the strongest effects of the pedagogical experiment. At the entry level, the average values of the two groups are practically equal - (1.90) for EG and (1.92) for CG.

This shows that the children in the two groups have similar results in the tasks on social roles, holidays, professions and the school environment, as well as in relation to the close degree of social maturity at the end of the study.

However, at the exit, the profiles differ clearly. The average value for EG reaches (2.34), while for CG it is (2.04).

The increase in EG allows for a transition to a dominant high level in most of the indicators - especially in terms of naming holidays and traditions, understanding roles and real relationships, as well as ideas about the school as an institution. In CG, the progress is significantly more moderate and the results remain in the zone of average achievements.

This differentiation can be explained by the nature of the activities in the EG – interactive projects, joint games, role-playing situations, activities and STE(A)M tasks for teams, aimed at pedagogical interaction and sharing. The inclusion of digital and robotic tools is not only for cognitive development, but also for the formation of social skills – skills for negotiation, waiting for one's turn, and cooperation and role-taking.

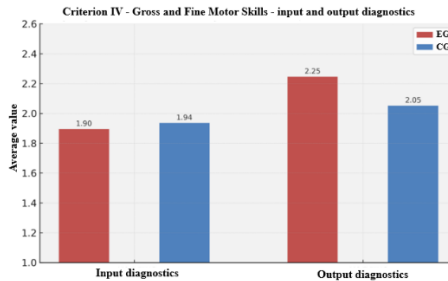


Diagram No. 16. Comparative diagram of the results under Criterion IV

The comparative analysis on *Criterion IV: Gross and fine motor skills* also shows that the EG exhibits higher results, although with more moderate differences compared to digital and social skills. At the input diagnostics, CG has a slight advantage - (1.94) and (1.90) for EG, but this difference is insignificant and is considered normal in the motor development of children.

At the exit diagnostics, the picture changes in favor of EG: the average value increases to (2.25), while in CG the value reaches (2.05). Progress is

visible in both groups, but in EG it is more pronounced and leads to higher achievements of children.

This is manifested in better eye-hand coordination, more confident graphic actions, more purposeful use of materials and techniques, as well as more active participation in mobile and competitive games.

Working with multi-mouse technology, playing with robotic toys, and performing STE(A)M tasks require precise movements, coordination, following the sequence of actions, and constant adaptation. These activities are naturally obtained with both fine and gross motor skills.

In the control group, such activities are more limited, which explains the weaker growth – progress is present, but it mainly reflects natural development, and not the effect of a purposeful innovative impact.

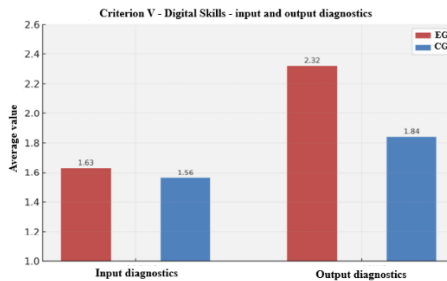


Diagram No. 17. Comparative diagram of the results under Criterion V

Criterion V: Digital skills is the clearest and most definitive indicator of the effectiveness of the experiment. At the input stage, the average values are relatively low in both groups – (1.63) for EG and (1.56) for CG, which is expected, since digital skills at this age are not yet purposefully formed and depend mainly on the family environment. The difference between the groups is minimal.

However, at the output, the largest difference between EG and CG in the entire experiment is observed. In the experimental group, the average value increases to (2.32), which means that the majority of children reach an average high level in all digital indicators.

In CG, the increase is much more limited – (1.84), which outlines a profile in which a significant share of children remain at a low or average level.

This differentiation is particularly clear in the indicators related to working in a software environment, participation in a small joint project, knowledge of the purpose and safe use of electronic/electrical devices.

In the EG, digital skills are formed - children use the devices to solve problems, model situations and work together. In the CG, digital skills are partial, only as an observation, which explains the lower results.

From a pedagogical perspective, **Criterion V** confirms that the pedagogical experiment with *Envision* multi-mouse technology, *Bee-Bot* robotic toys and the *STE(A)M* approach creates a new educational environment in which digital skills are developed purposefully, systematically and in close connection with other key skills.

It is here that the effect of innovative educational technologies is strongest and clearly limits the experimental group from the control group.

The analysis of the results of the conducted experimental study is the basis for conclusions, proving/rejecting the hypothesis, as well as a starting point in planning and organizing an educational environment with the application of innovative educational technologies.

Diagram 18 visualizes the results of the conducted input and output diagnostics in the experimental and control groups.

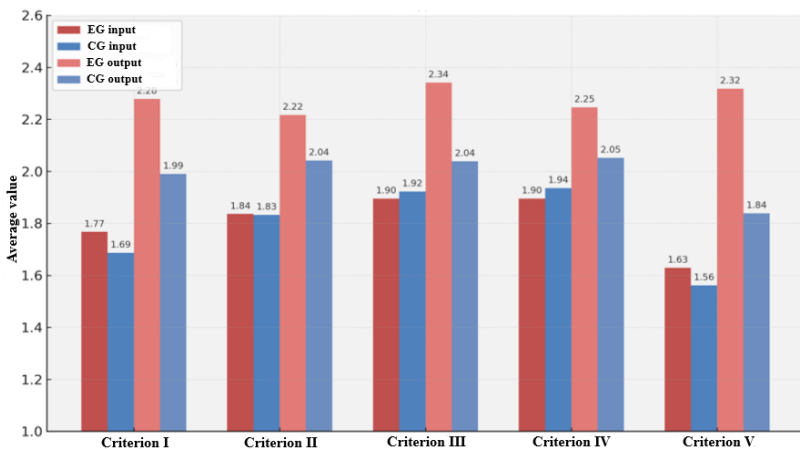


Diagram No. 18. Comparative diagram of results for all criteria – input and output diagnostics

After all said and done, the following **generalizations** can be formulated:

1. ***Methodological homogeneity of the groups***: At the ascertaining stage, EG and CG do not differ statistically, which guarantees the objectivity of the results.

2. ***Innovative educational technologies have a positive effect***: All criteria show higher results in EG; the differences are statistically and pedagogically significant.

3. ***The results in digital skills mastery increase the most***: Pedagogical situations with *Envision*, *Bee-bot* and *STE(A)M* lead to an increase in knowledge and the formation of competencies.

4. ***Social skills are developed through group/team tasks***: *STE(A)M* activities and common projects lead to an increase in initiative, empathy and teamwork.

5. ***Language and mathematical competencies are increased through interactive game tasks***: *Envision* and *Bee-bot* increase the sustainability and accuracy of performance.

6. ***The combination of innovative educational technologies is more effective than traditional methods***: The integration between *Envision*, *Bee-bot* and *STE(A)M* gives a complex pedagogical effect that cannot be achieved with traditional approaches.

This proves that innovative educational technologies have an impact on the effectiveness of knowledge acquisition and the formation of key competencies of children in preparation for school through their application in the experimental group.

CONCLUSION

The results of the experimental work show that the use of innovative educational technologies leads to increased cognitive activity, improved communicative and social skills, greater independence and sustainable interest in learning. This conclusion is the basis for proving the hypothesis, namely, that if pedagogical situations with various innovative educational technologies are developed and implemented in the process of education in kindergarten for children of the fourth age group, they will contribute to increasing the effectiveness of knowledge acquisition and formation of competencies in their preparation for school.

Innovative educational technologies become not just a tool, but a means of creating an integrated and engaging pedagogical environment. Through them, children reach certain knowledge and skills that are a prerequisite for school readiness.

The preschool teacher faces the permanent challenge of discovering non-traditional methods and forms of work for the formation of the competencies set out in the standards of the program content. Moreover, in the context of preschool education, to adapt them to the different capabilities of children. For this purpose, it is necessary to improve their pedagogical skills.

The use of software solutions such as the multi-mouse system, robotic bees, as well as STEAM technologies, are part of the possibilities for disrupting the learning process. They create a rich, stimulating and supportive educational environment in which children feel motivated, confident and active participants in their own development towards a successful start to school.

School readiness is a complex and long-term process in which all participants in the educational process are (should be) included. According to the Preschool and School Education Act (Art. 2(2)), these are: children, teachers, principals and other pedagogical specialists, as well as parents. Each of them (directly or indirectly) has their own contribution to the successful formation of competencies, but the key role is of pedagogical specialists. This role is determined by the fact that they implement the goals set in the state educational policy. This study, which does not claim to be exhaustive, is a kind of provocation to all participants in the process of preparing children for their new role – that of a student.

CONTRIBUTIONS OF THE DISSERTATION:

1. Basic theories and concepts related to the preparation of children for school are systematized. Normative statements are presented, through which the transition from one educational institution to another is carried out.

2. Direct and indirect factors on the preparation of children for school are identified. Types of readiness and ways to build them are analyzed.

3. In the context of competency-based education, innovative methods of pedagogical communication are studied. Educational software resources are adapted for the purposes of education in kindergarten, as well as the possibilities of STEM education.

4. A system of criteria and indicators for reporting children's readiness for school in the context of competency-based education is derived.

5. A system of exercises has been developed for the purposes of the educational experiment, which are set in an educational environment that differs from the traditional one.

6. The author's system of exercises supports the work of preschool teachers in the process of forming competencies. Having proven its effectiveness, the didactic technology is presented to preschool teachers, both through internal and external qualification.

PUBLICATIONS
RELATED TO THE TOPIC OF THE DISSERTATION

1. **IVANOVA, M.** 2022. Electronic resources to help the kindergarten teacher – *Yearbook of “Konstantin Preslavsky” University of Shumen, Faculty of Pedagogy*, Vol. XXVI D, Shumen, University Publishing House “Konstantin Preslavsky”, pp. 489–495, ISSN 1314 – 6769, 2022.

2. **IVANOVA, M.** 2023. About books and mice in kindergarten – *Yearbook of “Konstantin Preslavsky” University of Shumen, Faculty of Pedagogy*, Vol. XXVII D, Shumen, University Publishing House “Konstantin Preslavsky”, pp. 437–477, ISSN: 1314-6769; COBISS.BG-ID – 1276339428, 2023.

3. **IVANOVA, M.** 2024. Modern educational technologies in kindergarten – *Collection of scientific works of students and doctoral candidates from the Faculty of Pedagogy of “Konstantin Preslavsky” University of Shumen*, Shumen, University Publishing House “Konstantin Preslavsky”, pp. 50–54, ISSN: 2367-5764, 2024.