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OPPORTUNITIES OF CHATBOT TECHNOLOGY IN DEVELOPING COMPUTATIONAL SKILLS OF VISUALLY IMPAIRED PRIMARY SCHOOL STUDENTS

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Abstract. Currently, the use of artificial intelligence technologies in the education system is expanding new opportunities for individualization and digitalization of the learning process. In particular, ChatBot technology plays an important role in inclusive education, as it enables the creation of a learning environment adapted to the individual educational needs of students.

This article scientifically examines the effectiveness of ChatBot technology in developing the calculation culture of primary school students with visual impairments. During the study, the pedagogical and psychological aspects of using ChatBots in inclusive education were analyzed.

The research methodology was based on theoretical and empirical approaches. Within the theoretical analysis, scientific literature related to inclusive education, digital technologies, and the use of artificial intelligence was reviewed. At the empirical stage, a survey of teachers was conducted and pedagogical observation was organized. In addition, ChatBot-based tasks designed for primary school students with visual impairments were developed and implemented in the learning process. The obtained data were processed using comparative-analytical methods.

The results of the study proved that ChatBot technology is an effective digital tool for developing the calculation culture of primary school students with visual impairments. This technology ensures active participation of students in the learning process by presenting learning materials in an accessible, understandable, and interactive form. Furthermore, the use of ChatBots contributes to the systematic development of calculation skills, increases learning motivation, and enhances independent learning abilities. In inclusive education settings, it serves as an important pedagogical resource that considers the individual needs of students.

However, during the study, several limitations related to technical support and methodological adaptation were identified. Addressing these issues is an essential condition for the effective integration of ChatBot technology into the educational process.

Overall, ChatBot technology is considered a promising innovative tool aimed at improving the academic achievements of students with special educational needs, and further research is required to expand its capabilities in the future.

Keywords: students with low vision, Chatbot, artificial intelligence, inclusive education, education of learners with visual impairments, computational skills, digital technologies, primary school students

Introduction

At the current stage of development of the education system, ensuring equal opportunities for children with special educational needs is considered one of the strategic priorities. In this regard, improving the process of teaching mathematics to primary school students with visual impairments and developing their calculation skills is regarded as a scientifically and practically significant direction. The implementation of this task requires not only the renewal of educational content but also the modernization of teaching methods and tools.

Artificial intelligence technologies provide a qualitatively new level of individualization and adaptation in the educational process. In inclusive education settings, AI-based tools take into account learners' individual characteristics, enhance their cognitive activity, regulate the pace of learning material acquisition, and support the development of independent learning skills. In particular, for students with visual impairments, the availability of features such as audio support, text enlargement, and interactive feedback significantly increases the accessibility of the learning process. [1] The integration of information and communication technologies into education is regarded as an important factor in the modernization of teaching. This process not only updates educational content but also aims to enhance learners' cognitive activity and individualize instruction. Scientific studies widely explore the didactic potential of digital technologies and confirm their effectiveness in organizing the learning process. For instance, domestic researchers emphasize the need to strengthen the learner's role as an active subject, while international scholars highlight the interconnection between learning and development, constructivist learning principles, and the importance of considering individual differences.

In inclusive education, teaching students with visual impairments requires special pedagogical approaches. The formation of their calculation skills should not be limited to mathematical knowledge acquisition but should also aim at developing logical, cognitive, and spatial thinking abilities. In this context, the effective use of digital technologies becomes increasingly important.

In this regard, ChatBot technology is considered an innovative tool for supporting the learning process. It enables the activation of learners' educational activities through interactive dialogue, provides immediate feedback, and adapts learning materials to individual characteristics. ChatBots can implement functions such as step-by-step explanation of tasks, audio-based presentation, and adaptation to the learner's pace. [2]

The relevance of the study is determined by the need for a scientific justification of the didactic and methodological potential of ChatBot technology in developing the calculation culture of primary school students with visual impairments. Research in this area contributes to adapting digital tools to the

requirements of special pedagogy, improving teaching methodologies, and enhancing the quality of education.

In conclusion, the integration of ChatBot technology into inclusive education contributes to the effective development of calculation skills, increases learning motivation, and expands educational opportunities for students with visual impairments. Therefore, scientific research and practical implementation in this field are essential for further improving the education system. [3]

The use of ChatBot systems in education is considered an effective tool aimed at individualizing learning activities and developing learners' cognitive independence. Through this technology, students can complete tasks at their own pace and develop skills in analyzing and correcting their mistakes. This, in turn, contributes to the development of independent thinking and the formation of calculation culture. The main advantage of ChatBots is their ability to function as a virtual assistant providing pedagogical support in an inclusive environment, thereby facilitating communication between the learner and educational content and ensuring immediate and continuous feedback.

One of the main difficulties for primary school students with visual impairments is the limited ability to perceive and process information visually. This affects the performance of mathematical operations, understanding numerical relationships, and carrying out computational activities. Therefore, the use of auditory, interactive, and adaptive digital technologies plays a crucial role in developing their calculation skills, mathematical thinking, and learning independence. [5]

The formation of calculation skills is a key component of a student's overall mathematical competence. This process begins at an early age and requires systematic pedagogical and psychological support. Early intervention helps prevent learning difficulties and ensures their effective resolution. In this regard, individualization of instruction, accessibility of learning materials, and strengthened pedagogical support are essential tasks for students with special educational needs in digital learning environments.

Traditional teaching tools are often insufficient to fully address the individual characteristics of students with visual impairments. Visual limitations complicate the processes of recognizing, comparing, and processing mathematical information. Therefore, the use of adapted digital tools in accordance with special pedagogical requirements, including ChatBot systems, opens new opportunities for improving the quality of education. Such systems ensure accessibility of learning materials through features such as large fonts, high contrast, audio support, step-by-step explanations, and interactive feedback.

At the same time, although the use of ChatBot technologies has been widely studied in scientific literature, most research focuses on the general education context. The effectiveness of adapted ChatBot systems in special pedagogy, particularly in typhlopedagogy, remains insufficiently explored. In particular, there is still a need for scientific justification of their pedagogical and corrective impact on developing the calculation culture of primary school students with visual impairments.

Therefore, when developing an adapted ChatBot system, several important requirements must be considered. These include adapting tasks to students' visual capabilities, providing step-by-step explanations of mathematical operations, offering individualized corrective feedback, and ensuring multisensory support. These requirements help optimize learning load and improve students' mastery of educational content.

The aim of the study is to scientifically substantiate the pedagogical and corrective effectiveness of an adapted ChatBot system aimed at developing the calculation culture of primary school students with visual impairments and to determine its application possibilities in the educational process. To achieve this aim, a set of tasks is defined, including analyzing theoretical foundations of calculation culture formation, reviewing scientific studies on the use of ChatBot technologies, developing a structural model of the adapted system, justifying its interface and task system, conducting experimental validation, and preparing methodological recommendations.

In conclusion, the use of ChatBot technology in inclusive education can be considered an effective tool for developing calculation skills, individualizing learning activities, and strengthening corrective pedagogical support for students with visual impairments. However, there remains a need for systematic scientific research, methodological improvement, and the accumulation of empirical evidence in this field.

The development of computational culture in visually impaired primary school students remains one of the insufficiently explored areas in special pedagogy. Computational culture is considered a key component of the primary mathematics curriculum, forming the basis for students' understanding of numerical relationships, execution of arithmetic operations, and the development of mathematical thinking and logical reasoning.

However, due to visual impairments, these students have limited sensory channels for information perception, which reduces their ability to fully master the visual components of mathematical material. As a result, a number of specific difficulties arise in mastering each component of computational culture. These difficulties are presented in the table below. [5,6,7]

Table 1. Barriers to the Development of Computational Culture in Visually Impaired Students

Limitations in the perception of numerical and spatial representations	Difficulties in understanding algorithms for performing arithmetic operations	Insufficient adaptation of traditional instructional materials
Children with visual impairments are unable to fully perceive numbers, their quantitative differences, geometric shapes, and visual models used for performing operations (such as number lines,	The procedures for addition, subtraction, multiplication, and division are often explained through visual representations. However, for students with visual impairments:	Most modern teaching resources and exercises rely heavily on visual information, such as: • tables, • illustrations, • diagrams,

, tables, and diagrams). This leads to difficulties in understanding: • relationships between numbers, • numerical patterns, • positional notation. Even basic operations such as comparing numbers and arranging them in order become more complex due to increased visual cognitive load.	• the written form of operations, • column-based calculations, • graphically presented tasks are not clearly accessible, which reduces both comprehension and performance speed. This is especially evident when working with multi-digit numbers.	• schematic representations. For students with visual impairments, these materials lose their effectiveness unless properly adapted (e.g., enlarged print, high contrast, tactile representations, or audio support). Therefore, traditional teaching methods alone are not sufficient for this category of learners.
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Increased cognitive load	Slowing of cognitive processes such as comparison, classification, and structuring
Visual impairment forces the child to continuously rely on visual effort, which significantly increases cognitive strain. As a result: • the amount of mental energy available for performing computational operations decreases, • fatigue occurs more quickly, • motivation to complete tasks to the end declines. In addition, teachers are not always able to provide effective visual support tailored to the needs of such learners.	The main components of calculation culture—comparison, analysis, abstraction, and generalization—are typically developed through visual supports. However, in children with visual impairments, these cognitive processes develop more slowly due to: • fragmented perception of information, • difficulties in distinguishing details, • incomplete perception of visual images.

The research is based on the theoretical and methodological foundations of using ChatBot technology aimed at improving the development of computational culture in visually impaired primary school students within inclusive education. Accordingly, the key principles of the study are clarified through a system of pedagogical, didactic, and technological approaches.

First, the fundamental principle of inclusive education is to create an equal-access educational environment by considering learners’ individual characteristics, abilities, and educational needs. This principle requires adapting the learning process to the perceptual characteristics of visually impaired students. In such conditions, ensuring the accessibility and comprehensibility of learning materials is one of the main pedagogical tasks.

Second, the principle of individualization and adaptation of instruction involves organizing learning content according to each student’s cognitive abilities, learning pace, and individual educational trajectory. ChatBot technology serves as an important tool in implementing this principle, as it allows tasks to be adapted according to difficulty level, provides individualized feedback based on students’ responses, and delivers learning materials in an accessible format. [10]

Third, the activity-based approach considers the learner as an active subject of the educational process. In this regard, computational culture is not limited to the acquisition of ready-made knowledge but is formed through its practical application, analysis, and transformation. Interactive tasks provided through ChatBot stimulate active cognitive engagement and contribute to the development of students' logical and mathematical thinking skills.

Fourth, the integration of digital and artificial intelligence technologies into the educational process is based on the effective use of innovative tools aimed at improving learning quality. In this context, the ChatBot system acts as a virtual pedagogical assistant, providing immediate feedback, offering guidance for error correction, and ensuring the continuity of the learning process.

Fifth, considering the requirements of special education and tiflopedagogy necessitates the creation of an adapted learning environment for visually impaired students. In this regard, audio support, large fonts, high contrast, a simple interface, and step-by-step explanations are key elements that facilitate the perception of learning materials.

This set of principles forms the theoretical basis for the effective use of ChatBot technology in developing computational culture in primary school students. It also provides a scientific foundation for pedagogically justifying digital tools in inclusive education and defining their methodological potential.

Materials and Methods

In international practice, the use of ChatBot technology in mathematics education has been widely studied, and its effectiveness in personalizing learning, accelerating feedback, and enhancing students' cognitive engagement has been demonstrated in several countries.

In the United States, particularly in STEM education research, ChatBot systems are used to explain step-by-step problem-solving algorithms, automatically analyze errors, and provide individualized learning paths. AI-based assistants adapt to students' responses and adjust task difficulty accordingly, which contributes to deeper understanding of mathematical concepts and the development of problem-solving skills. [12]

In Singapore, ChatBot technologies are integrated into digital mathematics platforms and are used to analyze students' problem-solving processes and provide immediate feedback on specific errors. The Singaporean experience shows that AI effectively identifies error patterns and supports adaptive learning by providing personalized explanations.

In South Korea, ChatBots function as interactive tutors in mathematics lessons. They guide students step by step through tasks, explaining each stage and supporting the development of logical thinking skills. Additionally, systems analyze response time and error frequency to automatically adapt the learning process.

In the United Kingdom, ChatBot technologies are introduced as support tools in primary and secondary mathematics education, aimed at developing students' independent learning skills. British researchers describe ChatBots as

“always available digital tutors,” highlighting their effectiveness in homework support and error correction.

In China, AI-based ChatBots are used to analyze large datasets to predict student performance and design individualized learning pathways. These systems are particularly effective in automating computational skills and adjusting practice levels in mathematics education.

Overall, international studies identify three main pedagogical functions of ChatBot technology in mathematics:

- personalized learning;
- real-time feedback;
- cognitive scaffolding.

These functions enable students to learn independently, analyze errors, and develop computational strategies. [5]

Furthermore, international experience demonstrates that ChatBot technology has strong potential not only in general education but also in inclusive education. In particular, audio interfaces, adaptive tasks, and interactive explanations are especially important for students with visual or learning difficulties.

Thus, international practice confirms the broad didactic potential of ChatBot technology in mathematics education and emphasizes the need to further develop its adapted forms for inclusive education systems.

Table 2. Possibilities of Using ChatBot Technology in Mathematics Education

Country	Research Results
USA – Effect of Chat-Bot in an Online Mathematics Platform	The chatbot did not have a significant impact on learning outcomes, but it positively influenced students’ self-assessment. Heffernan, N., Lee, Y., & Ostrow, K. (2024). <i>Facilitating Student Learning With a Chatbot in an Online Math Platform</i> . ASSISTments Project, USA.
Philippines – Experience of Using ChatBots in Mathematics Lessons	ChatBots were effectively used as supportive tools aimed at improving students’ learning experience
Vietnam – AI-Based ChatBot Model for Mathematics Learning	ChatBots were effective in structuring learning tasks and providing timely feedback
China – AI-Supported Mathematics Learning and Engagement Factors	The level of trust in AI use directly influences learning outcomes
New Zealand – AI Chat-Bots for Reducing Mathematics Anxiety	ChatBots may reduce mathematics anxiety by providing emotional support

In order to determine the effectiveness of using ChatBot technology in developing computational culture among visually impaired primary school students, a complex set of theoretical and empirical methods was applied.

During the theoretical stage, a comprehensive analysis of domestic and international scientific literature related to inclusive education, special pedagogy, tiflopedagogy, digital technologies, and AI-based instruction was conducted. This

analysis made it possible to systematically identify the role of ChatBot technology in the educational process, its didactic potential, and its specific features in special education settings. In addition, the study clarified the key pedagogical functions of ChatBot technology, including individualized instruction, real-time feedback, and adaptation of learning materials. [13]

During the empirical stage, the learning activities of visually impaired primary school students were selected as the research object. A survey was conducted among teachers and special educators at the research site, and pedagogical observation was applied. These methods were aimed at identifying students' initial level of computational skills, learning motivation, and cognitive engagement. The obtained data served as baseline diagnostic information indicating the need for digital support in the learning process.

Within the framework of the study, a ChatBot system adapted for visually impaired students was developed. The system was designed in accordance with the requirements of special pedagogy and included audio support, large fonts, a high-contrast interface, simple navigation, interactive tasks, and step-by-step explanations. This structure was aimed at facilitating students' perception of learning materials and enhancing their independent learning abilities. The ChatBot functioned as a virtual assistant, providing immediate feedback during computational tasks and offering guidance for error correction.

During the teaching experiment, students completed tasks involving arithmetic operations, word problem analysis, and error correction with the help of the ChatBot. The results obtained before and after the experiment were comparatively analyzed to evaluate changes in the level of computational culture development. This approach made it possible to objectively determine the impact of ChatBot technology on students' learning outcomes. [14]

Data processing was carried out using comparative-analytical, descriptive, and qualitative analysis methods. These methods enabled a comprehensive evaluation of the research results, a detailed analysis of the impact of ChatBot technology on the learning process, and a substantiated assessment of its pedagogical effectiveness.

Overall, the methodological approaches used in the study fully complied with the requirements of inclusive education and were adapted to the specific learning characteristics of visually impaired students. This enhances the scientific validity and practical significance of the research results.

Results and Discussion

In accordance with the research objective, it is essential to determine the level of development of computational culture among visually impaired primary school students and to empirically substantiate the potential of ChatBot technology in its development. In the context of modern inclusive education, digital technologies are considered an effective tool for improving the learning outcomes of students with special educational needs. In this regard, ChatBot technology enables individualized learning, provides immediate feedback, and enhances students' cognitive engagement.

For this purpose, a two-month exploratory diagnostic experiment was conducted in 2025. A total of 20 second-grade students participated in the experiment. Among them, 10 students were visually impaired primary school students studying in a special education institution, while the remaining 10 were normally sighted students from general education schools. The use of comparative groups ensured the objectivity and validity of the research results.

Visually impaired students had conditions such as amblyopia, astigmatism, nystagmus, and hypermetropia. These impairments not only reduce the speed of visual information processing but also negatively affect spatial reasoning, visual imagination, and the understanding of mathematical concepts. As a result, computational skills develop more slowly and require additional pedagogical support.

In the experiment, a diagnostic task system based on ChatBot technology was used. A ChatBot is a digital tool that ensures interactive communication between the learner and learning content, providing immediate feedback during task completion. Its main feature is continuous monitoring of student performance and instant guidance for error correction.

The study consisted of two main stages. In the first stage, the level of development of computational skills was determined. Students were given 36 tasks aligned with the primary school curriculum. The tasks included addition and subtraction within 10 and 20, number comparison, simple word problems, logical sequences, and practical problem-solving tasks.

The results of the first stage showed that normally sighted students demonstrated a high level of performance (30–36 correct answers), with an average score of approximately 33 correct answers. Visually impaired students mostly showed an average level of performance (19–29 correct answers), with an average score of 24 correct answers. Only two students achieved a high level.

These results indicate that visually impaired students experience slower computational speed, difficulties in information processing, and require additional time to complete tasks. In addition, their computational strategies were not sufficiently developed. However, ChatBot technology enabled students to immediately identify errors, retry tasks, and gradually reach correct solutions.

In the second stage, students' ability to explain solutions, logical thinking, and use of mathematical language were assessed. Evaluation criteria included explaining solution steps, logical reasoning, use of mathematical terminology, self-assessment, and utilization of ChatBot feedback.

The results showed that no high level was identified in either group. Above-average performance was observed only among normally sighted students. An average level was recorded in 5 normally sighted and 1 visually impaired student, while a low level was identified in 9 visually impaired students. Visually impaired students had difficulties fully explaining solution processes and tended to rely on pre-prepared answers.

Overall, the research results indicate that computational culture in visually impaired primary school students is at a lower level compared to their normally sighted peers. At the same time, the use of ChatBot technology was found to

facilitate the learning process, improve computational skills, and positively influence learning motivation.

Thus, ChatBot technology can be considered a promising digital tool that expands learning opportunities for students with special educational needs in inclusive education settings.

Table 3 – Quantitative Indicators of Computational Skills (Stage I)

Students Group	Number of Students	Number of Correct Answers (max. 36)	Average Score
Normal-vision students	10	30–36	≈33
Visually impaired students	10	19–29	≈24

Comparative Indicators of Correct Answers of Normal-Vision and Visually Impaired Students

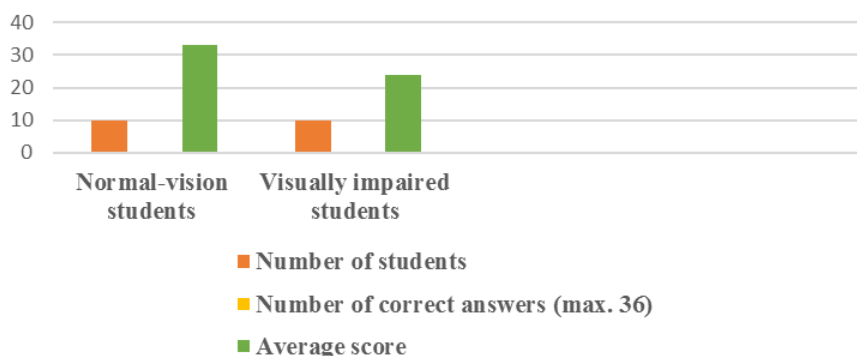


Figure 1 – Comparative Indicators of Correct Answers Between Normal-Vision and Visually Impaired Students

The table results show that normally sighted students demonstrate a high level of computational skills, whereas visually impaired students are mainly at an average level.

The comparative analysis revealed that the level of computational skills among visually impaired students is lower than that of normally sighted students. This difference can be explained by slower visual information processing, insufficient visual supports, and the need for additional time to complete tasks. In addition, visually impaired students exhibited slower work pace, rapid fatigue, unstable attention, and repetition of answers during task completion.

The second stage was aimed at identifying qualitative characteristics of students' computational activities. At this stage, students were assessed in terms of their ability to explain problem-solving steps, logical reasoning, use of mathematical terminology, self-checking skills, and the use of feedback provided by the ChatBot.

The results of the second stage showed that a high level (144–180 points) was not identified in either group. An above-average level was observed only among normally sighted students. An average level was recorded in 5 normally sighted students and 1 visually impaired student. A low level was identified in 9 visually impaired students.

Table –4. Distribution of Students by Performance Levels

Level	Normal-vision students	Visually impaired students
High (144–180 points)	0	0
Above average	5	0
Medium	5	1
Low	0	9

As can be seen from the table, the majority of visually impaired students are at the low level, whereas normal-vision students demonstrate results at the medium and above-average levels.

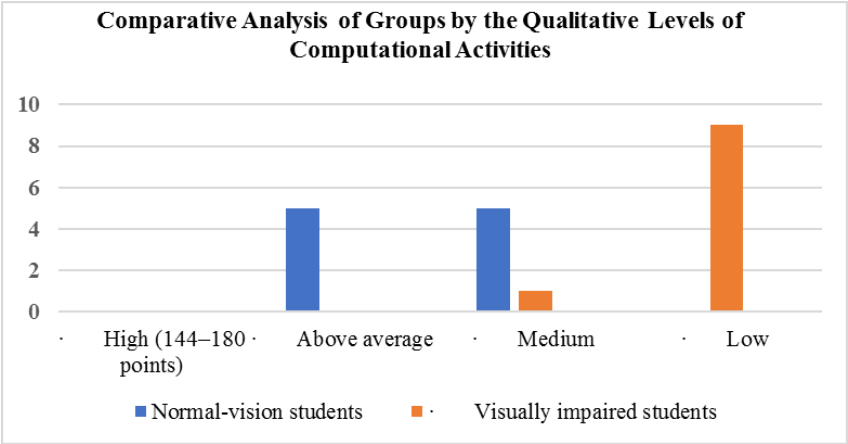


Figure 2 – Comparative Analysis of Groups by the Qualitative Levels of Computational Activities

Analysis of results visualization (Figures 1 and 2) demonstrates a clear difference in the level of computational literacy between visually impaired and normally sighted students. The diagrams clearly illustrate that visually impaired students show lower performance not only in quantitative indicators but also in qualitative characteristics of computational activity.

The presented diagram indicates a distinct gap between the two groups. The results of normally sighted students are close to a high level, whereas visually impaired students remain at an average level. According to the diagram, the majority of visually impaired students are at a low level, while normally sighted students demonstrate average and above-average performance.

These results indicate that visually impaired students experience difficulties in explaining solution methods, applying logical structures, and expressing mathematical reasoning. They mostly relied on ready-made answers and were unable to fully articulate their own thinking.

The research findings confirm that the computational literacy of visually impaired students is at a lower level compared to normally sighted students. This is associated with the characteristics of their cognitive processes, limitations in visual perception, and insufficient practical engagement.

In addition, the study identified the effectiveness of chatbot technology in the learning process. In particular, it provides immediate feedback, allowing

timely correction of errors, individualizes the learning process, and enhances students' cognitive activity.

Thus, the experimental results show that the use of chatbot technology in inclusive education can be an effective tool for developing computational literacy in visually impaired primary school students. This technology optimizes the learning process and expands educational opportunities for learners with special educational needs.

During the study, primary school teachers' opinions regarding the effectiveness of using chatbot technology for developing computational literacy in visually impaired students were also identified.

Conclusion.

In conclusion, this study demonstrated that the issue of developing computational literacy in visually impaired primary school students in inclusive education is both relevant and multifaceted. The theoretical analysis revealed that learners with visual impairments face a number of difficulties in acquiring mathematical knowledge, particularly in perception, processing, and logical structuring of information. This confirms the limitations of traditional teaching methods and the necessity of adapting instruction.

The proposed adaptive chatbot system was identified as an effective digital tool that enables the individualization of learning, provides accessible presentation of learning materials, and ensures immediate feedback. Experimental results showed that the use of chatbot technology positively influences the development of computational skills in visually impaired students, increases their learning activity, and supports the formation of self-monitoring and error-correction skills.

Comparative analysis confirmed a difference in computational literacy between visually impaired and normally sighted students; however, it also showed that this gap can be reduced through the use of specially adapted digital support. Furthermore, survey results among teachers indicated a generally positive attitude toward chatbot technology, although they emphasized the need for methodological support and practical guidelines for its effective implementation.

Thus, the adapted chatbot system is considered a promising pedagogical tool for developing computational literacy in visually impaired students in inclusive education. It contributes to the digitalization of learning, individualization of instruction, and expansion of educational opportunities for learners with special educational needs. The results of this study enrich the scientific and methodological foundations for integrating innovative technologies into special pedagogy and primary education practice and highlight the importance of further research in this direction.

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НАШАР КӨРЕТІН БАСТАУЫШ СЫНЫП ОҚУШЫЛАРЫНЫҢ ЕСЕПТЕУ ҚАБІЛЕТТЕРІН ДАМУДА СНАТВОТ ТЕХНОЛОГИЯСЫНЫҢ МҮМКІНДІКТЕРІ

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Аңдатпа. Нашар көретін бастауыш сынып оқушыларының есептеу қабілеттерін дамыту қазіргі инклюзивті білім беру жүйесінде өзекті ғылыми-педагогикалық мәселе болып табылады. Бұл санаттағы оқушылардың танымдық ерекшеліктері көру арқылы ақпаратты қабылдаудың шектеулілігімен сипатталады, соның салдарынан математикалық

ұғымдарды меңгеру, есептеу амалдарын орындау және логикалық ойлау дағдыларын қалыптастыру үдерісі баяу жүреді. Осыған байланысты оқу үдерісін дараландыруға және бейімдеуге мүмкіндік беретін цифрлық технологияларды, соның ішінде ChatBot жүйелерін қолдану қажеттілігі артып отыр.

Мақалада нашар көретін бастауыш сынып оқушыларының есептеу қабілеттерін дамытуда ChatBot технологиясының педагогикалық және дидактикалық мүмкіндіктері ғылыми тұрғыдан қарастырылады. Зерттеу барысында инклюзивті білім беру, арнайы педагогика және тифлопедагогика салаларындағы теориялық тұжырымдамаларға талдау жасалып, ChatBot-тың оқу материалын бейімдеу, жедел кері байланыс беру және когнитивтік қолдау көрсету функциялары негізделді.

Эмпирикалық зерттеу кезеңінде мұғалімдер мен арнайы педагогтарға сауалнама жүргізіліп, педагогикалық бақылау әдісі қолданылды. Сонымен қатар нашар көретін оқушыларға арналған бейімделген ChatBot жүйесі әзірленіп, оқу үдерісіне енгізілді. Жүйе дыбыстық сүйемелдеу, қарапайым интерфейс, қадамдық түсіндіру және интерактивті тапсырмалар негізінде құрылды. Алынған мәліметтер салыстырмалы-аналитикалық және сапалық талдау әдістері арқылы өңделді.

Зерттеу нәтижелері ChatBot технологиясының нашар көретін оқушылардың есептеу дағдыларын дамытуға, оқу мотивациясын арттыруға және дербес оқу әрекетін қалыптастыруға тиімді ықпал ететінін көрсетті. Сонымен қатар, ол оқу материалын қолжетімді форматта ұсыну арқылы инклюзивті білім беру сапасын арттыратын маңызды құрал екені дәлелденді.

Дегенмен, технологияны енгізуде әдістемелік бейімдеу мен техникалық қамтамасыз етуге байланысты бірқатар шектеулер анықталды. Бұл мәселелер ChatBot жүйелерін арнайы білім беру саласында тиімді қолдану үшін қосымша ғылыми зерттеулер мен әдістемелік әзірлемелерді қажет етеді.

Тірек сөздер: нашар көретін оқушылар, ChatBot, жасанды интеллект, инклюзивті білім беру, тифлопедагогика, есептеу қабілеті, цифрлық технология, бастауыш сынып оқушылары

ВОЗМОЖНОСТИ ТЕХНОЛОГИИ СНАТВОТ В РАЗВИТИИ ВЫЧИСЛИТЕЛЬНОЙ КУЛЬТУРЫ СЛАБОВИДЯЩИХ УЧАЩИХСЯ НАЧАЛЬНОЙ ШКОЛЫ

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Аннотация. Развитие вычислительных способностей у слабовидящих учащихся начальной школы является одной из актуальных

научно-педагогических проблем современной системы инклюзивного образования. Познавательные особенности данной категории обучающихся характеризуются ограниченностью восприятия информации через зрительный канал, вследствие чего процесс усвоения математических понятий, выполнения вычислительных операций и формирования логического мышления протекает замедленно. В этой связи возрастает необходимость использования цифровых технологий, обеспечивающих индивидуализацию и адаптацию образовательного процесса, в том числе систем Chatbot.

В статье рассматриваются педагогические и дидактические возможности технологии Chatbot в развитии вычислительных способностей у слабовидящих учащихся начальной школы. В ходе исследования проведён анализ теоретических концепций в области инклюзивного образования, специальной педагогики и тифлопедагогики, на основе чего обоснованы функции Chatbot, такие как адаптация учебного материала, обеспечение оперативной обратной связи и когнитивная поддержка обучающихся.

На эмпирическом этапе исследования были проведены анкетирование учителей и специальных педагогов, а также педагогическое наблюдение. Кроме того, разработана адаптированная система Chatbot для слабовидящих учащихся и внедрена в учебный процесс. Система включает элементы звукового сопровождения, упрощённый интерфейс, пошаговое объяснение и интерактивные задания. Полученные данные обработаны с использованием сравнительно-аналитических и качественных методов анализа.

Результаты исследования показали, что технология Chatbot оказывает положительное влияние на развитие вычислительных навыков слабовидящих учащихся, способствует повышению учебной мотивации и формированию самостоятельной учебной деятельности. Также доказано, что данная технология является важным средством повышения качества инклюзивного образования за счёт представления учебного материала в доступной форме.

Однако в процессе внедрения технологии были выявлены определённые ограничения, связанные с методической адаптацией и техническим обеспечением. Эти вопросы требуют дальнейших научных исследований и методических разработок для эффективного применения Chatbot-систем в специальном образовании.

Ключевые слова: слабовидящие учащиеся, Chatbot, искусственный интеллект, инклюзивное образование, тифлопедагогика, вычислительные способности, цифровые технологии, учащихся начальной школы

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