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THE PRACTICAL IMPORTANCE OF THE ADAPTIVE-DIDACTIC MODEL FOR DEVELOPING MATHEMATICAL CONCEPTS

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Abstract
This article examines the difficulties of developing elementary mathematical concepts in younger schoolchildren with intellectual disabilities and substantiates an adaptive-didactic model designed to overcome them. Within the model, correctional-developmental technologies for forming mathematical concepts are refined by flexibly choosing, at each lesson stage, modifications of methodological fixation that match the pupil's perception speed and attentional focus, with a correctional orientation and freedom of choice given priority. Drawing on the psychological and pedagogical literature, the article describes the approaches underlying the model: systemic, activity-based, person-centered, differentiated-adaptive, correctional-developmental, concentric-spiral, and evidence-based. It shows how mathematical content in the strands of number and quantity, shape and volume, and space and time can be carried step by step from object-based action to pictorial modeling and then to symbolic representation, and it outlines the role of visual didactic cards, sensory-tactile materials, and didactic games. Through diagnostics, monitoring, and a mechanism of gradually withdrawing assistance (a support hierarchy), the article explains how instruction can be tailored to each pupil's individual mathematical profile. The proposed model allows special-school teachers to individualize teaching, combine correctional work with subject content, and lay the groundwork for children's adjustment to social and practical life.

Keywords: Children with special needs, intellectual disabilities, mathematical concepts, correctional-developmental technologies, visualization, sensory perception, didactic games, special education, logical thinking, integrated education.

Introduction

Аннотация:
В статье рассматриваются трудности формирования элементарных математических представлений у младших школьников с интеллектуальными нарушениями и обосновывается адаптивно-дидактическая модель, направленная на их преодоление. В рамках модели коррекционно-развивающие технологии формирования математических представлений совершенствуются за счёт гибкого выбора на каждом этапе урока модификаций методической фиксации, соответствующих скорости восприятия и фокусу внимания ученика, при приоритете коррекционной направленности и свободы выбора. На основе психолого-педагогической литературы описаны подходы, лежащие в основе

модели: системный, деятельностный, личностно ориентированный, дифференцированно-адаптивный, коррекционно-развивающий, концентрически-спиральный и научно обоснованный (доказательный). Показано, как математическое содержание по направлениям «число и количество», «форма и объём», «пространство и время» можно последовательно переводить от предметного действия к образному моделированию, а затем к символической записи; раскрыта роль наглядных дидактических карточек, сенсорно-тактильных материалов и дидактических игр. С помощью диагностики, мониторинга и механизма постепенного сокращения помощи (иерархии поддержки) объясняется, как приспособить обучение к индивидуальному математическому профилю каждого ученика. Предлагаемая модель позволяет учителям специальных школ индивидуализировать обучение, сочетать коррекционную работу с предметным содержанием и создавать основу для адаптации детей к социально-практической жизни.

Ключевые слова: дети с ограниченными возможностями здоровья, интеллектуальные нарушения, математические представления, коррекционно-развивающие технологии, наглядность, сенсорное восприятие, дидактические игры, специальное образование, логическое мышление, интегрированное обучение.

Anotatsiya:
Ushbu maqolada intellektual nuqsonli kichik yoshdagi o‘quvchilarda elementar matematik tasavvurlarni shakllantirish muammolari tahlil qilinib, ularni hal etishga qaratilgan adaptiv-didaktik model asoslanadi. Bu model orqali matematik tasavvurlarni shakllantirishning korreksion-rivojlantiruvchi texnologiyalari dars bosqichlarida idrok tezligi, diqqat fokusiga mos metodik fiksatsiya modifikatsiyalarini korreksion yo‘nalganlikda erkin tanlov ustuvorligida qo‘llash asosida takomillashtirilgan. Mavzuga oid psixologik-pedagogik manbalar asosida modelning tizimli, faoliyatli, shaxsga yo‘naltirilgan, differensial-adaptiv, korreksion-rivojlantiruvchi, konsentrik-spiral va dalillarga asoslangan yondashuvlari tavsiflangan. Matematik mazmunni son-miqdor, shakl-hajm va fazo-vaqt yo‘nalishlarida predmetli harakatdan tasviriy modelga, so‘ngra ramziy ifodaga izchil o‘tkazish yo‘llari hamda ko‘rgazmali didaktik kartalar, sensor-taktil materiallar va didaktik o‘yinlarning o‘rni ko‘rsatilgan. Diagnostika, monitoring va yordamni bosqichma-bosqich kamaytirish (yordam ierarxiyasi) mexanizmi orqali o‘qitishni har bir o‘quvchining individual matematik profiliga moslashtirish imkoniyati yoritilgan. Taklif etilgan model maxsus maktab o‘qituvchilariga o‘quv jarayonini individuallashtirish, korreksion ishni fan mazmuni bilan uyg‘unlashtirish va bolalarning ijtimoiy-amaliy hayotga moslashuviga zamin yaratish imkonini beradi.

Kalit so‘zlar: imkoniyati cheklangan bolalar, intellektual nuqsonlar, matematik tasavvurlar, korreksion-rivojlantiruvchi texnologiyalar, ko‘rgazmalilik, sensor idrok, didaktik o‘yinlar, maxsus ta’lim, mantiqiy tafakkur, integratsiyalashgan ta’lim.

Introduction

At the present stage of social development, protecting the legal and social interests of children with special educational needs, providing them with quality education, and preparing them for life have become one of the priorities of state policy. As the President of the Republic of Uzbekistan, Shavkat Mirziyoyev, has stressed, supporting children with special needs and creating inclusive conditions for them is a sign of our society's moral maturity. Regulatory documents and programs on measures to further improve the system of education and upbringing for children with special educational needs serve as the legal basis for reforms in this area. [1]

Mathematics lessons occupy an important place in the special school curriculum, because this subject offers great opportunities for correcting the cognitive activity of pupils with intellectual disabilities, developing elements of logical thinking in them, and preparing them for independent life. However, there is a deep mismatch between the abstract nature of mathematical objects and the visual-practical and visual-figurative character of these children's thinking. Because logical operations such as analysis, synthesis, comparison, abstraction, and generalization are insufficiently developed in these children, teaching them mathematical concepts requires specific correctional-pedagogical approaches and adapted educational technologies.

Aim and objectives of the study. The aim of the study is to substantiate an adaptive-didactic model for forming elementary mathematical concepts in younger schoolchildren with intellectual disabilities and to identify its components. To achieve this aim, the following objectives were set: to analyze the relevant psychological, pedagogical, and methodological sources; to systematize the learning content in the strands of number and quantity, shape and volume, and space and time on the basis of concentrs (concentric content units); to define the role of visual didactic cards, sensory-tactile materials, and didactic games; and to develop a monitoring mechanism based on the gradual reduction of types of assistance.

Object of the study and methods used. The methodology of teaching mathematical concepts to children with intellectual disabilities has long been a pressing issue in special pedagogy. In his cultural-historical theory, L.S. Vygotsky introduced the concept of the "zone of proximal development" (зона ближайшего развития) in teaching children with disabilities and demonstrated that the educational process must rely on the child's preserved capacities (sensory channels). [2]

Correcting cognitive impairments requires a systemic approach: the child first acquires knowledge through action with an object, then through an image, and finally through a sign and word. J. Bruner distinguished three stages of representing knowledge in education: enactive (through action), iconic (through images), and symbolic (through signs) [3]. This principle is especially important for pupils with intellectual disabilities, because they need the object-based and pictorial supports to be retained longer before moving on to working with abstract signs.

The role of visual and structured materials in forming mathematical concepts is also emphasized in foreign research. Z. Dienes advanced the principle of showing the structure of number with blocks and presenting the same concept in different forms [4]. In the

recommendations of the U.S. Institute of Education Sciences, explicit and systematic instruction, the use of visual representations, and continuous monitoring of pupil progress are listed as effective practices for pupils struggling with mathematics [5]. B. Butterworth and colleagues examined dyscalculia from the standpoint of brain function and education, and addressed the early identification of calculation difficulties and their remediation through exercises adapted to the learner's capabilities [6]. In the meta-analysis by D. Browder and colleagues, the use of systematic instruction and prompting when teaching mathematics to pupils with significant cognitive disabilities was identified as an evidence-based practice [7]. E. Bouck and J. Park systematically reviewed research on the use of manipulatives and showed that positive results with such tools have accumulated in work with pupils with disabilities [8]. These approaches serve as the scientific basis for organizing special correctional sessions in the modern integrated education setting.

L.S. Vygotsky's views on special pedagogy particularly emphasize the interaction of the primary limitation in development with the social environment, the possibility of compensation, and the leading role of education in driving development forward [2]. V.I. Lubovsky and co-authors substantiate the continuity of diagnostics, education, and correction, taking into account both general and specific regularities of development [9]. In our model, these theoretical principles are expressed through two solutions. First, diagnostics does not merely record what a pupil cannot do, but determines under what type of tool, instruction, or assistance the pupil begins to perform the task. Second, each task, alongside mastery of mathematical content, also serves a correctional purpose, developing perception, attention, speech, memory, fine motor skills, spatial orientation, and self-monitoring of one's own activity.

The difficulties that children with intellectual disabilities experience in mastering mathematical concepts have been analyzed by many researchers. For example, the concept of dyscalculia, a systematic impairment of calculation ability, and its causes have been studied, and the need to organize lessons through visual-practical games to overcome it has been emphasized [6]. In addition, international practice has found it effective to simplify the structure of the learning material and to enrich lessons with preparatory (propaedeutic) periods. However, the integration of modern digital didactics and sensory materials (for example, Montessori materials and Dienes blocks) [4] into special correctional education requires systematic investigation.

Results obtained and their analysis. An adaptive model should not be about "making the task easier" for the pupil. Rather, it should include breaking learning activity into comprehensible stages, repeating material as much as necessary, choosing an evidence-based type of assistance, and reducing that assistance as the pupil's independence grows.

Table 1. Methodological foundations of the adaptive-didactic model

Approach	Content in the model	Practical expression
Systemic	Integrity of the goal, diagnostics, content, process, monitoring, and outcome	Monitoring data changing the next task and the level of assistance
Activity-based	Understanding mathematical relationships through object-based action	Grasping, sorting, matching, counting, arranging, measuring
Person-centered	Taking into account the pupil's strengths, needs, interests, and mode of response	Individualizing the tool, storyline, pace, and response format
Differentiated-adaptive	Determining the current level in each concentr and the response to assistance	Using different entry points and a support hierarchy within one class
Correctional-developmental	Integrating the mathematical goal with perception, attention, speech, motor skills, and self-monitoring	Setting the subject goal and the correctional goal together in an integrative task
Concentric-spiral	Expanding content through repeated return and gradual increase in complexity	Moving from object to sign in number and quantity, shape and volume, and space and time
Evidence-based	Justifying pedagogical decisions with observed data and tested strategies	Explicit instruction, systematic prompting, recording, feedback, and generalization

The systemic approach requires viewing all blocks of the model (goal, diagnostics, content, technology, monitoring, and outcome) as an interconnected whole. If the initial diagnostics are detached from the content concentrs, the data obtained does not help in selecting tasks; if monitoring records only the final score, it is not visible under what assistance the pupil succeeded; if the outcome is not checked by transfer to everyday situations, the functionality of the formed mathematical concept remains undetermined. For this reason, each block of the model supplies information to the next block, and the monitoring result forms feedback returning to the diagnostic-propaedeutic block.

According to the activity-based and correctional-developmental approaches, a mathematical concept is formed not by memorizing a ready-made verbal definition, but in the process of purposeful action with an object, perceiving the result, denoting the action with speech or an alternative means of communication, transferring it to a pictorial model, and gradually moving to symbolic expression. Actions, gestures, and object manipulation that are semantically congruent with the mathematical content can create additional encoding channels and link abstract content with perceptual-motor experience [10]. However, a manipulative does not automatically become a teaching tool. Its color, shape, method of action, and the teacher's instructions must reveal the targeted mathematical relationship, and superfluous decoration must not distract attention.

The person-centered and differentiated approaches require teaching the pupil according to an individual mathematical profile rather than a general diagnostic group. For example, one pupil may count up to five objects correctly but have difficulty matching a set with a numeral; a



second pupil names geometric shapes but cannot group them by size; a third pupil performs the "on top – underneath" relationship in practice but makes mistakes when showing it in a picture. The concentric-spiral approach provides for returning to the content at different stages rather than presenting it once. For example, in the number and quantity strand, the pupil first separates sets of objects and matches them in pairs, then expands the counting range, then links a numeral with a set, and finally works with addition and subtraction. In the shape and volume strand, the pupil moves from selecting objects by shape, size, and color to knowing the names of geometric shapes and transferring them from a model to a drawing. In the space and time strand, relationships such as "above – below" and "before – after" are first mastered on the pupil's own body and in the classroom environment, then on the basis of pictures and drawings, and finally in connection with the daily schedule and the calendar. In each new circle, the previous content is repeated, but the level of complexity and independence increases; this ensures the volume of repetition necessary for this category of children.

In the model, didactic game technologies are regarded not merely as a motivational tool but as a means of creating a meaningful situation for performing a mathematical operation. Game storylines such as "Shop," "Objects in the room," or "Daily schedule" bring counting, comparison, and time relationships closer to a real-life situation. However, the game rules must be simple, the stages sequential, and the verbal instructions short, and a skill acquired in a game setting must later be rechecked in a task without the game and in an everyday situation. Otherwise, the pupil may become accustomed to acting correctly only in the game setting.

The evidence-based approach requires justifying pedagogical decisions with observed data. In practice, this is expressed through the support hierarchy: the teacher begins the task with the level of assistance the pupil needs, gradually reduces the assistance as the pupil succeeds, and returns to the previous stage when difficulty arises (Table 2). This procedure corresponds to the practice of gradually fading systematic instruction and prompting described in the sources [7].

Table 2. Support hierarchy and the order of its reduction

Level of support	**Content**	**Practical expression**
Independent performance	The task is performed without assistance	The pupil counts five cards and chooses the matching numeral
Verbal or gestural prompt	A short question or gesture is given	"How many? Count once more." The teacher points to the card
Pictorial support	A picture, diagram, or color-coding is used	Using a number line or a color-coded grid card
Object-based support	A real object or manipulative is provided	Building a set with Dienes blocks
Joint action	The task is performed together with the teacher	The teacher guides the pupil's hand and they count together

Recording the support level allows the teacher to see exactly with which tool the pupil succeeds. For example, if a pupil counts a set correctly with object-based support but makes mistakes with pictorial support, the next lesson focuses on this transitional stage. In this way, the monitoring result serves not as a general score but as a practical basis for choosing the next task and the type of assistance.

Implementing the model requires a number of pedagogical conditions: the teacher's methodological preparation in diagnostics and monitoring, a sufficient supply of visual and sensory materials in the classroom, a stable lesson structure, and cooperation with parents. The last condition is important, because the concepts a pupil has mastered at school acquire a functional character only when applied at home and in everyday life.

Conclusions and Recommendations

The study showed that in forming elementary mathematical concepts in pupils with intellectual disabilities, what is effective is not memorizing a ready-made definition but an adaptive-didactic approach that breaks learning activity into stages. To overcome the gap between the abstractness of mathematical content and the visual-practical character of these children's thinking, the content must be moved consistently from object-based action to a pictorial model and then to symbolic expression.

The scientific and practical significance of the developed model is manifested in the following. First, diagnostics determines not what the pupil cannot do but under what assistance the pupil begins to perform the task, and thereby determines the next task and the type of assistance. Second, each task, alongside the mathematical goal, also serves a correctional purpose, developing perception, attention, speech, fine motor skills, and self-monitoring. Third, sensory-tactile materials and didactic games become teaching tools only when their color, shape, and method of action reveal the targeted mathematical relationship. Fourth, it is the pupil's individual mathematical profile, not the general diagnosis, that determines the choice of instruction. In this process, assistance is reduced step by step as independence grows.

The concentric-spiral structure allows the pupil to master content by returning to it repeatedly in the course of moving from object to sign, while the support hierarchy grounds the teacher's pedagogical decision in observed data. Didactic games are considered effective only when the skill is also checked outside the game and in everyday situations. For this reason, the effectiveness of the model is determined not by the availability of individual tools but by the preservation of the connection among diagnostics, content, technology, and monitoring.

Monitoring results should return to the diagnostic-propaedeutic stage and serve as a basis for reselecting content, and the formed concepts should be verified through their application in everyday situations. The proposed model enables special school teachers to individualize the educational process, to integrate correctional work with subject content, and to create a solid foundation for children's adaptation to social and practical life. In the future, it is advisable to study separately the effect of digital didactic tools on the effectiveness of the model.



References

1. Mirziyoyev Sh.M. Alohida ta’lim ehtiyojlari bo‘lgan bolalarga ta’lim-tarbiya berish tizimini yanada takomillashtirish chora-tadbirlari to‘g‘risida. O‘zbekiston Respublikasi Prezidentining qarori, PQ-4860, 2020.
2. Выготский Л.С. Собрание сочинений: в 6 т. Т. 5. Основы дефектологии / под ред. Т.А. Власовой. Москва: Педагогика, 1983. 368 с.
3. Bruner J.S. Toward a Theory of Instruction. Cambridge, MA: Harvard University Press, 1966.
4. Dienes Z.P. Building Up Mathematics. London: Hutchinson Educational, 1960.
5. Gersten R., Beckmann S., Clarke B., et al. Assisting Students Struggling with Mathematics: Response to Intervention (RtI) for Elementary and Middle Schools (NCEE 2009-4060). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education, 2009.
6. Butterworth B., Varma S., Laurillard D. Dyscalculia: From Brain to Education // Science. 2011. Vol. 332, No. 6033. P. 1049–1053.
7. Browder D.M., Spooner F., Ahlgrim-Delzell L., Harris A.A., Wakeman S. A Meta-Analysis on Teaching Mathematics to Students With Significant Cognitive Disabilities // Exceptional Children. 2008. Vol. 74, No. 4. P. 407–432.
8. Bouck E.C., Park J. A Systematic Review of the Literature on Mathematics Manipulatives to Support Students with Disabilities // Education and Treatment of Children. 2018. Vol. 41, No. 1. P. 65–106.
9. В.И. Лубовский, Т.В. Розанова, Л.И. Солнцева и др. Специальная психология: учеб. пособие / под ред. В.И. Лубовского. 2-е изд., испр. Москва: Академия, 2005. 464 с.
10. Tran C., Smith B., Buschkuehl M. Support of mathematical thinking through embodied cognition: nondigital and digital approaches // Cognitive Research: Principles and Implications. 2017. Vol. 2. Article16. DOI: 10.1186/s41235-017-0053-8.
11. Razokova N.K. “Theoretical and methodological foundations of inclusive education: pedagogical approaches, and implementation strategies” // Modern American Journal of Linguistics, Education, and Pedagogy ISSN (E): 3067-7874 Volume 2, Issue 4, April, 2026.