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PECULIARITIES OF PERCEPTION IN MASTERING THE SUBJECT OF MATHEMATICS BY STUDENTS WITH MENTAL RETARDATION

The article presents the results of an experimental study conducted among first grade students with mental retardation (MR) as part of a diagnostic and correctional program aimed at the formation and development of skills in perceiving and reproducing visually perceived information. The analysis of the completed tasks allowed us to establish that standard pedagogical methods of assistance – such as demonstration by sample, repetition of instructions and an increase in execution time – are insufficient for the full assimilation of educational material by students with ASD. It is revealed that students in this category require both quantitative expansion and qualitative complication of the content of pedagogical support. The tasks assigned to the zone of immediate development were located at a high level of complexity of presentation and required a cyclical form of organization of activities with mandatory stages of reflexive control. Correct perception of visual stimuli and successful completion of tasks determine the formation of basic mental operations – generalization, comparison and analysis of one's own actions. As part of the additional stimulation, tasks were offered to recognize changes

in a series, find similarities and differences, identify absurd or fictional objects, memorize sequences of objects and symbols, and recognize objects by their contour. The results of the study made it possible to specify the features of the cognitive development of students with MR and to identify pedagogical conditions conducive to the successful formation of visual-sensorimotor perception skills in the study of mathematics.

Keywords: mental development, students, mental retardation (MR), knowledge ideas, learning difficulties.

Introduction

As part of the development of inclusive education in Kazakhstan and abroad, special attention is paid to providing pedagogical support to students with special educational needs, especially those with intellectual disabilities.

This category of schoolchildren is characterized by pronounced difficulties in mastering academic disciplines, including such basic ones as mathematics, which require well-formed operations of analysis, synthesis, generalization, comparison and developed visual and spatial perception. Issues related to the mechanisms of perception of mathematical material and sensorimotor interaction in the performance of tasks are still insufficiently studied in the context of primary education of children with MR. Practice shows that students with MR have difficulty reproducing visually perceived patterns, distinguishing between elements of geometric shapes, and establishing spatial connections, which negatively affects the pace of learning the subject. In these conditions, traditional pedagogical tools turn out to be insufficient, and the adaptation of educational tasks and the use of diagnostic and correctional approaches become a prerequisite for effective learning.

The object of this study is the process of learning educational material in mathematics by students with mental retardation.

The subject of the study is the peculiarities of visual perception and reproduction of geometric shapes during the performance of tasks at various levels of complexity.

The purpose of the study is to identify and characterize the features of perception of visually perceived information in the study of mathematics among students with MR based on experimental tasks of three levels: recognition, understanding and application. To achieve this goal, the following research objectives were identified:

– To characterize typical difficulties of perception and performance of tasks in mathematics in children with MR;

– To conduct an experimental test of the ability to perceive and reproduce visually perceived elements in first-graders with MR;

– Analyze the quantitative and qualitative performance of tasks of various levels of complexity;

– To determine the relationship between sensorimotor coordination and the success of mathematical tasks;

– To formulate pedagogical recommendations for improving the perception of mathematics and teaching processes in this category of students.

In the study, children with mental retardation showed a low level of perception and transmission of visually perceived information when performing mathematical tasks, which is reflected in reduced accuracy, poor spatial differentiation, and a high degree of dependence on pedagogical support.

The methodological basis of the study was the diagnosis of visual- sensory and sensorimotor processes based on an adapted program by N. Breuer and M. Voiffen, aimed at identifying the level of perception and reproduction of graphic elements.

The study is of theoretical and practical importance, because the results obtained make it possible to improve the methods of teaching mathematics in primary schools.

This study is preceded by a review of current domestic and international studies on the cognitive-psychomotor characteristics of Primary School students with intellectual disabilities, as well as an analysis of existing correction methods proposed in the next section.

N. P. Lokalova identifies the following indirect causes of difficulties in studying Mathematics: 1) decreased efficiency; 2) poor concentration. These factors lead to a decrease in the ability of individual students to perform learning activities in mathematics lessons.

This is especially noticeable when performing exercises and tasks that require intellectual efforts. The researcher identifies many more specific reasons: the transition from practical actions with objects, with numbers in performing arithmetic operations is not formed; the concepts of "more - less" are not fixed; spatial representations are insufficiently developed; there is no ability to divide a number into parts convenient for calculation. The author also highlights the insufficiency of visual analysis and synthesis; the lack of development of a strong connection between visual and motor images of numbers; impaired fine motor skills of the hands; the lack of development of visual-motor coordination when performing written tasks, the insufficiency of development of spatial representations; the above-mentioned disorders are the reasons for mirror writing of numbers, the inability to correlate their size and the height of the cell, etc [1].

G. M. Kapustina notes in her research that first-grade students correctly name the order of numbers from one to ten. When determining the number of specific objects, they do not distinguish the counting process from its result. Practice shows that when asked by the teacher to name the total number of objects, a student can

pronounce the name of the one on which he currently stopped. Such facts, according to G. M. Kapustina, indicate significant difficulties in mastering the ability of effective counting, that is, the ability to relate the last of the named numerals to the entire set of the sample as a whole, and not just to its last element [2].

One of the leading methods in mathematical education is the visual- practical method of modeling. Students with mental retardation should be directed to subject, subject-schematic and graphic models. Such actions of substitution and modeling become the basis for the formation of cognitive abilities, which determines visual-sensorimotor development [3]. The organization of the work by the teacher consists of the maximum expansion of practical actions, reliance on a sample, demonstration and specific instructions from the teacher on the ability to rely on a visual model and verbal instructions. At the same time, the actions were accompanied by speech, the ability to give a verbal report, and then planning the upcoming work.

Modern research confirms that the low level of mathematical achievement in children with mental retardation is directly related to limited cognitive flexibility, impaired executive functions and reduced ability to work memory. For example, in a study by Jitendra et al. It is emphasized that the difficulties in solving mathematical problems in younger schoolchildren with intellectual disabilities are due not only to limited conceptual apparatus, but also to the inability to retain and consistently reproduce visual stimuli [4]. According to Zhang et al. (2021), the success of geometric tasks in children with special educational needs depends on the level of development of visual-spatial perception, which, in turn, can be effectively adjusted using step-by-step visualization and graphical models [5].

Kazakhstani researchers also emphasize the importance of an integrated approach in teaching students with ASD. In particular, the studies of Zhusupova L.Sh. and Baimenova A.B. (2020) emphasize the need for the formation of stable sensorimotor connections and spatial perception when solving mathematical tasks in elementary school [6].

Similar approaches are presented in the work of Nurakhmetova D.S. et al. (2023), which developed an adaptive model for the formation of arithmetic skills in younger schoolchildren with ASD, including modules for sensory diagnostics and graphical modeling [7].

Materials and methods

An empirical study was conducted in the first grades of secondary school and was aimed at identifying the level of formation of visual- sensorimotor perception in students with mental retardation (SD). The diagnostic and correctional program developed by N. Breuer and M. Voiffen [8], adapted to the conditions of school education, was used as a methodological basis.

The aim of the experimental stage was to determine the ability of students with MR to correctly perceive and transmit visually perceived signs as a key condition for successful mastery of basic mathematical knowledge and skills. According to the author's concept of the method, low academic performance in primary school is associated with insufficient maturity of sensorimotor functions, which requires targeted pedagogical intervention and special diagnostics.

The technique is aimed at children of seven years of age and involves performing tasks to hold and transfer graphic elements in a certain sequence. When teaching literacy, these can be elements of letters, in the context of mathematical learning, elements of numbers and geometric shapes. All tasks were classified according to the level of difficulty: from elementary (recognition) to more complex (understanding and application), which made it possible to take into account the zone of immediate development of each student. The diagnostic toolkit included three groups of tasks reflecting a consistent increase in cognitive load.:

– tasks at the "recognition" level – simple sample reproduction,

– tasks at the level of "understanding" – establishing connections between elements and consciously performing an action,

– Tasks at the "application" level are the independent execution of a composite task based on the proposed components.

The sample population of the study consisted of 34 students in the first grades (15 boys and 19 girls) with a pre-established MR status. The testing was conducted individually in a natural learning environment, in a familiar school environment. To ensure the reliability of the results, a uniform assignment submission procedure was applied, taking into account the individual pace of completion and the possibility of multiple re- submissions if necessary.

The data obtained during the diagnosis was recorded using a protocol card and subjected to quantitative analysis, which made it possible to determine the percentage of accuracy in completing tasks, as well as typical errors at each level of difficulty. This provided the basis for interpreting the results and developing pedagogical recommendations for correcting visual- sensorimotor perception in students with MR.

Results

Contents of tasks. The correct perception and transmission of visual signs corresponds to the level of visual discrimination. Three levels of tasks were used to test this ability. The tasks include the elements of the directions of the lines, their number, the location of the elements and signs, as well as their correspondence to the model (geometric shape). (Table 1, Fig. 1).

Learning objectives, 1st grade. Section 1c "Geometric shapes"

Task No. 1 for the "Recognition" level

Is to draw a ray according to the model. Execution according to the criteria. Completion according to the following criteria:

1) Knows the ray designation
2) Draws a line and a point correctly
3) Matches the sample

Table 1 – Results the task for the “Recognition” level (%)

Content/completion	Accuracy %	Inaccuracy %
1 Direction of lines	46,4	53,6
2 Position of elements	59,1	40,9
3 Matching the sample	51	49

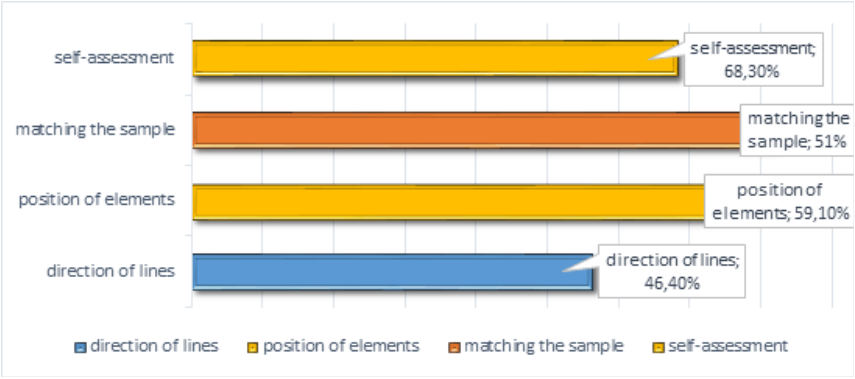

Figure 1 – "Recognition" level

The data in Table 1 indicate that the students’ indicators for compliance with the direction of the lines of a given ray figure according to the sample as a result of the accuracy of execution is 46.4 %. The position of the elements is 59.1 % and matching the sample is 51 %, the data indicate an above average value. This is due to both the seriousness of the training assignment and its implementation. However, the maturation of brain structures also ensures the development of sensorimotor coordination. However, the inaccuracy indicates that the students’ motor coordination has not yet been developed. Educational activities require both time and mutual efforts (teacher and students) from students. Interest in the correctness of the task gave a positive test result.

However, in the works of Weiser G. A., studying the peculiarities of storing, processing information and using it in the activities of students with mental retardation, he claims a verbal disorder [9]. But, it is encouraging that these children try to take the most accessible actions from the general instructions of the teacher.

The tasks are designed in such a way as to make students understand and depict a geometric shape (in this case) based on given random data, which will allow them to complete the learning task and achieve the educational goal.

Task No.2 for the "Understanding" level.

Draw two connected beams. During the lesson, the teacher first asks students to name the necessary signs of the geometric shape and its components and correctly complete the task according to the pattern (Table 2, Figure).

For example: a ray is a straight line and a point.

Completion according to the following criteria:

1) Direction of lines

2) Two rays form an angle

Table 2 – Results of the task for the "Understanding" level by students in (%)

Content/Completion	Accuracy %	Inaccuracy %
Direction of lines	65,5 %	34,5 %
Two rays form an angle	48,1 %	51,9 %

This task required children to follow a pattern. The task involved performing actions based on knowledge acquired in the previous lesson, namely, drawing two connected rays forming an angle. The students were already familiar with this geometric figure, but in each lesson, several students failed to generalize that two rays form an angle. Independent completion of the task and achievement of the expected result were often subjective (Table 2, Figure 2).

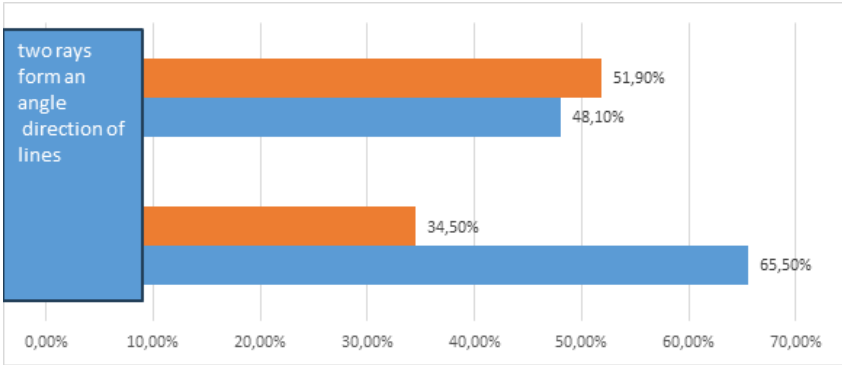

Figure 2 – Task for "Understanding" 1st grade.

The students evaluated the resulting geometric shape not by the quality of the result, but by its appearance, that is, by the fact that it copied what they actually drew. The following inaccuracies were found in 48.1 % of the drawings: 24.1 % drew two beams, but could not build an angle, and 24 % drew two beams located opposite each other and in different directions. After completing the assignment, it turned out that some students made minor mistakes, did not fully understand or even remembered the information. This affected their ability to complete the task correctly and led to inaccurate results.

In this case, the teacher should return to the studied material and give the assignment to the students again (for consolidation). This will allow students to consolidate the material (grade: Line, Ray) and assimilate basic knowledge.

For the "Understanding" level, the teacher should repeat drawing the geometric shape. An important characteristic of an angle is the presence of two rays originating and exiting from the same point – the vertex, and an unimportant characteristic is the length and direction of the rays. It is important to explain to children that important characteristics remain unchanged, while unimportant characteristics change. Unimportant characteristics do not affect the basic properties of the figure. However, if one of the important characteristics changes, the resulting shape will be completely different.

Task No. 3 for the "Application" level.

For example:

1) Connect the dots and create geometric shapes – a triangle or a square.

● ● ● ● ● ●

Complete this task according to the following criteria:

1) Connect the dots correctly.

2) Draw the geometric shape (triangle, square) correctly.

Table 3 – Results of the task for the "Application" level

content/completion	Accuracy %	Inaccuracy %
1. Direction of lines	39,8	60,2
2. Formation of two figures	48,4	51,6

The direction of the line in geometric figures is clearer and more distinct in girls than in boys in most cases.

The results of the tasks at the application level (Table 3, Fig. 3) show the accuracy of the task execution of 39.8 % and the formation of the figure of 48.4 %. The inaccuracy of the lines and the formation of the figure itself predominate in the result.

The perception and visual-sensorimotor development of first-graders through developmental activities is aimed at activating mental processes and functions responsible for the quality and ability to perform developmental activities. At this stage, the regulating function of the child's psyche focuses on the development of the will: the child's memory, attention and thinking develop arbitrarily; the ability to act in an organized manner in accordance with the tasks set and their objective behavioral models develops [10].

This is explained by the fact that at this stage the child begins to study at school, and the student's status and educational activities require responsibility, effort and discipline from the child [11]. Work done as correctly as possible is an indisputable indicator of the development of mathematical skills and the acquisition of basic elementary knowledge.

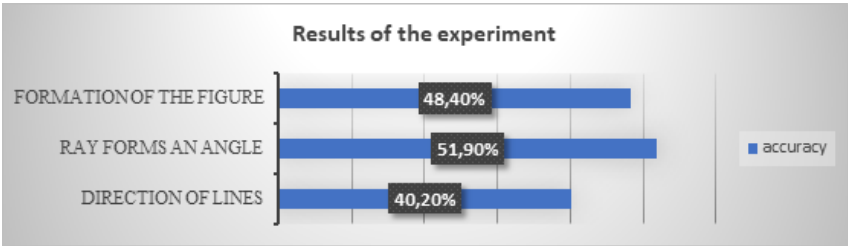

Figure 3 – Results for tasks

The students completed the tasks according to the sample. However, the results of most students are below average. The obtained results of the experimental study indicate weak perception and inaccuracy of visual- motor coordination, which as a result shows the result of performance three levels below average. The direction in accuracy of lines in the first task for recognition by students showed 40.2 %, which indicates low perception and weak transmission of the perceived object and the lack of formation of coordination of movement. The second task on the level of understanding, where two rays form an angle, the result shows 51.9 %. The students completed the task with the teacher's instructions and repeated presentation according to the sample. The third task from the given method - the formation of a triangle or a square – shows 48.4 %. Students preferred the formation of two figures, both triangles and squares, which was expressed in the external acceptance of the goal of the task.

Discussion

As a result of this study, first-graders with mental retardation were tested for visual-sensorimotor perception by H. Breuer and M. Woiffen at the level of "recognition", "understanding", "application". According to the results of the experiment, first-graders, which is 35 % of students, coped with the task with the help of the teacher's guiding actions. 44 % of students did not complete some of the assignments, visual-sensorimotor perception and transfer to analogy are not sufficiently developed, and for the remaining 21 % of students with mental retardation, the teacher's instructions caused difficulty in completing the assignment. The overwhelming majority of students with mental retardation had a spontaneous shift in the way of achieving the result. This was manifested in an insufficiently full awareness of their own method of activity. Thus, low ability in mental operations, such as analysis and synthesis, and deficiencies in working memory led to difficulties in performing accurate and correct actions and operations with various quantities and actions [12].

Thus, the results of the experiment indicate a reduced actual and potential ability of children with mental retardation in solving educational problems. The main task of the teacher is to direct the actions of the students to the phenomena being studied in the surrounding world. Develop the ability to distinguish between flat shapes (triangle, circle, square, rectangle) and spatial shapes (sphere, cylinder, cone, pyramid). Only then will students be able to determine their place in the world around them and understand that each surface of the spatial figure is flat.

Practice and research by scientists have proven that students with mental retardation, even knowing the exact definition of the subject, cannot analyze from the necessary point of view and compare the data with the concept.

The complication of the content of the task from the position of taking into account the possibilities of its comprehension and implementation by students with mental retardation leads to a gradual understanding of the necessary actions [13].

Conclusion

The conducted experimental study aimed at identifying the features of perception and reproduction of visually perceived information by students with mental retardation in the study of mathematics, allowed us to empirically confirm the hypothesis put forward. The results of experimental tasks at the levels of recognition, understanding, and application have shown that children with MR actually demonstrate a reduced level of accuracy, insufficient differentiation of spatial features, and a high degree of dependence on external pedagogical support.

These factors limit the successful completion of educational tasks and indicate that the standard forms of pedagogical support – demonstration by sample, increased time, repetition of instructions are insufficient. It is necessary to qualitatively complicate the content of assistance and organize activities in a reflexive and cyclical form with a mandatory stage of self – verification.

The task analysis allowed us to identify specific difficulties that arise at each level: from basic perception (recognition) to attempts to independently perform complex actions (application). This confirms need to adapt methodological approaches to teaching mathematics to this category of students with an emphasis on the development of sensorimotor coordination, visual analysis and elementary spatial logic.

Thus, the hypothesis of the study was confirmed, and the identified features allowed:

– to clarify the pedagogical conditions under which the formation of visual-sensorimotor skills in younger schoolchildren with MR is possible;

– to substantiate the importance of step-by-step presentation of training tasks of varying complexity;

– develop proposals for adapting the learning process, including modeling, visualization, and repetition of actions.

The limitation of the study was the relatively small sample size and focus only on the first year of study. In the future, it seems promising to expand the empirical base, as well as to include in the study of dynamic changes in visual-sensory activity during long-term learning, including using digital and graphical tools.

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ЗЕРДЕ БҰЗЫЛЫСЫ БАР ОҚУШЫЛАРДЫҢ «МАТЕМАТИКА» ПӘНІН МЕҢГЕРУ БАРЫСЫНДАҒЫ ҚАБЫЛДАУ ЕРЕКШЕЛІКТЕРІ

Мақалада визуалды түрде қабылданатын ақпаратты қабылдау және жаңғырту дағдыларын қалыптастыруға және дамытуға бағытталған диагностикалық-түзету бағдарламасы шеңберінде психикалық дамуы тежелген бірінші сынып оқушылары арасында жүргізілген тәжірибелік-эксперименттік зерттеудің нәтижелері келтірілген. Орындалған тапсырмаларды талдау стандартты педагогикалық көмек әдістері – мысалы, үлгі бойынша көрсету, нұсқауларды қайталау және орындау уақытын ұлғайту – ЗПР бар студенттердің оқу материалын толық игеруі үшін жеткіліксіз

екенін анықтауға мүмкіндік берді. Осы санаттағы оқушылар педагогикалық қолдау мазмұнының сандық кеңеюін де, сапалық күрделілігін де талап ететіні анықталды. Жақын даму аймағына жатқызылған тапсырмалар ұсынудың күрделілігінің жоғары деңгейінде орналастырылды және рефлексивті бақылаудың міндетті кезеңдерімен қызметті ұйымдастырудың циклдік формасын талап етті. Көрнекі ынталандыруды дұрыс қабылдау және тапсырмаларды сәтті орындау Негізгі ойлау операцияларының қалыптасуын анықтайды – өз әрекеттерін жалпылау, салыстыру және талдау. Қосымша ынталандыру шеңберінде қатардағы өзгерістерді тану, ұқсастықтар мен айырмашылықтарды табу, абсурдтық немесе ойдан шығарылған объектілерді анықтау, объектілер мен белгілердің тізбегін есте сақтау және объектілерді олардың контуры бойынша тану бойынша тапсырмалар ұсынылды. Зерттеу нәтижелері ЗПР бар оқушылардың когнитивті даму ерекшеліктерін нақтылауға және математиканы оқу кезінде визуалды-сенсоримоторлы қабылдау дағдыларын сәтті қалыптастыруға ықпал ететін педагогикалық жағдайларды анықтауға мүмкіндік берді.

Кілтті сөздер: психикалық даму, оқушылар, психикалық дамуының тежелуі (ПДТ), білім, елестету, оқудағы қиындықтары.

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ОСОБЕННОСТИ ВОСПРИЯТИЯ ПРИ ОСВОЕНИИ УЧЕБНОГО ПРЕДМЕТА «МАТЕМАТИКА» УЧАЩИМИСЯ С УМСТВЕННОЙ ОТСТАЛОСТЬЮ

В статье представлены результаты опытно-экспериментального исследования, проведённого среди обучающихся первых классов с задержкой психического развития (ЗПР) в рамках диагностико-коррекционной программы, направленной на формирование

и развитие навыков восприятия и воспроизведения зрительно воспринимаемой информации. Анализ выполненных заданий позволил установить, что стандартные педагогические приёмы помощи – такие как демонстрация по образцу, повтор инструкций и увеличение времени на выполнение – оказываются недостаточными для полноценного усвоения учебного материала обучающимися с ЗПР. Выявлено, что учащиеся данной категории требуют как количественного расширения, так и качественного усложнения содержания педагогической поддержки. Задания, отнесённые к зоне ближайшего развития, располагались на высоком уровне сложности предъявления и требовали цикличной формы организации деятельности с обязательными этапами рефлексивного контроля. Правильное восприятие зрительных стимулов и успешное выполнение заданий обусловливают формирование базовых мыслительных операций – обобщения, сравнения и анализа собственных действий. В рамках дополнительной стимуляции были предложены задания на распознавание изменений в ряду, нахождение сходств и различий, определение абсурдных или вымышленных объектов, запоминание последовательностей предметов и символов, а также узнавание объектов по их контуру. Результаты исследования позволили конкретизировать особенности когнитивного развития учащихся с ЗПР и определить педагогические условия, способствующие успешному формированию навыков зрительно-сенсомоторного восприятия при изучении математики.

Ключевые слова: психическое развитие, обучающиеся, задержка психического развития (ЗПР), знания, представления, трудности в обучении.

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