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RESEARCH ARTICLE

The Role of Exercises in The Process of Forming Geometric Concepts Among Students with Intellectual Disabilities

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Abstract

The article examines the role of exercises in the process of forming geometric concepts among students with intellectual disabilities. Geometry is not only a branch of mathematics related to shapes, size, position and spatial relations, but also an important means of developing perception, attention, comparison, classification, visual memory, spatial orientation and practical thinking. For students with intellectual disabilities, the acquisition of geometric concepts is often complicated by difficulties in abstraction, generalization, verbal reasoning, spatial imagination and voluntary attention. Therefore, exercises become a central pedagogical tool that connects concrete experience with conceptual understanding. The article analyzes the scientific and theoretical foundations of using exercises in special mathematics education, relying on cognitive, developmental, activity-based and correctional pedagogical approaches. The study emphasizes that exercises should not be limited to mechanical repetition; they should be systematic, purposeful, visual, practical, differentiated and connected with real-life situations. The article shows that geometric exercises help students recognize shapes, compare objects, identify essential features, distinguish similar figures, use geometric vocabulary and apply knowledge in everyday activities. The results of the theoretical analysis indicate that the effectiveness of exercises depends on gradual complication, multisensory support, teacher guidance, repeated practice, corrective feedback and the emotional involvement of students. The article concludes that exercises play a formative, corrective, developmental and motivational role in teaching geometry to students with intellectual disabilities.

KEYWORDS

intellectual disability, geometric concepts, exercises, special pedagogy, mathematics education, spatial thinking, visual perception, correctional teaching, inclusive education, cognitive development.

INTRODUCTION

The formation of geometric concepts occupies an important place in the mathematical education of students with intellectual disabilities. Geometry introduces learners to the properties of objects and figures, helps them understand form, size, direction, position, symmetry and spatial relations, and develops the ability to analyze the surrounding world through visual and practical experience. For students with intellectual disabilities, geometric knowledge has not only academic but also correctional, developmental and social significance. It supports orientation in space, understanding of everyday objects, practical problem solving and preparation for independent life.

Students with intellectual disabilities often experience difficulties in mastering mathematical concepts because their cognitive activity develops more slowly and unevenly. They may have limited ability to compare objects according to several features, distinguish essential and non-essential characteristics, generalize visual impressions, remember geometric terms and transfer learned knowledge to new situations. These difficulties are especially visible in the process of learning geometry, because geometric concepts require a connection between perception, speech, action and abstract thinking. A student should not only see a circle, square or triangle, but also understand which features make the figure what it is, how it differs from other figures and where it can be found in real life.

In this context, exercises play a decisive role. An exercise is not merely a repeated task; it is a specially organized pedagogical action aimed at forming, strengthening and applying knowledge, skills and habits. In special pedagogy, exercises are considered one of the main means of correctional and developmental teaching because they allow the teacher to move from simple perception to conscious recognition, from imitation to independent action and from practical manipulation to verbal explanation. Through exercises, students with intellectual disabilities gradually learn to observe, compare, classify, name, construct, draw and use geometric shapes.

The relevance of the topic is connected with the need to improve mathematics instruction for students with intellectual disabilities in both special and inclusive educational settings. Modern education emphasizes that every learner has the right to access meaningful mathematical content. However, access to content does not mean only simplifying the curriculum. It requires the development of appropriate methods, tasks and learning conditions that correspond to the learner's cognitive characteristics. In teaching geometry, such conditions are created largely through a carefully designed system of exercises.

The purpose of this article is to reveal the scientific and theoretical foundations of the role of exercises in forming geometric concepts among students with intellectual disabilities. The article aims to analyze the pedagogical essence of exercises, determine their correctional and developmental functions, describe the stages of geometric concept formation and identify the methodological requirements for organizing effective exercises in special mathematics education.

The article is based on theoretical and analytical research. The methodological foundation includes the study of scientific literature in special pedagogy, developmental psychology, mathematics education and inclusive teaching methodology. The research does not present the results of a separate experimental intervention; instead, it synthesizes existing theoretical approaches and pedagogical ideas in order to clarify how exercises contribute to the formation of geometric concepts among students with intellectual disabilities.

The first method used in the study is conceptual analysis. It allows the clarification of such key concepts as intellectual disability, geometric concept, exercise, spatial thinking and correctional teaching. The second method is comparative theoretical analysis, which makes it possible to compare different scientific approaches to the development of mathematical thinking. The third method is pedagogical generalization, through which the role of exercises is interpreted in relation to classroom practice. The fourth method is systematization, which helps identify the main types, functions and requirements of exercises used in the formation functions and requirements of exercises used in the formation of geometric concepts.

The theoretical basis of the article includes the developmental ideas of L. S. Vygotsky, especially the importance of guided learning, social interaction and the zone of proximal development. The article also considers the views of J. Piaget and B. Inhelder on the development of spatial representations in children, as well as P. van Hiele's theory of levels of geometric thinking. The works of D. H. Clements and M. T. Battista are significant for understanding geometry as a field closely connected with spatial reasoning. Research on mathematics instruction for students with intellectual disabilities is also used to support the importance of concrete, representational and abstract stages of learning, systematic practice and the use of manipulatives.

The theoretical approach is appropriate because the formation of geometric concepts among students with intellectual disabilities is a complex pedagogical process. It cannot be explained only by the number of exercises or by the presentation of visual materials. It requires an understanding of the student's cognitive development, the structure of the concept being taught, the gradual transition from action to speech and thought, and the teacher's role in organizing meaningful practice.

The theoretical analysis shows that exercises perform several interconnected functions in the formation of geometric concepts among students with intellectual disabilities. The first function is formative. Through repeated and purposeful actions, students acquire initial knowledge about geometric figures, their names, properties and relations. For example, when students repeatedly identify circles among other figures, trace their outlines, compare them with wheels or buttons and name them in speech, they gradually form a stable representation of the circle. The same process applies to squares, triangles, rectangles and other geometric forms.

The second function of exercises is corrective. Students with intellectual disabilities often have difficulties in visual differentiation, spatial orientation, attention stability and speech-based reasoning. Geometric exercises can be used to correct and develop these weak areas. When a student compares a square and a rectangle, he or she learns to notice length, width, angles and sides. When the student arranges figures according to size, he or she develops comparison and sequencing skills. When the student finds a shape in the classroom environment, spatial observation and transfer of knowledge are strengthened. Thus, exercises correct not only mathematical knowledge but also broader cognitive processes.

The third function is developmental. Properly organized geometric exercises contribute to the development of perception, memory, thinking, speech and fine motor skills. Drawing a triangle, constructing a square from sticks, completing a pattern with shapes or describing the position of an object develops coordination between visual perception and practical action. Naming figures coordination between visual perception and practical action. Naming figures and explaining differences between them develops mathematical vocabulary and connected speech. Classifying objects by shape, color or size develops logical operations. Therefore, geometry exercises serve as a means of intellectual development.

The fourth function is motivational. Many students with intellectual disabilities experience anxiety or passivity in mathematics lessons because they associate mathematics with failure. Geometry exercises, especially those based on concrete materials, play, drawing, construction and everyday examples, can reduce fear and increase interest. When the student sees that a difficult mathematical idea can be touched, moved, colored or built, the learning process becomes more accessible and emotionally positive. Success in small exercises creates confidence and prepares the learner for more complex tasks.

The formation of geometric concepts should be organized gradually. At the first stage, students become familiar with shapes through direct sensory experience. They observe, touch, move, compare and match objects. At this stage, exercises should be concrete and practical. The teacher may ask students to find round objects, place a triangle on a picture, sort blocks by shape or match identical figures. The main goal is to create a visual and sensory basis for future understanding.

At the second stage, students begin to identify and name figures. Exercises at this stage connect perception with speech. The teacher encourages students to say the names of figures, repeat geometric terms, answer simple questions and use words such as round, straight, corner, side, big, small, above, below, near and far. For students with intellectual disabilities, verbalization is very important because it helps stabilize the concept. A figure that has been named and described becomes clearer for memory and thinking.

At the third stage, students compare and distinguish figures according to essential features. This stage is more complex because it requires analysis. The student must understand that a triangle has three sides and three corners, while a square has four equal sides and four corners. Exercises should help the learner focus on essential properties rather than accidental features such as color or size. If a triangle is red in one task and blue in another, the student should still recognize it as a triangle. This requires varied exercises using figures of different sizes, colors, orientations and materials.

At the fourth stage, students learn to construct and represent geometric figures. They draw shapes, build them from sticks, create them with paper strips, use templates and reproduce them in notebooks. These exercises are especially valuable because they transform passive recognition into active production. When a student constructs a figure, he or she begins to understand its structure more deeply. For example, building a rectangle from four sticks helps the student see the relation between opposite sides and corners.

At the fifth stage, students apply geometric concepts in practical and everyday situations. They recognize shapes in classroom objects, household items, road signs, toys, buildings and pictures. They use geometric vocabulary to

describe objects and locations. This stage is essential because knowledge becomes meaningful only when it can be transferred beyond the lesson. For students with intellectual disabilities, transfer is often difficult, so exercises should deliberately connect school tasks with real life.

The results of the analysis also show that exercises should be differentiated. Students with intellectual disabilities are not a homogeneous group. Some students may recognize basic shapes but have difficulty describing them. Others may name figures but confuse them when their position changes. Some students may need tactile support, while others benefit more from visual models or verbal prompts. Therefore, the same geometric topic should include exercises of different levels of difficulty. Differentiation may involve changing the number of figures, reducing visual distractions, providing models, using prompts, extending time or offering additional practice.

An important result is that the effectiveness of exercises depends on the sequence from concrete to representational and then to abstract forms. At the concrete level, students manipulate real objects and geometric models. At the representational level, they work with pictures, drawings, diagrams and symbols. At the abstract level, they use terms, definitions and mental images without direct support. Students with intellectual disabilities often need more time at the concrete and representational stages than their peers. If the teacher moves too quickly to abstract explanations, the concept may remain formal and unstable.

The analysis also demonstrates that exercises must be repeated but not monotonous. Repetition is necessary because students with intellectual disabilities may need many encounters with the same concept before it becomes stable. However, mechanical repetition of identical tasks may reduce interest and lead to passive memorization. The teacher should repeat the same concept through different forms of activity. For example, the concept of a square can be practiced through matching, coloring, constructing, drawing, finding in the environment, comparing with a rectangle and using it in a pattern. Such varied repetition strengthens understanding and prevents fatigue.

Teacher guidance is another decisive condition. Exercises do not automatically lead to concept formation. The teacher must direct attention to important features, ask guiding questions, provide examples and counterexamples, correct errors tactfully and encourage students to explain their actions. If a student chooses a rectangle instead of a square, the teacher should not simply say that the answer is wrong. It is more effective to compare the sides, count the corners and help the student discover the difference. In this way, the exercise becomes a learning situation rather than a test of memory.

DISCUSSION

The role of exercises in the formation of geometric concepts among students with intellectual disabilities should be interpreted within a broader correctional and developmental framework. Geometry teaching is not only the transmission of mathematical information. It is also the development of the learner's ability to perceive the world in an organized way, distinguish forms, understand spatial relations and use mathematical language. Exercises create the practical basis for this development because they involve action, perception, speech and thought at the same time.

From the perspective of Vygotsky's theory, exercises are most effective when they are organized within the student's zone of proximal development. A task that the student can complete independently may strengthen previous knowledge, but it does not always lead to new development. A task that is too difficult may cause frustration and refusal. The most productive exercise is one that the student cannot yet complete alone but can complete with teacher support. In geometry lessons, this means that the teacher should provide scaffolding through demonstration, visual cues, guiding questions, partial models and step-by-step instructions. Gradually, this support should be reduced so that the student becomes more independent.

Piaget's ideas about the development of spatial thinking also help explain the importance of exercises. Children develop spatial representations through action with objects and gradual coordination of perceptual experience. Students with intellectual disabilities may remain longer at the stage where concrete action is necessary. Therefore, geometric instruction should not begin with formal definitions. It should begin with touching, moving, grouping, building and comparing objects. Only after sufficient practical experience can the student understand verbal explanations more meaningfully.

Van Hiele's theory of geometric thinking is also relevant. At the initial level, students recognize shapes by their overall appearance. Later they begin to notice properties, and only at higher levels can they reason about relations between properties. Many students with intellectual disabilities remain at the visual and descriptive levels for a longer time. This does

not mean that geometry instruction should be avoided. On the contrary, it means that exercises should be selected according to the learner's current level. Visual recognition exercises, property-based comparison, classification tasks and guided descriptions help students move gradually from perception to analysis.

The use of exercises also corresponds to the principles of activity-based learning. A concept is formed more effectively when the student acts with the object of knowledge. In geometry, the object of knowledge is not only a drawing in the textbook but also a physical figure, a classroom object, a construction material or a spatial relation. When students build a triangle from sticks, place a circle under a square, draw a line between two points or arrange objects from largest to smallest, they internalize mathematical relations through action. This is especially important for students whose abstract thinking is limited.

One of the most important methodological requirements is the connection between exercises and speech. Students with intellectual disabilities may perform a practical task correctly but fail to express what they have done. If speech is not developed, the concept may remain situational and unstable. Therefore, each exercise should include simple verbal support. The teacher may ask: "What shape is this?", "How many sides does it have?", "Where is the circle?", "Which figure is bigger?", "Why is this not a triangle?" Such questions should be adapted to the student's level, but they are necessary for connecting action with thought.

Another important issue is error correction. Errors in geometry learning are natural and diagnostically valuable. A student who confuses a square and a rectangle may not yet understand the importance of equal sides. A student who does not recognize a triangle when it is turned upside down may depend too much on familiar orientation. A student who calls all round objects circles may need help distinguishing two-dimensional and three-dimensional forms. Exercises allow the teacher to identify these difficulties and correct them through targeted practice. Correction should be calm, concrete and explanatory. Harsh criticism reduces motivation and may make the student afraid of mathematical tasks.

Exercises should also be connected with life skills. Students with intellectual disabilities need geometry not only for school achievement but also for everyday orientation. They encounter shapes in signs, doors, windows, tables, plates, clocks, money, maps and household objects. They need to understand directions, positions and sizes in daily activities. Therefore, exercises should include practical contexts. For example, students may identify the shape of classroom furniture, arrange objects on a desk according to instructions, find the shortest path, compare the size of boxes or recognize signs by shape. Such exercises make geometry socially meaningful.

The use of visual and tactile materials is especially important. Geometric concepts are abstract if they are presented only through words, but they become accessible when students can see and manipulate them. Models, blocks, cards, mosaics, puzzles, templates, geoboards, drawing tools and digital visualizations can support understanding. However, materials should be used purposefully. Simply giving students manipulatives does not guarantee learning. The teacher must organize actions with these materials so that students notice the intended geometric properties.

Motivation is another important condition. Exercises should be emotionally engaging and achievable. Students with intellectual disabilities may quickly lose interest if tasks are too long, visually overloaded or unrelated to their experience. Short, clear, colorful and successful exercises are more effective. Game elements, practical construction, pair work and praise can increase engagement. At the same time, motivation should not be based only on entertainment. The student should gradually understand the usefulness of geometric knowledge.

Assessment should also be exercise-based. Instead of relying only on written tests, the teacher should observe how the student recognizes, selects, constructs, compares and explains figures during practical tasks. Such assessment provides a more complete picture of learning. It also allows the teacher to adjust instruction immediately. For example, if a student can match identical shapes but cannot identify them among distractors, the next exercises should focus on differentiation. If a student can name shapes but cannot draw them, construction and tracing exercises are needed.

The discussion confirms that exercises are not an auxiliary element of geometry instruction; they are its methodological core. For students with intellectual disabilities, geometric concepts are formed through a long process of guided activity. Exercises provide the bridge between perception and understanding, between action and speech, between school mathematics and everyday life.

The formation of geometric concepts among students with intellectual disabilities requires systematic, purposeful and correctionally oriented instruction. Due to difficulties in abstraction, generalization, spatial imagination, attention and speech development, these students need a special organization of learning in which geometric ideas are introduced through concrete action, visual support, repeated practice and meaningful application. Exercises play a central role in this process.

The scientific and theoretical analysis shows that exercises perform formative, corrective, developmental and motivational functions. They help students recognize geometric figures, distinguish their properties, compare objects, classify shapes, develop spatial orientation, use mathematical vocabulary and apply knowledge in practical situations. Properly organized exercises support not only mathematical learning but also the development of perception, memory, thinking, speech, fine motor skills and independence.

The effectiveness of exercises depends on several pedagogical conditions. They should be accessible, gradual, varied, visually supported, connected with speech and related to real-life experience. They should move from concrete manipulation to representational tasks and then to abstract understanding. Teacher guidance, differentiated support, positive feedback and systematic repetition are necessary for stable concept formation.

Thus, exercises should be considered one of the most important means of teaching geometry to students with intellectual disabilities. They make geometric knowledge understandable, practical and personally meaningful. Through exercises, students not only learn shapes and spatial relations but also develop cognitive activity, confidence and readiness to use mathematical knowledge in everyday life.

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