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Technological Approach to the Formation of Mathematical Competence in Preschool Children

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POVZETEK – Članek obravnava težave z oblikovanjem matematičnih idej pri predšolskih otrocih. Predlaga združevanje posameznih komponent izobraževalnega procesa (vsebine, metod, načinov in oblik) v dosledni pedagoški postopek. Tehnološki pristop bo zagotovil kakovost matematičnega izobraževanja predšolskih otrok. Avtorja sva razvila izobraževalni postopek "Oblikovanje matematične kompetence", ki je sestavljen iz sistema izobraževalnih in praktičnih situacij. Med študijo primera so otroci usvojili matematične koncepte in pridobili znanje v obliki posplošenih postopkov. Posplošeni postopki prispevajo k oblikovanju strukture simbolnega in logičnega mišljenja, ki omogoča lahek prehod od vizualnega in simbolnega k verbalnemu in logičnemu mišljenju. Praktične situacije nudijo priložnost za pridobivanje matematične kompetence in za oblikovanje sposobnosti uporabe pridobljenega znanja pri reševanju življenjskih situacij.

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ABSTRACT – The article discusses the problems of the formation of mathematical ideas in preschool children. It proposes to combine the individual components of the educational process (content, methods, means, forms) into a coherent pedagogical procedure. The technological approach will ensure the quality of mathematical education of preschool children. The authors developed the educational procedure "The Formation of Mathematical Competence", which consists of a system of educational and practical situations. During the case study, the children learned mathematical concepts and acquired knowledge in the form of generalized procedural ideas. Generalized procedural ideas contribute to the formation of a structure of figurative and logical thinking, which provides a smooth transition from visual and figurative to verbal and logical thinking. Practical situations give the opportunity to acquire mathematical competence; to form the ability to use the acquired knowledge to solve life situations.

1 Introduction

The development of science and production requires of a modern person to master a large amount of knowledge and practical skills. In a short time, the child must learn the culture of previous generations. In this regard, the teachers are faced with the task of increasing the effectiveness of teaching and raising children at all age levels. Preschool education is the first stage in which the learners begin to master knowledge. Their further development depends on the result which will be obtained at this stage.

The analysis of the experience of teachers at preschool educational institutions showed that they have significant difficulties in organizing the mathematical development of preschool children. One of the reasons is the teachers' insufficient knowledge of

the basics of mathematics. In the process of explanation, they do not reveal the essential features of mathematical concepts and do not know how to adapt these concepts to the children's level of visual and figurative thinking. Knowledge is imparted verbally or at the level of empirical generalization.

Children must learn the system of scientific concepts and the methods of obtaining them, highlight and relate individual aspects of the subject, and establish connections between them (Elkonin, 1974, p. 63). Education in its various forms is a decisive factor in the development of a child's thinking and speech. As N. Talyzina notes, the theory of education should be aimed at studying the laws of transformation of the phenomena of collective consciousness into individual psychological phenomena. "In those cases when the necessary types of activities and the methods of their execution are not objectified and not fixed as components of social experience, but exist only as facts of individual consciousness, the theory of education should indicate the way to identify and define them, making them accessible for assimilation" (Talyzina, 1975, p. 42). If the structure of educational activity is simplified, reduced to the perception and memorization of knowledge and verbal formulations, then the concept is not really acquired, and the positive impact of learning on the learners' development is significantly reduced (Vallon, 2008).

As D. Elkonin notes, the result of educational activity, in which the assimilation of scientific concepts occurs, is primarily a change in the learner, in his/her development. The scientist notes that these changes are the achievement of the child's new learning abilities, that is, a new course of action. According to D. Elkonin's definition (1997), the educational activity is a purposeful activity that aims to master a generalized course of action in the field of scientific concepts. According to V. Davydov, the educational activity is an activity that has a developing character, the content of which is the theoretical knowledge and the skills that are based on it (Davydov, 2008, pp. 110–118).

Investigational studies by N. Nepomnyashcha (1983) indicate that if a child has mastered the method of establishing the most general relationships, he/she solves problems and numerical examples much easier. The child will not search for random results, but consciously and reasonably apply the learned method to solve a specific problem. Having solved it, he/she will be able, and this is the main thing, to justify and prove the correctness of his/her decisions.

Through training, it is necessary to convey to children not only empirical knowledge about the properties and methods of acting with objects, but the experience of cognition by mankind of the phenomena of reality: nature, society and thinking, generalized in science and fixed in the system of scientific concepts. D. Elkonin notes that the activity will be developing in the context of children's mastery of the scientific content, that is, the system of scientific knowledge and the ways to obtain it (Elkonin, 1974, p. 64).

Among the achievements of the visual and figurative thinking of preschoolers, which are important for the formation of generalized representations, scientists (Rychik, 1987) distinguish the following:

- Representation in the operational structure of the dynamic image of an object, the essential principles of its change and development, revealing the meaning of generalized concepts.
- Concentration of the child on these principles when performing an objective or mental action.

□ Generalization of the operational structure of the dynamic image during the change of the object or conditions (Rychik, 1987, p. 47).

The achievements of visual and figurative thinking allow learners to ascend from the abstract to the concrete within the transitional unit of the process of thinking, that is, a generalized procedural idea. "The essence of this approach is to maintain the characteristic activity of visual and figurative thinking in children's educational activity, to consistently organize and direct the cognitive process to realize the content of the actions performed, which complies with the general concept" (Rychik 1987, p. 47).

Only a dynamic image contains the properties that are not disclosed by static visibility. Therefore, it is necessary to perceive the changes in objects as processes caused by their internal nature and subject to their internal principles, that is, they occur regardless of external influences (Shchedrovytskiy, 1987).

During the assimilation of mathematical concepts, the suitable actions of the child are determined as a necessary means of assimilation. These actions are modeled in an external, material (or materialized) form, which makes it possible not only to reveal their contents to the child, but also to ensure their assimilation. Afterwards, a program of a phased transformation of actions is drawn up, and at each stage the actions are modified according to independent characteristics. In all stages of the transformation of actions, operational control over the course of their implementation is ensured, which, in the last stages of assimilation, is transformed into self-control (Talyzina, 1975).

S. Rubinstein (1958) singled out two characteristic features of dialectical generalization: it is carried out in such an analysis of any single fact (event, task) that reveals the internal connection of its individual manifestations; based on this connection, a person immediately generalizes all other facts. In this case, a lengthy comparison of many similar facts is not required for their gradual empirical generalization.

In the representation of educational material, the forms of everyday and scientific concepts are not distinguished, leading to the absolutization of the empirical experience of children. Therefore, the role of illustrative clarity, as well as the mental operation of comparison when concepts appear, is exaggerated (Vygotskii, 1996).

The study by N. Menchinska (2004) proved that children, focusing on specific objects requiring the use of concepts, do not always rely on essential features. Often there is a reproduction of the learned text or the words of the teacher. It means that knowledge in such cases has a verbal, formal character. Verbal knowledge (Leontyev, 1992) does not change the essence of the process of its assimilation, which convincingly proves the impossibility of transferring knowledge in its finished form. A child can receive it only as a result of his/her own activity, aimed not at words, but at those objects the knowledge of which we want to form. For the assimilation of concepts, the corresponding objective activity of the child with the object that is being studied is necessary. During learning activities, children model the process of generating concepts. As E. Ilyenkov (2002) wrote, the educational process has to reproduce in a closed form the actual historical process of the creation and development of knowledge.

The competency-based approach in modern education, according to I. Bekh (2009), should provide a high level of competence in the subjects of scientific education. The fundamental point of scientific competence is that it directly depends on the quality of educational achievements that will be transformed into the subject's competency

system. Only proper scientific evidences have sufficient potential for such competence. So, only the pedagogy of development (and not the pedagogy of memorizing words and empirical generalization) can ensure the development of the subject-specific competence at the highest level.

Most of the scientific evidences obtained by scientists remain unclaimed by practitioners. Preschool teachers do not have enough time to process a large amount of theoretical material nor the ability to transform it into a compendium of lessons by which children can be taught. The technological approach might be an alternative to such a learning path. It will help to transfer scientific evidences from a theoretical plane to a practical one (Selevko, 2005). The main advantage of the technological approach is that it will contribute to the development of the educational procedure, which can be reproduced by teachers at different levels of professional training.

To ensure the quality education of preschool children, it is necessary to provide the teacher with a mechanism for the implementation of the educational content selected by scientists, taking into account the children's individuality. In this regard, the individual components of the educational process (content, forms, methods, means) must be combined into a holistic educational procedure. The latter should be presented as a system of components of the educational process that are interconnected, built on a scientific basis, programmed in time and space, and lead to the planned results.

The educational procedure reflects the path to mastering specific educational material within a specific subject, topic and question. The training material should be structured (Selevko, 2004). O. Piekhota (2013) notes that the procedure is knowledge-intensive and takes into account various aspects of educational and cognitive activity (pedagogical, psychological, physiological, methodological). The technological approach to the formation of the mathematical competence of preschool children requires the definition of clear criteria for the organization of the educational process. H. Selevko (2005) determines the important criteria of the procedure, such as consistency, comprehensiveness, integrity, scientificity, structuredness, reasonableness, and algorithmic characteristics.

Aims of the present study

It is necessary to combine the scientific evidences of the theory of developmental education to create a procedure for the acquisition of mathematical knowledge by preschool children. On the basis of the complementarity principle, it is necessary to integrate the following scientific concepts into the educational process: meaningful generalization (Davydov, 2008), the essence and correlation of knowledge and thinking (Ilyenkov, 2002), the genesis of the dynamic image (Rychik, 1987), the procedural nature of scientific knowledge (Shchedrovytskiy, 1987), and the activity integration (Losev, 1995).

The purpose of the procedure is to form a structure of figurative and logical thinking, which provides a smooth transition from visual and figurative to verbal and logical thinking. The conceptual idea behind the procedure is the mastery of mathematical generalized procedural ideas, which in content correspond to a scientific concept; the rational solution of practical problems based on the use of mathematical knowledge; taking into account the individual characteristics of children; the development of thinking.

It is necessary to combine the individual components of the educational process, such as the mathematical meaning – counting, form, size, space, time; active methods – dialogue, modeling; abstract and plot teaching means – models, diagrams, drawings; various forms of training – individual, group, collaborative; formation of a holistic view of objects; development of creativity, speech, moral education; familiarization with the objects of the natural and personal environment.

2 Study methods

To effectively teach mathematics to preschool children, we have developed a system of educational (activity-based approach) and practical situations (competency-based approach). In educational situations, the children mastered mathematical concepts, and in practical situations they acquired competencies. All educational material is presented in textbooks for the educator (Zaitseva, 2016d; 2016e; 2016f) and in self-instructional workbooks (Zaitseva, 2016a; 2016b; 2016c).

The implementation of the activity-based approach (Galperin, 1959) in the educational process requires orientation towards the following methodological provisions: in the development and organization of training, the primary provisions are the activities and actions that are specified by the content knowledge; the ultimate goal of training is the formation of a course of action that ensures the implementation of activities; in the educational process, the subject of learning carries out educational activities and models future practical activities; the mechanism for mastering knowledge is the solving of learning situations; studying is a combination of two interconnected activities, the activities of the subject that is studying, and of the subject that is teaching; the activities of the teacher relate to the development, organization and management of educational activities; the child's activity relates to mastering knowledge. Competence as a scientifically relevant experience appears when a preschool child uses scientific knowledge as a generalized course of action to solve a certain type of problem. If he/she uses this knowledge as a course of action for solving only one practical problem and cannot transfer this method to solving other similar problems, it means that he/she has not formed such an experience. Under such conditions, the pedagogical process is a system in which all components are interconnected (Slastenin, 2000).

The first step in the creation of the educational procedure "The Formation of Mathematical Competence in Preschool Children" was the development of a two-level (basic and advanced level) partial program. In the program for each age group a certain mathematical meaning is determined. The content provided a system of mathematical concepts for each age group in the following sections: multitude, counting (quantitative, ordinal), numbers, geometric shapes, magnitude, space, time. The program has a structure with a quarterly distribution of educational material, which allows you to select it for each lesson and to observe the gradually increasing difficulty of knowledge. The tasks that contribute to the formation of cognitive interest and learning skills are a significant complement to the program.

Dividing the mathematical content into basic and advanced levels provides the teacher with the opportunity to take into account the individual characteristics, interests

and abilities of children, and their development prospects. The tasks of different difficulty levels help to avoid averaging a child's education, limiting his/her ability to master the mathematical knowledge within a certain age group.

The next stage of the work was the transformation of scientific mathematical concepts (an essential feature) into generalized mathematical procedural ideas. The generalized procedural idea coincides in form with the dynamic image of the action object, and in content with the concept that is being formed. The concepts must be presented precisely in the form of a dynamic image. The latter consists of operations that are similar in content to a scientific concept. Performing an action which is regulated by a visual and figurative thinking process, the learner becomes aware of the advantage of the initial state of the action object and infers its final state. The acquired knowledge, on the basis of the selected indicative basis of the course of action, thereby reveals to the child the general meaning of long-known specific phenomena. For the child to consciously assimilate the process, based on which a generalized procedural idea of the essential properties of certain objects is formed, it is important to determine the necessary and sufficient operations (quantity and sequence) that make up the structure of this process. Even the absence of one operation gives an inaccurate picture of the phenomenon that is being studied.

Each mathematical concept is revealed through the objective transforming actions of cognitive orientation. As a result, the child masters the necessary number of operations carried out in a certain sequence, which constitutes a generalized course of action. A detailed compendium of lessons, which define the topic, goal, demonstration and handout material, and the course of the lesson (questions for children), helps the teacher to get the planned results. The compendium of lessons has a clear structure, which provides several interrelated stages:

- The motivation of activities;
- The statement of the problem, which requires the use of new knowledge;
- An adequate objective transforming activity;
- The reproduction of a new course of action in a typical situation;
- Developing tasks;
- The result of the lesson.

The competency-based approach is realized by practical tasks that are solved on the basis of the acquired essential properties. It is during the practical activity that the child gains experience. He/she can solve problems of various types, associated with a wider social or domestic practice. Competence as a scientifically relevant experience appears when a preschooler uses scientific knowledge as a generalized course of action to solve a certain type of problem. If he/she uses this knowledge as a course of action for solving only one practical problem and cannot transfer this method to solving other similar problems, it means that he/she has not formed such an experience.

The use of practical situations creates the conditions for children to acquire mathematical competence. In the classroom, an initial familiarization with the mathematical concept is carried out. Mastering the skills to use the acquired knowledge (counting, measuring, navigating in space and time) in various types of activity, such as game, work, design. The application of the knowledge of mathematics in practical situations requires its inclusion in new systems of relationships, finding the already known rela-

tionships under new conditions. Practice gives the child the opportunity to distinguish the right thoughts from false ones and is a criterion of their validity. The basics of experience are gained in the process of performing a series of practical tasks, where the idea is fully realized, according to which the ultimate goal of knowledge is not knowledge in itself, but the practical transformation of reality to meet the material and spiritual needs of a person.

After each lesson, practical situations are used in which two or three children participate. The interaction between the teacher and the child in this form can last 3-5 minutes. An important component of such situations is the questions for children. They encourage learners to establish relationships (quantitative, spatial, temporal, causal, sequential), give proof for their own opinions, and generalize their knowledge on a particular topic. The practical tasks are aimed at a direct transformation of reality. A problem field was created for solving practical problems, which provides the setting of conditions and goals.

The workbook contributes to the consolidation of the procedure "The Formation of Mathematical Competence in Preschool Children". It consists of a set of cards for organizing the independent work of children. For each age group, a workbook with tasks of different difficulty levels is offered. With continuity in mind, the workbooks and textbooks complement each other. The placement of cards allows the teacher to independently choose the form of training (individual, group, frontal) in accordance with the learning conditions (amount of knowledge, number of children in the group, the presence of handouts).

Mathematics characterizes the quantitative side of the environment. Therefore, the tasks with mathematical content are designed in such a way to ensure the development of speech, creativity, and to enrich the child's understanding of various aspects of the environment (Losev, 1995). The development of a child's speech in the process of solving mathematical tasks is facilitated by the exchange of opinions on the topic of assimilation of the material, and the compilation of short plots or descriptive stories.

3 Results and discussion

The educational procedure "The Formation of Mathematical Competence in Preschool Children" instead of several separate tasks – the transfer of knowledge, the formation of skills, and their application – sets one goal: to form such an activity that from the very beginning includes a given knowledge system and ensures the formation of practical experience.

To master mathematical knowledge, external and internal incentives for motivation are used: the plots of fairy tales, a problem and a game, or a problem and a practical situation. The artistic texts or plot drawings help to create the emotional strength of the lessons. Under the conditions of an organized educational and cognitive activity, the acquired knowledge becomes not only understandable, but also internally accepted, acquires significance for the child, and resonates with his/her experiences. Knowledge of measurement will help you to do many good deeds: choose a board of the appropri-

ate size to fix a slide for the kids; patch a hole in a bee hive. The ability to count objects will be of use when choosing the necessary number of ropes for kids to tie them to the sledge; will help travelers buy the necessary number of bus tickets; will help determine the number of balls that will be needed for a game.

Positive criteria are used to control and evaluate children's actions, for example, correctly, accurately, in an original way (in their own way). In the process of evaluating their work, the conventional signs (multi-colored stars) are applied that correspond to each criterion. The learners have the right to acquire all three stars or refuse any (or all) if they fail to reach the appropriate level of task performance. The child does not receive a negative assessment. The use of conventional signs makes it possible to carry out a personal assessment method, which consists of comparing the child's previous achievements with those newly acquired.

How well the children fulfill the mathematical task depends on the teacher's ability to formulate instructions. Each child acquires knowledge at his/her own pace. Some students complete the tasks quickly, while others are just starting their work. To those who have finished or are completing the task, the teacher suggests that they paint the image, while the teacher carries out one-on-one work with those who have difficulties.

After all the children have completed the task, the teacher draws attention to the children's drawings: "Sasha has all the cups of the same color – this is a tea set.", "Natasha drew the cups with handles. It will be convenient for drinking hot drinks.", "Olena painted all the cups in different colors. Each member of the family can choose a cup in their favorite color.", "Mariyka drew the cups with flowers, as a bright spring meadow." Painting exercises are used so that the child does not wait for the others to complete the task and does not become intellectually passive. Also, such tasks help to prepare the child's hands for practicing writing and develop creativity.

Mathematical tasks have great potential for the development of creativity. Each learning situation involves a problem, for the solution of which the child needs to be smart, curious, original and demonstrate imagination. Mathematical tasks contribute to the awareness of knowledge about nature. For example, while familiarizing themselves with plants, the concepts of "many" and "one" help children to distinguish a bush from a tree; the ability to compare in size is facilitated by the question "Why do apricot flowers appear first, then the leaves, but it is the other way round for the cherry tree?", "Why are leaves on trees larger at the bottom and smaller at the top?", "Why do deciduous trees change their leaves, but conifers do not?".

Therefore, the effectiveness of the educational procedure "The Formation of Mathematical Competence" ensures that the psychological mechanisms of the development of a preschool child are taken into account. The proposed educational material provides a perception of the world as a whole, an understanding of the fact that mathematics characterizes the quantitative side of objects and phenomena. A clear, logically motivated mathematics, focused on the capabilities of children provides the teacher with space for creativity and pedagogical research. The learning material for this procedure is presented so that the teacher has the opportunity, depending on the specific conditions for organizing the mathematical activity of children (the purpose and content of the lesson, how well the learners master the subject matter, the number of children in the group), to

choose the form of the lesson, vary the number and sequence of tasks, and accelerate or slow down the rate of the assimilation of knowledge.

4 Conclusion

The technological approach will help to solve the problem of generalizing and systematizing the results of a large number of psychological and pedagogical studies, and pedagogical experience. Theoretical developments that remain unclaimed by teachers can be introduced into mass pedagogical practice and ensure the quality of preschool education. Procedural materials provide an opportunity for adults to qualitatively acquaint preschool children with mathematical concepts. By precisely executing the procedure algorithm, the children master the generalized mathematical ideas, forming the ability to rationally solve practical problems.

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Tehnološki pristop k oblikovanju matematične kompetence pri predšolskih otrocih

Članek obravnava težave z oblikovanjem matematičnih idej pri predšolskih otrocih. Dosežki vizualnega in simbolnega mišljenja omogočajo učencem, da napredujejo od abstraktnega h konkretnemu znotraj prehodne enote procesa mišljenja, tj. posplošenega postopka. "Bistvo tega pristopa je ohranjanje otrokovega značilnega vizualnega in simbolnega mišljenja med poučno dejavnostjo ter dosledno organiziranje in usmerjanje kognitivnega procesa, da bi otroci lahko dojeli vsebino izvedenih dejanj, kar je skladno s splošnim konceptom."

Znanstveniki ločijo med naslednjimi dosežki vizualnega in simbolnega mišljenja predšolskih otrok, ki so pomembni za oblikovanje posplošenih predstav:

- *Predstava znotraj operativne strukture dinamične podobe predmeta in osnovna načela njegovega spreminjanja in razvoja, ki razkrivajo pomen posplošenih konceptov.*
- *Otrokova osredotočenost na ta načela med izvajanjem objektivne ali miselne dejavnosti.*
- *Posplošenje operativne strukture dinamične podobe med spreminjanjem predmeta ali pogojev.*

Le dinamična podoba vsebuje lastnosti, ki jih statična podoba ne razkriva.

Med usvajanjem matematičnih konceptov so otrokova dejanja, ki služijo temu namenu, opredeljena kot nujno potrebno sredstvo. Ta dejanja so zasnovana v zunanji, materialni (ali materializirani) obliki, kar nam omogoča, da otroku razkrijemo njihovo vsebino ter zagotovimo njihovo usvojitev.

Otroci, osredotočeni na specifične predmete, ki zahtevajo uporabo konceptov, se ne zanašajo vedno na bistvene elemente. Pogosto prihaja do reprodukcije učenega

besedila ali učiteljevih besed. To pomeni, da ima v takšnih primerih znanje verbalni, formalni značaj. Verbalno znanje ne spremeni bistva procesa njegovega usvajanja, kar prepričljivo dokazuje, da je znanje nemogoče prenesti v njegovi končni obliki. Otrok lahko sprejema znanje le kot rezultat lastne dejavnosti, ki ni usmerjena proti besedam, temveč proti tistim predmetom, o katerih hoče pridobiti znanje. Za usvajanje konceptov je potrebna objektivna aktivnost otroka s predmetom, ki ga preučuje. Med učnimi dejavnostmi otroci modelirajo proces ustvarjanja konceptov. Izobraževalni proces mora v sklenjeni obliki reproducirati dejanski zgodovinski proces nastanka in razvoja znanja.

Večine znanstvenih dokazov, ki so jih pridobili znanstveniki, se praktiki ne poslužujejo. Vzgojitelji predšolskih otrok nimajo dovolj časa na razpolago, da bi obdelali veliko količino teoretičnega gradiva in ne sposobnosti, da bi ga preoblikovali v kompendij učnih ur za poučevanje otrok.

Tehnološki pristop je morda alternativa takšni učni poti. Pomagal bi prenesti znanstvene dokaze iz teorije v prakso. Glavna prednost tehnološkega pristopa je ta, da bi prispeval k razvoju izobraževalnih postopkov, ki bi jih nato lahko izvajali vzgojitelji na različnih stopnjah strokovnega usposabljanja.

Za zagotovitev kakovostnega izobraževanja predšolskih otrok moramo vzgojiteljem priskrbeti mehanizem za izvajanje izobraževalne vsebine, ki so jo določili znanstveniki, pri čemer upoštevamo individualnost otrok. Iz tega razloga moramo posamezne komponente izobraževalnega procesa (vsebine, metode, načine in oblike) združiti v celosten izobraževalni postopek. Slednji naj bo zasnovan kot sistem medsebojno povezanih komponent izobraževalnega procesa, ki so osnovane na znanstveni podlagi, časovno in prostorsko programirane ter vodijo k načrtovanim rezultatom. Izobraževalni postopek nakazuje pot k obvladovanju specifične učne snovi znotraj specifičnega predmeta, teme in vprašanja.

Avtorja sva razvila izobraževalni postopek "Oblikovanje matematične kompetence", ki je sestavljen iz sistema izobraževalnih in praktičnih situacij. Tehnološki pristop bo zagotovil kakovost matematičnega izobraževanja predšolskih otrok. Predlaga združevanje posameznih komponent izobraževalnega procesa (vsebine, metod, načinov in oblik) v dosledni pedagoški postopek.

Namen tega postopka je oblikovanje strukture simbolnega in logičnega mišljenja, ki omogoča lahek prehod od vizualnega in simbolnega k verbalnemu in logičnemu mišljenju. Idejna zasnova tega postopka je obvladovanje posplošenih matematičnih postopkov, katerih vsebina se ujema z znanstvenim konceptom. Nadalje racionalno reševanje praktičnih problemov na podlagi uporabe matematičnega znanja, upoštevanje individualnih značilnosti otrok in razvoj mišljenja.

Za učinkovito matematično poučevanje predšolskih otrok sva razvila sistem izobraževalnih (pristop, osnovan na dejavnosti) in praktičnih situacij (pristop, osnovan na kompetenci). V izobraževalnih situacijah so otroci usvojili matematične koncepte, v praktičnih pa so pridobili kompetence. Vsa učna snov je predstavljena v učbenikih za pedagoge in delovnih zvezkih za samoizobraževanje.

Prvi korak k ustvarjanju izobraževalnega postopka "Oblikovanje matematične kompetence pri predšolskih otrocih" je bil razvoj dvostopenjskega delnega programa (osnovna in višja raven). V programu za posamezno starostno obdobje je predstavljen določen matematični pomen.

Naslednja faza je bila preoblikovanje znanstvenih matematičnih konceptov (bistvenega elementa) v posplošene matematične postopke. Oblikovno se posplošen postopek sklada z dinamično podobo predmeta dejanja, vsebinsko pa s konceptom, ki ga oblikujemo. Koncepti morajo biti predstavljeni v obliki dinamične podobe. Slednja je sestavljena iz operacij, katerih vsebina je sorodna znanstvenemu konceptu.

Vsak matematični koncept je razkrit preko objektivnih, kognitivno usmerjenih transformacijskih dejanj. Posledično se otrok nauči število operacij, ki jih je treba izvesti v določenem zaporedju in ki predstavljajo posplošen način dela.

Pristop, osnovan na kompetenci, se realizira s pomočjo praktičnih nalog, ki jih rešujejo na podlagi spoznanih osnovnih lastnosti. S praktično dejavnostjo otrok pridobiva izkušnje. Zmožen je reševati različne vrste problemov, ki so povezani s širšo družbeno ali domačo prakso. Kompetenca kot znanstveno relevantna izkušnja se pojavi, kadar predšolski otrok uporabi znanstveno znanje kot posplošen način dela, da bi rešil določeno vrsto problema. Če otrok uporabi to znanje kot način dela pri reševanju le enega praktičnega problema in te metode ni zmožen prenesti na reševanje drugih, sorodnih problemov, to pomeni, da te izkušnje ni pridobil.

Delovni zvezek prispeva k utrjevanju postopka "Oblikovanje matematične kompetence pri predšolskih otrocih". Vsebuje komplet kartic za organiziranje samostojnega dela otrok. Za vsako starostno skupino je na voljo delovni zvezek z nalogami različne težavnostne stopnje.

Delovni zvezki in učbeniki se dopolnjujejo, s čimer ohranjamo kontinuiteto. Postavljanje kartic omogoča vzgojitelju, da samostojno izbere obliko izobraževanja (individualno, skupinsko, frontalno) v skladu z učnimi pogoji (količina znanja, število otrok v skupini, uporaba izročkov).

Matematika označuje kvantitativni vidik okolja. Naloge z matematično vsebino so zato zasnovane na takšen način, da omogočajo razvoj govora, ustvarjalnost in bogatijo otrokovo razumevanje različnih vidikov okolja.

Izobraževalni postopek "Oblikovanje matematičnih kompetenc pri predšolskih otrocih" namesto številnih ločenih nalog – prenos znanja, oblikovanje spretnosti in njihova uporaba – zastavlja en sam cilj: oblikovanje dejavnosti, ki bo od samega začetka vsebovala sistem znanja in zagotovila pridobivanje praktičnih izkušenj.

Učinkovitost izobraževalnega postopka "Oblikovanje matematične kompetence pri predšolskih otrocih" potemtakem zagotavlja upoštevanje psiholoških mehanizmov razvoja predšolskih otrok. Predlagano izobraževalno gradivo ponuja dojemanje sveta kot celote in razumevanje dejstva, da matematika označuje kvantitativni vidik predmetov in pojavov. Matematika, ki je jasna, logično naravnana in osredotočena na sposobnosti otrok, vzgojiteljem omogoča določeno mero ustvarjalnosti in pedagoškega raziskovanja. Pripravljeno gradivo je zasnovano na način, ki vzgojitelju nudi možnost – odvisno od specifičnih pogojev za organiziranje matematične dejavnosti otrok (namen in vsebina učne ure, kako dobro otroci obvladajo snov, število otrok v skupini) – da izbere obliko učne ure, spreminja število in zaporedje nalog ter pospeši ali upočasni hitrost usvajanja snovi.

Tehnološki pristop bo pomagal rešiti problem posploševanja in sistematiziranja rezultatov velikega števila psiholoških in pedagoških raziskav ter pedagoških izkušenj. Teoretične dosežke, ki se jih vzgojitelji ne poslužujejo, lahko vpeljemo v množično pe-

dagoško prakso in s tem zagotovimo kakovost predšolskega izobraževanja. Gradivo, ki prikazuje postopke, odraslim omogoča, da predšolske otroke kvalitativno seznanijo z matematičnimi koncepti. Če je algoritem postopka natančno izveden, otroci usvojijo posplošene matematične ideje in oblikujejo sposobnost racionalnega reševanja praktičnih problemov.

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