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Psychological Factors in the Formation of Basic Mathematical Concepts at Preschool Age

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Abstract

The paper deals with the analysis of the important psychological factors in the formation of the mathematical concepts in the education of the preschool children. The author's basic idea is to show the importance and necessity of increasing the share of planned and organized educational activities at certain periods of educational process. It is well-known that there is a continual struggle for dominance between neurons in the human's brain, which are the product of new connections between active neurons and new ways of control. The aim of the paper is to emphasize the importance of developing mathematical concepts at an early age in the creation of neural connections that contribute to the development of logical structures and abstract thinking as well as to initiate further research in this area. This is a theoretical work, in which the descriptive method of identifying pre-school age period as vital to the future development of an individual.

Mathematical contents have a major influence on the development of intellectual processes, in particular on the logical thinking and deduction. Therefore, a well-planned and systematic acquisition of basic mathematical concepts in early childhood, i.e. at preschool level, is highly recommended. This has been confirmed by numerous researches published in the relevant fields dealing with structure, capacity and developmental tendencies of human brain, all pointing to the fact that human brain is dominantly formed by the age of seven.

First mathematical concepts are developed in the immediate environment surrounding every individual. That environment is the objective reality that exerts influence on perception, stimulating a cooperative activity of many senses (hearing, sight, touch) and resulting in a multitude of impressions. The higher the number of impressions that have worked on the senses, the higher the number of synapses immediately influencing the development of more complex neural activities.

Keywords: Psychological factors, mathematical concept, logical structures, preschool period, educator, child, enviroment.

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INTRODUCTION

Acquisition of basic mathematical concepts at early age is a complex process that demands a coordinated involvement of perceptual, practical and cognitive activities. The younger the child, the more complex the process, and vice versa: as they get older, children become increasingly readier to discover and acquire certain rules that exist objectively in mathematics.

Mathematics and mathematical contents at preschool level have a strong emotional impact, and, since the stimulation of emotions enforces the interest in the offered activities, consequently, thinking and logical reasoning is also motivated and improved. On the other hand, if there is no interest in certain activities, the process of thinking about the related contents will also be wanting.

A claim that mathematical mode of thinking is rather intricate and difficult, and thus abstract and inadequate for young children, has often been insisted on in everyday practice. However, if we take the developmental process into consideration, we cannot accept this, because, as anything else in human life, thinking must also undergo developmental changes. These changes, or segments in development are followed by cognitive activities framing the formation of certain order and regulations within the sphere of personal experience. The process of thinking is a pleasure in itself which, as such, does not exclude emotions at any stage.

In order to take the right approach to a child and make him/her familiar with the logical mathematical concepts, i.e. in order to help the child understand and acquire these concepts, it is necessary to have a good knowledge of psychological features of the child at that (early) age.

Psychological Aspects in the Formation of Basic Mathematical Concepts at Preschool Age

The period from birth to starting to go to school is the most crucial for the development of personality, predominantly when it comes to psycho-physical development. Emotional development is particularly noticeable, as well as the development of motor and perceptual faculties, whereas recent research emphasizes also the development of mental operations and structures. The fastest progress in this period concerns the growth and expansion of neural structures. Almost 90% of neural structures are developed until the child reaches the age of seven.

Intellectual abilities development is also very extensive in this in this period. Almost 50% of the intellect development is completed by the age of four, 30% by the age of eight, and the rest of 20% until the person reaches full maturity. Still, it is necessary to take the following fact into consideration: the process of developing all the mentioned faculties and structures is not carried out in isolation, but relies on environmental influences, which implies that practice is inevitable. Mental structures development and logical-mathematical structures development are interconnected and mutually conditioned processes, the former structures entail the latter and vice versa: the latter structures inertly cause the development of the former. If we examine the development of the logical thinking as a representative example, then we can conclude that without adequate stimuli and practice this process, especially at this age, would be significantly delayed and impeded.

It is mathematical contents that provide an extraordinary contribution to the development of mental capacities. Logical-mathematical content intensifies mental abilities development, which results in a further improvement and growth of all mathematical abilities, particularly logical thinking and deduction. This regards elementary mathematical concepts from the child's environment which introduce the child into the world of mathematics and logical reasoning, without diverting from the essential guidelines of the mathematical path of discovering the rules of objective reality. From the psychological perspective, acquisition of the basic mathematical concepts at preschool level is mostly connected with the development of cognitive structures, which expand and change rapidly. If we consider chronologically all the possible stages in a person's cognitive development, then out of the four well-known Piaget's phases of cognitive development we would chose the second, preoperational phase to approximately coincide with the period from the age of two to the age of six. Needless to say, the first and sensorimotor phase should by no means be neglected, as it plays a highly significant role in the total development of a person.

Hence, from the standpoint of psychology, a well-planned and organised work on the acquisition of mathematical concepts by the preschoolers is based on the development of mental structures and cognitive operations. Mental structures and cognitive operations are continually modified and changed throughout person's development. "What we see and hear is not just a matter of senses, but of centers in the brain which process and interpret the received information." [3] Dynamics of those processes depends mainly on the person's dispositions and his/her personal activities in the interaction with some image or notion. For this reason, the same person can react differently to different ideas or notions, responding sometimes with the higher and sometimes with the lower cognitive level.

Preschool period is also dynamic when it comes to the development of thinking. In the beginning, it is characterized by senso-motor activities that make part of practical thinking, which is subsequently transformed into verbal thinking. Verbal thinking stage is characterized by a completely egocentric intelligence. Of course, this does not mean that the child in this phase is selfish, but that the perceived images and notions are interpreted from the child's own perspective, that is, the child is for the most part focused on himself/herself. The egocentrism in activities and in thinking is evident in children's symbolic games, which are foundations for the speech development. Nevertheless, Piaget has concluded that egocentrism does not entirely prevail at this age, and that another form of thinking occurs based on perception: intuitive thinking. [8]. Indeed, a child's intuition is rather limited and it does not allow the child to make a distance from the personal experience and perception of images and notions that surround them.

When working with the preschoolers, it is essential for the educators to be well acquainted with all important features of the preoperational stage, since all their work is related to this period of personal development. Certainly, the previous, sensorimotor phase should also be well-known, as well the subsequent phase of concrete operations. Knowing of these phases is, on the one hand, important for the monitoring of transition from one developmental stage into another and, on the other hand, it is also required in order to organise appropriately the work with the children at the second stage so as to improve their future development. Individual approach

and individualized work with different children, provided it is well-organized, contributes greatly to the development of affinities towards the learning of mathematical concepts [7].

Thus, the preoperational phase is what distinguishes the cognitive development of a preschool child. Educators' task, however, is to focus all their activities on the aim of helping the children of this stage mature and move into the next, higher stage of cognitive development. Mathematical contents intended for the preschoolers encourage intellectual development and development of memory and thinking. There are numerous experiments that can be performed with the aim of a more comprehensive acquisition of basic mathematical concepts. We will list just a few, such as conservation experiment, series of objects experiments, etc.

Development of conservation is of high importance as it is a crucial prerequisite for basic mathematical concepts adoption and cognitive activities. Unless the conservation ability is developed enough, the children could not adequately understand and acquire the notion of mathematical set, length, size and quantity of matter. Due to the intelligence which is perceptual in the preoperational phase, that is to say it is confined to what is perceived at the given moment, the child is incapable of understanding that the change of order and position of objects in a set does not imply a change of number or length of the objects in the set. Furthermore, the child is not capable of understanding the quantity of matter, that is, the child cannot comprehend for a while that the change of shape of a matter does not mean that its quantity has also changed. Many tests and repetitions of the tests are required before the child adequately acquires some of the mathematical concepts. Undeveloped reversible operations impede the child in the process of objective reasoning and correct acquisition of the planned concepts. Children have a way of a global observing of phenomena, without paying attention to details. The syncretism inherent in their manner of thinking prevents them from separating the important from the less important, which is to say that the children emphasize only the things on which they are focused without cognitive decentering, failing to view the surrounding phenomena more objectively.

Intelligence of preschool children, especially of the younger ones, depends largely on perception. As long as the objects are within the child's sight, he/she succeeds in establishing a connection or relation between them. However, if the object is removed from the range of the child's perception, he/she will most likely be incapable of establishing visually destabilized connection between those objects. Still, the child will try to solve the problem by means of a simple intuition which is in turn related to perception itself.

Since mathematical concepts do not possess material characteristics and are distinguished by internal relations (quantitative, special, structural …), the success rate in their acquisition depends on comprehension and acknowledgment of the stages in children's intellectual development. [4]. It is therefore intuition that characterizes children's thinking at this age. Their intuition is subjected to perception to a great extent. This has been attested by Piaget's numerous researches that relate children's intuition at the age of six to specific schemes of action, i.e. sensorimotor schemes, which differ from the operational thinking due to the lack of two-direction activities. In order to be able to form a relationship between objects and phenomena,

a child must develop certain operations that would help him/her perform cognitive activities in two directions.

Many researches both in our country and abroad have proved that children up to the age of six in most cases do not understand the conservation of set, size, length and matter. Thus, a child's thinking is egocentric and irreversible, which means that all things and events are observed from one single viewpoint. Yet, if the children of this age are in the preoperational phase and still do not have logical thinking sufficiently developed, which is one of the prerequisites for acquisition of mathematical concepts, it does not mean that we should not plan and carry out mathematical contents with them – on the contrary, we should work on the formation of basic mathematical concepts. This developmental phase and period should be used for a more rapid improvement of those cognitive operations which are important for formation of the basic mathematical concepts. This is the reason why characteristics of child's age and his/her individual capacities should always be taken into account during the activities [1].

Psychological Features of the Process of Basic Mathematical Concepts Acquisition at Preschool Age

Learning of mathematical contents is rather different from other educational areas. "Contemporary research indicates that preschoolers develop and possess certain metacognitive faculties that support cognitive control of the child during the learning process, as well as their understanding of their own mental processes, the consciousness of their own learning, planning of problem solving, monitoring of the learning progress, and experience of socio-cognitive conflict, thus affecting the child's learning." [2]. The greatest difference concerns the nature of contents, as it is well known that mathematical contents are characterized by a high level of abstraction. Necessary cognitive activity of children in the process of basic mathematical concepts acquisition is rather unconscious at the beginning, becoming increasingly conscious with the further development. A child's first contact with a new object or phenomenon is carried out on the visual basis, as well as through practical manipulation that provides acquaintance with its characteristics. Following this, the child perceives similarities and differences between the objects, eventually coming to a generalization of the most important characteristics. This also leads towards abstraction and capacity for overview, which come to the foreground at the very transition from the preoperational into concrete operational stage.

Manipulative activities are the basis for acquisition of basic mathematical concepts. Manipulating an object, the child gets to know it better. The child watches, compares and analyses objects, drawing certain conclusions. This is a manner of developing certain concepts. Therefore, the process of basic mathematical concepts acquisition is preceded by perception and image-creation, as well as abstraction and generalization. Throughout the whole process, speech plays a highly significant role, being the factor which accelerates the transition from perceptual to cognitive operations.

When it comes to mathematical contents, planning of a mathematical concept acquisition appears to be the most important at the preschool level. All the activities of children aiming at this should be grounded into each child's psychological and

physical potential. Younger preschoolers do not have a motive to learn something; they are focused on the practical rather than on mental activity. "Special attention should be paid to the issues of individualization, as it is well known that many negative effects, causing damage to the child's personality, can be brought by the experience of a failure, especially if the failures are frequent [5]. Thus, one of the most challenging tasks for the educators is a "recognition of individual particularities of every child in the educational process" [6].

It is only with the cognitive motives development that it becomes possible to create a more organized approach to the concrete activities involving mathematical content. Approximately, it coincides with the older preschool age, where a play or a game intensifies the problem-solving motives in a 5 or 6 years old child, which demands a harder intellectual effort.

Development of basic mathematical concepts and mental structures development entail processing of the acquired concepts at the higher level of abstraction. This extends the mathematical knowledge and stimulates a further development of intellectual processes.

CONCLUSION

Changes in preschool children's development are intense and evident in every field of their activities. In accordance with the general developmental changes, the process of learning also changes. Gradually, the spontaneous learning is substituted by a deliberate and sustained following of the educator's activities, i.e. the simple forms of learning are progressively developed. With the development of attention, thinking and memory, the scope of basic mathematical concepts acquired by the child also increases. The very process of acquisition of a concept contains more than a transmission; it involves cognitive processing of new information, as well as their storage in the existent system of structures. The higher the number of information and the more valid their processing, the more developed the cognitive structures. This is the only way of developing reversible operations system which is indispensable for a further development of mathematical knowledge and skills.

RECOMMENDATIONS

Since psychological factors are extremely important in the development of individual abilities of each individual at all age levels, their influence on the initial adoption of mathematical concepts at an early age is very intense. In order to achieve better initial adoption of mathematical concepts, we suggest the following measures:

- In each of the upbringing and educational group in the kindergarten, at the very beginning of the year, team work of psychologists, educators and teachers should assess individual capabilities of children.
- Based on estimated possibility of achievement of children the team should develop differentiated plan of the implementation of planned mathematical concepts in each age group.

- To create such a climate in the upbringing and educational group that promotes interest in mathematical terms and, at the same time, supports their understanding, requiring them to find the same in the immediate environment and apply them in practical situations.
- To integrate mathematical content from other content and create an integrated approach to their comprehension.
- In adopting the mathematical concepts to design activities whose perception involves multiple senses.
- To plan activities with a strong emotional impact.

REFERENCES

Budimir–Ninković, G. (2005). *Teacher and Contemporary Educational Technology*, Technology Informatics Education, No. 3, Belgrade: Institute for Pedagogical Research; Novi Sad: Centre for Development and Application of Science, Technology and Informatics, p. 103.

Ćebić, M. (2010). *Elementary Education in Mathematics for Preschoolers*, Belgrade: Faculty of Teacher Training in Belgrade, p. 29.

Danilović, M. (2005). *Psychological Foundations and the Essentials of Information Processing and Understanding*, Technology Informatics Education, No. 3, Belgrade: Institute for Pedagogical Research; Novi Sad: Centre for Development and Application of Science, Technology and Informatics, p. 21.

Dejić, M., Egerić, M. (2005). *Methodics of Teaching Mathematics*, Jagodina: Faculty of Teacher Training in Jagodina, p. 26.

Mićanović, V. (2009). *Psychological and Pedagogical Basis for Application of Contemporary Educational Technology in the Elementary Mathematics Teaching,* Technology Informatics Education for the Society of Learning and Knoeldge, No. 5, Part II, Novi Sad: Faculty of Technological Science: Centre for Development and Application of Science, Technology and Informatics: Natural Sciences and Mathematics Faculty; Belgrade: Institute for Pedagogical Research, p. 34.

Milić, S. (2002). *Individualised Approach in Educational Process,* Podgorica: Pedagogical Centre of Montenegro, p. 33.

Obradović, M. (1998). *General Methodics of Teaching Mathematics,* Zagreb: Prosvjeta, p. 69.

Piaget, J., Inhelder, B. (1982). *Child's Intellectual Development,* Belgrade: Institute for Textbooks and Teaching Tools.

Okul Öncesi Dönemde Temel Matematiksel Kavramların Oluşum Sürecini Etkileyen Psikolojik Faktörler

Özet

Bu araştırmada okul öncesi dönemdeki çocukların matematiksel kavramları oluşturma sürecini etkileyen önemli psikolojik faktörler analiz edilmiştir. Araştırmada benimsenen temel görüş, eğitim sürecinin belirli dönemlerindeki planlı ve sistemli eğitsel etkinliklerin önemi ve gerekliliğidir. Aktif nöronlar ile yeni control yolları arasında kurulan yeni bağlantıların bir ürünü olarak insan beyni ile nöronlar arasında sürekli bir mücadele olduğu bilinmektedir. Bu araştırmada mantıksal yapı ve soyut düşünmeye katkı sağlayan düşünce bağlantılarının oluşturulması için matematiksel kavramları erken yaşta geliştirmenin önemi vurgulanmıştır. Bu araştırma, bireyin gelecekteki hayatı için yaşamsal önemi olan okul öncesi dönemi betimsel yöntemle belirlemeye yönelik teorik bir çalışmadır.

Matematiksel içeriğin, entelektüel süreçlerin gelişiminde, özellikle de mantıksal düşünme ve kestirmede önemli bir etkisi vardır. Bu nedenle erken çocukluk döneminde, yani okul öncesi düzeyde iyi planlanan ve sistematik olarak ilerleyerek temel matematiksel kavramların öğretilmesi tavsiye edilir. İnsan beyninin kapasitesi ve gelişimsel eğilimlerinin büyük oranda yedi yaşında oluştuğu gerçeğine işaret eden yayınlanmış çok sayıda araştırma tarafından teyit edilmiştir. Bu ortamda pek çok anlamda (işitme, görme, dokunma) uyarıcı ve işbirliğine dayalı bu etkinlikler algı üzerinde pek çok etkiye sahiptir. İlk matematiksel kavramlar bireylerin yakın çevrelerinde gelişmiştir. Ne kadar fazla sayıda duyu çalışırsa karmaşık sinir faaliyetlerinin gelişimini etkileyen sinapsların sayısı da o kadar artar.

Anahtar Sözcükler: Psikolojik faktörler, matematiksel kavramlar, mantıksal yapılar, okul öncesi dönem, eğitimci, çocuk, çevre.