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Original scientific paper
UDK: 37.025
DOI: 10.17810/2015.09

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NTC LEARNING SYSTEM AND DIVERGENT PRODUCTION

Resume: A short presentation of the basic findings of an explorative research, in which the possibility of encouraging the development of critical thinking with the NTC learning system was explored, i.e. only the results of its influence on the development of one aspect – divergent productionare presented. This paper is a modest addition to the research of an important question – the psychology of thinking in the teaching process, while the findings indicate the didactic reach of the NTC system. The research was conducted on a purposive sample (N= 23). The theoretical basis is Osborn's system of creative development, which is founded on the following psychological mechanisms: *research and test other possibilities of applying the idea; adapt, modify, increase, decrease, condense, substitute, change the element order, reorder everything, combine two or more ideas* (Kvascev, 1981), and Torance's (Torancce, according to Kvascev, R, op.cit.)system of creative development which is theoretically based on: revealing the multiple meanings of the given facts and increase of the given information value; developing the strategies of creative learning through discovery; developing the motivational components of creativity; the synthesis of empirical research and theoretical generalization; the associative basis for discovery; finding the new on the basis of incomplete facts and insufficiently structured material; the individualization of creative learning according to the cognitive development of the examinee (Kvascev, op.cit).

Research method is experiment with one group, while the initial and final questioning was conducted with divergent production tasks (Stojakovic, 2009).

The basic findings refer to the following: the statistical relevancy of the development after the application of the NTC system which indicates the relevant positive influence of the NTC learning system on the development of thinking. This therefore confirms the starting belief – *assumption* about the possibility of transfer, in other words the possibility that tasks saturated with creative thinking, creative imagination, inventiveness and divergent production used in the NTC learning system influence the release from conformist thinking and give more successful effects in divergent production.

The didactic implications of this refer to: the effects of the NTC program, the participants in this explorative research confirm the practical aspect of theoretical ideas which reached us as a consequence of the cognitive revolution and creativity research (Ozborn, Torans, Kvascev...).These ideas were expressed practically in the content of programs, with which we can successfully develop the influence of early presentation on the development of divergent thinking, universal material representations…

***Key words*:** NTC Learning System, divergent production.

Introduction

Many neuropsychologists searched for the answer to the question of how important brain size is to intelligence, latter the importance of certain parts of the brain etc. Today we question the brain localization relevancy in the study of intelligence. Namely, it is considered that intelligence is not a function of the parietal lobes, or other parts of the brain. But rather intellectual ability is increased if a person possesses, as a whole, a neurological system which functions well.

Among a number of accepted views on intelligence (psychometrical, developmental, biological, cognitive) today those which can be categorized as biological are on the increase. In this group also there are different approaches. One of them is devoted to the research of the human brain structure; another is devoted to the research of indexes for the measurement of brain functioning (intelligence is not a static quality; it is projected in problem situations). In the same group but with a different approach are the ones who research human genetics, and search for the answer to the question to what extent is intelligence an inherited characteristic. In the fourth group of the biological approach to intelligence the topic of research are the ways in which the nervous system develops or does not develop, hence the ways in which genes express themselves or fail to express themselves in different phases of development.

For now none of the mentioned approaches have been able to solve the question – what is intelligence? It is considered that researchers who are biologically oriented do not accept the definition of intelligence put forth by other orientations – intelligence tests, thoughts on intelligence etc. and therefore search for correlations between intelligence tests and brain size, electrophysiological functioning of the nervous system, genetic inheritance and other factors. Hopes of biologically oriented researchers lie in the possibility to directly read intelligence by observing brain waves or genetic equipment in the future.

In the last few decades a large body of knowledge has been accumulated on the topic of brain organization. Technology has been developed which is for a more precise at determining brain functions. However, determining this specificity, as many view it, carries with it a paradox. It is considered that the nervous system acts as a collection of thousands of isolated centers which "turn on" at will. It is spectacularly harmonized and therefore the reactions rarely interfere with each other. A billion nervous cells function so that we can have a single experience. Explorative research, the results of which we are presenting in this paper, refer to the possibilities of the NTC program and the practical aspects of the theoretical ideas which reached us as a consequence of the cognitive revolution. Some of these ideas primarily refer to the following: the developmental view, universal mental representations, different forms of intelligence, advantages and disadvantages of early presentation, the role of individuality, motivation and emotion…

The theoretical background and terminology explanation

The theoretical basis of this research is the Osborn's system for developing creativity, which is founded on the following psychological mechanisms: *research and implement other primary idea possibilities; adapt, modify, increase, decrease, reduce, condense; substitute; change the element order; reorder everything; combine two or more ideas* (Kvascev, 1981) and Torancce's (Torancce, prema Kvascev, op.cit.) system of developing creativity whose theoretical basis lies

in: realizing the multiple meanings of the given facts and the amplification of the given data; developing strategies for creative learning through discovery; the development of motivational components of creativity; synthesis of empirical research and theoretical generalizations; the associative basis of discovery; the discovery of something new based on incomplete facts and insufficiently structured material; the individualization of creative learning according to the cognitive development if the examinee (Kvascev, R., op.cit).
In the theoretical background also included were the findings of R. Kvascev who, while researching the abilities for learning and personality, found that among intellectual operations on which creative forms of learning are based, selected the following as significant results: the transformation of the given information and ideas in the sense of discovering new meanings of concepts and the development of new inventions. Speaking of this he found that the psychological processes of idea transformation are based on the fact that the functional meaning of a subject can be noticed in many ways regardless of the constancy of the object (R. Kvascev, 1980). From the psychological principles on which forms of creative thinking are based important for this paper are the following: old experience is used in a new situation; the given objects in a situation or state are transformed, changed, viewed in a new meaning, a new role before they can be used in a new way... It can therefore be concluded that intellectual operations and psychological principles form a general schema of creative processes (ibidem), which, among other things, is comprised of divergent thinking. The core importance of this complex concept could be narrowed down to the intellectual operations of researching many possible solutions to a problem, producing a large number of new ideas, associative fluency (production of analogies, similar problems, the discovery of new relations), expressive fluency (organizing ideas within a theory or system), flexibility (different approaches to solving a problem situation and the ability to solve a task in different ways); originality; elaboration (development of work, theory and systems (ibidem).

In addition to the aforementioned, in the theoretical framework, and as help in the resolution of the divergent thinking term framework, sections of Gilford's ability theory (Gilford, 1967, prema: Kvascev, op. cit.)can be taken. According to Gilford, factors of divergent thinking significant for this paper are: the discovery of the new, unusual; methodological originality, the anticipation of new ideas, solutions, answers, discovery of new meaning, flexibility, fluency… Among theories of creative work we will single out Mednick's (Mednick, 1964, prema: Kvascev, 1980) understanding of creative thinking, which, as he sees it, is formed form associative elements of new combinations which fulfill certain demands, or can in some way be used. The basic task in creative thinking, according to him, is connecting ideas which are at a distance from each other. One of the associative mechanisms of the creative process is "mediation". Mednik considers that wider flexibility of cognitive structures as a mediator between the stimuli and the answer, based on relations, and not just on associations, can contribute to the success of the creative process (Mednik, op. cit.). Research of distant associative elements and their grouping into new usable combinations can also contribute.

The purpose of the above description of theories, principles, factors etc. is to touch on the question of creative production from different views. Therefore, to indicate the importance of ability theory, their connection to creativity theory, to highlight that they are the source of many principles that form the basis of creativity fostering theories, with which factors and psychological elements are determined which explain these complicated psychological mechanisms. In this way a framework is created for the understanding of the theoretical basis of the research, the results of which are shown here and which were the basis of the choice for the research approach, i.e. its elements (ibidem).

NTC learning system

NTC is an abbreviation of "Nikola Tesla Center" - department for the gifted in the Teachers Association of Serbia, which functions in Mensa Serbia, MaticaSrpska and the Teachers Society in Novi Sad. The aim of the program is the fostering of intellectual development of gifted school children and the discovery of gifted children. The NTC program was created by RankoRajovic (founder of Mensa in a few countries and a long standing member of the Mensa international committee for gifted children, UNICEF collaborator for education) and Uros Petrovic (long standing president of MENSA Serbia and a writer for children). The program was implemented in Slovakia, Italy, The Czech Republic, Romania, Montenegro, Croatia, Bosnia and Herzegovina, Slovenia, and Serbia. The implementation is in a summer camp, which lasts for 10 days, usually in the form of workshops.

The essence of the problem finds its basis in cognitive psychology, which has been interested in the connection between cognition and neurology for a longer time, and many authors have tried to find an answer to this question from the biological basis of cognition. Interest for the way in which anatomy and physiology of the nervous system influence cognition is great. Cognitive psychology studies the connections between the brain and other aspects of the nervous system's cognitive processing and human behavior (Rajovic, 2012).

In order to understand the results and their clear interpretation we give a short overview of the development of understanding and research on the influence of the brain on cognition. In XIX century we come across research on the localized functions in the brain (physiologist Johannes Miller, according to: Lurija, 1983).The conceptions of many authors are widely known on the inability to dissolve thinking into elementary mechanisms (associations or structural processes - Gestalt psychology XX century). The reasons for a late research of the brain organization some authors see in the phenomenological approach to thinking, which considers thinking a spiritual act, and in that way holds back neurological and brain organization research. Contemporary neuropsychology tackles the problem of the brain basis of intellectual activity by examining the relation between thinking and the brain (ibidem).

Critics of neuropsychology note that a guided selective process of thinking could not have been understood as a result of the mechanic actions of separate associations. Hence Herbart's attempt to, based on the mathematical model of thinking, determine the direction of thought by imposing the stronger and suppressing the weaker representations was assets as a formal grid. It is mostly criticized for not being able to explain how to determine the strength of a representation and for not explaining the nature of thinking, as a selective plastic process directed towards a certain goal, subordinate to the situation. Furthermore the doubt of the Würzburg School (Meser, Biler, Ah, Klipe..., according to: Lurija, op.cit.) that thinking can be comprsed of representation associations, as well as the statement that thinking consists of direct " observation of relations", and can therefore exclude representations and speech associations, also that the thinking act is a self-sufficient and independent function, as is the act of noticing and remembering, lead to the rejection associative representation of thinking. According to Lurija, the values which the Würzburg Schoolcreated in the psychology of thinking, separating thinking as anindependent unit of psychological research, presenting thinking as a primal and indivisible act, which can be described only with the subjective method, closed the road to its naturalistic research (Lurija, op.cit). The gestalt psychologists (Keler, Verhajmer, Kofka, Dunker, ibidem) got the same complaints regarding the understanding of thinking as a whole act, of a unique structure, their refusal to see anything

other than the structural laws "wholeness" and "impregnation" made it impossible to further research thinking. Further detailed analysis of thinking as a whole act was enabled with the concrete analysis of the basic representations of thinking in the basic stages of the term development in the works of Vygotsky and Piaget's results of the analysis of the term development as well as Bruner's and research of others.

For the understanding of this research in is important to note that the meaning of a word, which represents the basic tool of thinking, has a crucial role in the description of the psychological structure of thinking as a whole. In the past many psychologists from the Soviet Union worked on a detailed description of the real thinking structure model by using computers. The followers of Vygotsky's thinking (Leontijev, Galjperin et al. according to: Rajovic, 2012) researched the structure of thinking based on a general conception of active psychological activity structure. In other countries a slightly different orientation existed, the psychological analysis of concrete thinking forms was connected to a heuristic theory of thinking, and they compared human thinking to the work of a computer. The findings of these studies helped neuropsychology to systematically search for brain mechanism systems which ensure its basic connections and stages. From the perspective of this research, significant is Lurija's view of the neuropsychological aspect of thinking in which the conclusion that the starting point of thinking is the fact that for thinking there needs to exist a problem, task or goal. The first phase after understanding a task is not just understanding certain reactions, but the opposite, refraining from impulsive reactions, orientation towards the conditions of the task, component analysis of the situation, task, selecting important elements and their comparison. The second stage according to Lurija consists of a choice between alternatives and forming a scheme for solving the task, in which some ways seem more acceptable than others. This phase some consider statistical, because in it a choice is made, by taking into consideration the connections that stand behind a meaning of a word. Completed codes are in the basis of the analysis process. Some represent this with the term "tactic", in order to distinguish the stages of finding a strategy and solving the problem. It is important to note that using the suitable operations is more the executive phase, than the creative phase of thinking, therefore it involves great complexity. Acquired internal codes, which form the operative basis of thinking activity, represent basic thinking operations and the basis of the executive phase of thinking. The last phase consists of comparing the acquired results with the starting conditions of the task. The thinking process understood in this way is used by neurologists to research brain systems which are involved in the creation of thinking processes through the study of thinking disorders. Neuropsychological description of constructive (concrete-real) and discursive (verbal-logical) disorders in thinking after a brain injury to different areas of the brain can give us a better understanding of the brain organization of intellectual activity (ibidem).

Let us direct our attention to another detail important for the question of this research – myelination, a biochemical process, which helps follow the process of neuron maturation for its characteristic function. Myelination is the last condition for the defining of specific functions for each neuron in a neural bundle. Myelin enables the coted fibers to develop independent activities in the biochemically and function vise. This is important to note because, as Bunam says, the process of myelination starts with a certain genetic program, lasts until it finishes its job of coating certain groups of neurons with a white myelin layer and finishes, with the same program, leaving behind a lasting completed and stable construction (Bojanin, 1985). It is considered that myelin membrane enhances the functioning quality of the coated neurons. This is important because a connection was deduced between the process of

myelination and the simulative factors of the outside environment, which consist of adequate sense stimuli, especially kinesthetic. Significant is the fact that myelination ends at age 7 that is 12, while according to Lurija (op.cit), some structures finish their myelination at the age of three. For this text it is important that environmental factors can influence myelination, i.e. the structure of neurons, hence the influence on myelination means influence on psychological functions which correlate with certain nervous entities. This indicates the equal effect of environmental and genetic factors not only in the formation of functions but also the structures which are the base of those functions. This is the reason why the tasks in the R. Rajovic's manual are significant for the whole child development, because, as Bojanin states, biological, psychological and social factors are not the sum of vector forces which are strung. These factors intertwine and flow into a single event of human life (op.cit).

NTC program represents the application of knowledge which was acquired through neurophysiology; therefore we approach the question of learning from the standpoint of neurology, which has interesting implications for learning and didactics. For didactic work the following is of importance: the great significance of early gathering of experience, the imperative "use or loose", the flexibility of the child's nervous system and how we lose an ability or function if we do not practice it, the importance of action and activity, the specific characteristics of human ability and talent, the possibility to have the organizational role (in the cognitive sense) which music possesses in early childhood, the key role of emotional encoding… Exercises from the NTC program seem to be applicable as a good practical usage of Ceci's theory of intellectual ability. In other words as an example, as Ceci himself states, that people or populations can seem as if they are lacking in intellectual ability, such as deducing abstract rules, but if they are in an interesting and stimulating context they show high levels of ability. These exercises are a good affirmation of the aforementioned views (Ceci, according to: Gojkov and Stojanovic, 2012). We could therefore conclude that it is through context, tasks and exercises that Ceci analyses the results on positive plurality in intelligence tests, which, according to some, leans on the level of general intelligence. However Ceci like Gardner considers that there are many things beyond what intelligence tests measure, which is an indicator of precise thinking in tasks which demand knowledge and skills which school does not highlight. The tasks and exercises in the NTC program are directed in precisely this direction. To a certain extent this program could be viewed as an application of Brunerand Piaget's understanding of the possibility of overcoming temporary disharmony in the dynamism of development (from assimilation to accommodation) with representation techniques. Therefore in this program practically through exercises it is shown how basic operations of connecting to the immediately present can be incorporated in representations through performances and perceptive organization, ostensivity operation as it is referred to by logistics. Geographic and topographic maps, which are iconic in nature, are through pictures converted into linguistic expressions and visual form. Tasks are a good example of how, based on perceptive organization, iconic thinking can be developed with techniques of higher order information organization, based on consistent concluding which exceeds what can be indicated (Rajovic, op.cit).

The NTC system can be viewed as a good help for progressive release from the immediate, which further enables productive combinatorial operations in the absence of what is signified by speech. The program is, therefore, founded on understanding of the internal capacity importance (symbolization or representation), but also on Bruner's heightened importance of the possibility of the child's intellectual development through techniques which encourage the child's development.

As is mentioned in the manual for the application of this program, the present is marked with significant findings of scientists who study the mind, brain and genes. A lot of knowledge from these areas has already been accumulated, but only a fraction has gotten a practical pedagogic form. The road to pedagogical working practice has never been direct. "However, the program whose effects we are discussing could significantly shorten the time and wandering, misdirection, because it offers the possibility to test the techniques" (Rajovic, op.cit).

It is a fact that this program, whose effects we strive to examine in this paper, is already being applied in preschool institutions or summer schools in Novi Sad, Belgrade, Nis, Pancevo, Sabac, Backa Palanka, Kikinda, Uzice, but also outside of Serbia (Prague, Brno, Ljubljana, Koper, Bazel, Gorica, Vales, Zadar…), with the practitioners' conviction of its usefulness for the stimulation of children's mental development, coordination of movement and motoric, encouragement of attention, concentration, divergent thinking, deducing and functional knowledge.

Methodological context

The *subject and problem* of this explorative research refers to the exploration of the possibility that the NTC system of learning can encourage the development of critical thinking, i.e. in this paper we give results which assess the possible influence on one aspect- divergent production. The *intention* is to give a modest contribution to the research of an important question of psychological thinking process in the classroom. The results indicate the reach of the NTC system i.e. they serve as argumentation for the hypothesis which would be in the basis of a wider structural design of the questions at hand. Therefore the question in the basis of this paper refers to the contribution of the NTC learning system to the development of divergent thinking, and the *assumption* is belief in the possibility of transfer, i.e. that tasks saturated with creative thinking processes, creative imagination, inventiveness and divergent production would result in the release from conformist thinking and give better effects in divergent production.

Research subjects and organization: The research was conducted on a purposive sample (N=23). The Regional center for professional development in Uzice and Kikinda organized a summer school for the gifted from which the sample for this research was gathered. The gathering of the sample started when the Regional center for professional development sent a letter to schools in their city and each school made a selection of 2 students from the generation (IV grade of elementary school). The selection process was as follows first the teachers recommended a few students from their class which they consider gifted, secondly on the basis of those recommendations the school psychologist and pedagogue chose two students. Therefore in one school which had 100 students in the generation a double selection was conducted (teacher recommendation, and from a total of 8-10 recommendations which reached the professional team, the psychologist did the evaluation and sent to the regional center 2 students); work with students was conducted every day 5 x 45 minutes. Work was done by teachers who completed NTC exercises such as: hiding words in a sentence, making puzzle questions, converting text into associations…). The initial test had been done before the start of the NTC methods, and the final test was conducted on the last day, therefore, after 10 days. The method of research is an experiment with one group. The initial and final research was conducted with divergent production tasks (Stojakovic, 2009). The instrument

was modeled on the tasks which can be found in the literature which deals with this question, the instrument is presented in the appendix no.1.

The authors of the study are aware of the importance of the duration of the exercises on the program efficacy. They strived to make the content as saturated as possible with processes of creative thinking, creative imagination, inventiveness and divergent production, which consequently influences the release form conformist thinking and gives better effects in divergent production. As an example we give the content of two workshops:

Workshop: *Hiding words in sentences* (My pop eagerly ate - pea). Examples: Do good deeds. (dog); Andrew entered the room. (ewe); This is the best agency in town. (stag); Mr. and Ms. Smith are best friends. (hare); Many boats graze bravely on the mountain. (zebra); Jack always eats breakfast. (jackal); The plural of ox is oxen. (fox); The thief tried to rob earrings from the jewelry box. (bear); Here is a beautiful tulip I got for you. (pig); I want more doughnuts. (red); I started to yell owing to a sudden pain. (yellow); He is a big ray of hope. (gray); The ogre entered the forest. (green); The beautiful wings were specially made for angles. (orange);

Workshop: *The double association technique* (20 nouns). Instruction "In this memory system, first a certain association/picture must be assigned for each number from 1 to 20 (according to the shape, phonetic similarity, symbolisms; e.g. one is a rocket, two is a swan, three is a bird etc.). Afterwards the written nouns are connected to a certain number, if the first noun is a balloon, than it is connected with the number 1 (rocket) and a story is made with the two concepts (The rocket took off, but it broke down, than with the help of a balloon it flew to Mars.)".

The given examples illustrate the tasks which the participants did during the mentioned 10 days. From the tasks we can see that they practiced a more flexible understanding of the given elements in a sentence, texts... (hiding words in sentences, double association technique)... Therefore, in the research of this program's effects we started with the assumption that the mentioned and types of exercises (the analysis of important relations and connections, synthesis, generalization of important information and connection of important facts...) will influence divergent thinking. It is important to note that this program did not insist on exercises which directly refer to divergent production, hence, the fourth graders which found themselves in this program (Uzice and Kikinda, N=23) did not directly practice divergent thinking in the NTC system program, in other words production on tasks in which divergent thinking is examined. The exercises in the NTC system of learning could have only indirectly influenced the development of divergent production, therefore through transfer. In this way the hypothesis of the influence of this learning on different aspects of thinking ability, i.e. divergent thinking was examined.

Findings and interpretation

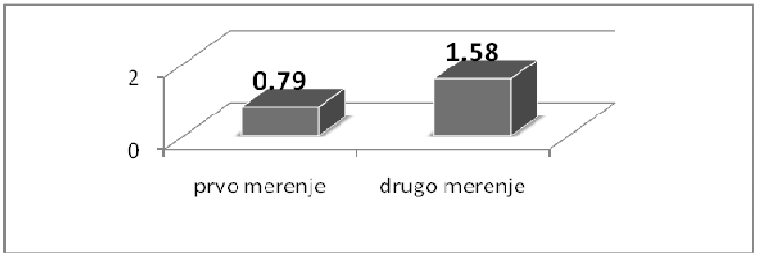
In the data analysis we start form the descriptive statistics in which the results of the initial and final measures are compared for each task individually, i.e. object for which we needed divergent answers (needle, cup, ball, grain). Therefore a review is given of the correct answers for the divergent production of listed items usage values. Secondly we give graphical representations of the average number of the correct answers on the initial and final measures for divergent ideas and usage values of the same items.

Descriptive statistics- Table 1. 1. ***Correct answer overview for ball on the initial and final measure***

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
ball_t_1	19	0	3	15	,79	,976
ball_t_2	19	0	5	30	1,58	1,575
Valid N (listwise)	19					

On the basis of the findings reached through a descriptive analysis we conclude that the total number of correct answers for the usage of a ball on the initial measure is 15, their span is form 0 to 3. The average number of correct answers per person for the usage of a ball is 0.79 while the standard deviation from the value is 0.976. The total number of correct answers for the usage of a ball on the final measurement is 30; their range is from 0 to 5 correct answers per person. The average number of correct answers is 1.58 while the standard deviation from that value is 1.575.

Chart1.1. ***The representation of the number of correct answers for the use of a ball in the initial and fundamental measurement***



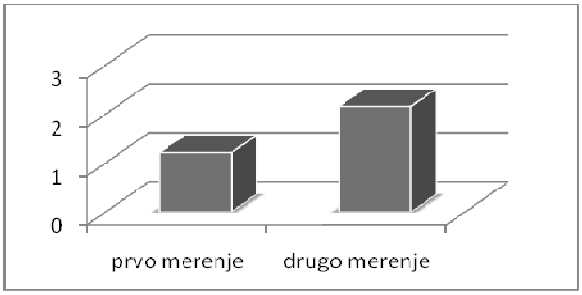
***** first measure second measure

Table 1.2. ***The rewiev of correct answers for cup in the initial and fundamental measurement***

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
cup_t_1	19	0	4	23	1,21	1,228
cup_t_2	19	0	4	41	2,16	1,214
Valid N (listwise)	19					

The number of correct answers for the usage of a cup on the initial measure is 23, and their span is from 0 to 4 correct answers per person. The average number of correct answers is 1.21 and the standard deviation from that value is 1.228. On the final measure the total number of correct answers is 41, the span is from 0 to 4 correct answers per person, the average number of correct answers is 2.16, and the standard deviation from that value is 1.214.

Chart 1.2.*The representation of the average number of correct answers for the usage of a cupon the initial and fundamental measure*



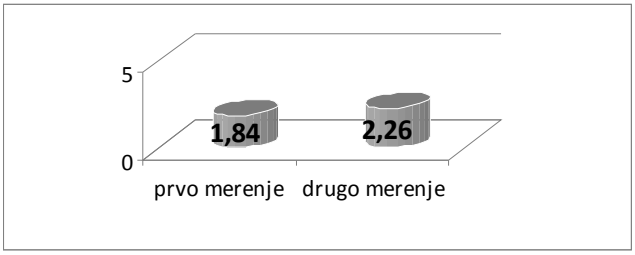
*first measure second measure

Table 1.3. ***Overview of the correct answers for needle on the initial and fundamental measure***

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
needle_t_1	19	0	5	35	1,84	1,302
needle_t_2	19	0	6	43	2,26	1,447
Valid N (listwise)	19					

The total number of correct answers for a needle on the initial measure is 35; the span is from 0 to 5 correct answers per person. The average number of correct answers is 1.84, and the standard deviation from that value is 1.302. On the final measure the total number of correct answers was 43, the span was from 0 to 6, the average number of correct answers was 2.26 per person, and the standard deviation value was 1.447.

Chart 1.3. The representation of the average number of correct answers for the usage of a needle on the initial and final measure



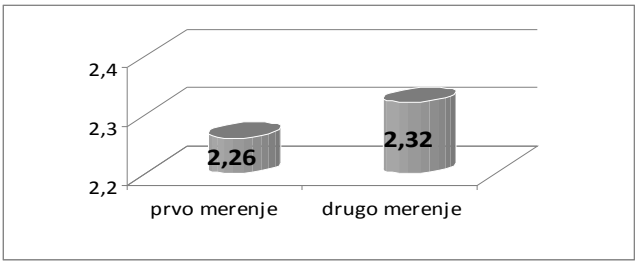
* first measure second measure

Table 1.4.*Overwiev of the correct answers for grain on the initial and final measure*

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
grain_t_1	19	1	4	43	2,26	1,195
grain_t_2	19	0	4	44	2,32	1,293
Valid N (listwise)	19					

On the initial measure the total number of correct answers was 43, with range from 1 to 4. The mean value was 2.26 while the standard deviation was 1.195. On the final measure the total number of correct answers was 44, the range was from 0 to 4, mean value was 2.26, and the standard deviation from that value was 1.293.

Chart1.4.*The average number of correct answers for the usage of a grain on the initial and final measure representation*



***first measure second measure**

From the abovementioned overviews we can see that there were better results on the final measure in all of the subjects. Already the first step of the findings analysis would indicate a positive effect which is believed to be, at least in part the result of NTC method of task solving in the program. In the further statistical analysis we viewed the sum effects, therefore in the further analysis we can see the total number of correct answers on the initial and final measure, from which we can also see a greater success rate in divergent production on the final test. This is graphically represented in a chart where it is easily noticed.

It is noticeable that the weakest divergent production was in the different usage value for the object ball (initial 0.79 – fin. 1.58), and the highest for the object grain (initial 2.26 - fin. 2.32), and a better divergent production was noticed for the objects: needle and mug (mug: initial 1.21 – fin. 2.16 and needle: initial 1.84 – fin. 2.26). The cause of such results can in this paper only be speculated. One of the explanations is that the objects themselves enabled a greater plurality of use. When we view the effect of the divergent usage for grain, already in the initial test a greater divergent production was measured. A stronger influence of the experience effect would be expected, i.e. a greater familiarity, therefore in that case the ball and cup would have had the highest results in the initial test of divergent production.

It is also important to note that the objects were chosen so that the previously mentioned object characteristics, i.e. the knowledge of their characteristics, previous knowledge and experience do not have a significant effect. Namely, that they are in the same position, equally familiar to the participants.

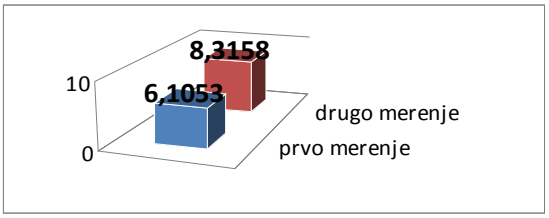
All of the correct answers on tests 1 and 2

Table2.1.*Overview of the total number of correct answers on the initial and final measure*

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
ukupno1	19	2,00	15,00	116,00	6,1053	4,06741
ukupno2	19	2,00	19,00	158,00	8,3158	4,73817
Valid N (listwise)	19					

It can be noted that the total number of all of the correct answers in the initial measure was 116, mean value was 6.1053 while the standard deviation was 4.06741. On the second measure there was a total of 158 correct answers, the mean value was 8.3158, while the standard deviation was 4.73817. We can conclude that the total findings in divergent thinking are manifest, which further verifies the findings of the statistical analysis of the t-test, which indicate a statistically significant increase in the number of all correct answers on Test 2.

Chart 2.1.*Average number of correct answers on the initial and final measure overview*



THE TOTAL NUMBER OF CORRECT ANSWERS (T – TEST)

The fact that the mean number of divergent answers on the final test refers to the initial state of divergent production, determined by the t-test of paired causes is statistically significant increased illustrates the instruction and guidance influence on the students' divergent production, which are implemented in the NTC system, the effects of which are explored in this study. Argumentation of these findings is given in tables below for the divergent production of each element separately, which is clearly shown in the graphic representation.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	total1	6,1053	19	4,06741	,93313
	total2	8,3158	19	4,73817	1,08701

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Total 1 – total 2	-2,21053	2,76041	,63328	-3,54100	-,88005	-3,491	18	,003

Eta squared=0.40

Sig. (2-tailed) is 0.03 which less than the assigned alpha level of 0.05. Based on this we can conclude that there exists a statistically significant difference in the results for a needle on the first and second measure.

The influence of instructions and guidance on the student's divergent production was tested with a paired T-test value. We can conclude there is a statistically significant increase in the total number of correct answers on the measurement (M=8.3158 SD=4.73817) in comparison to the initial measurement (M=6.1053, SD=4.06741), p<0.005. The average number of all correct answers in the final measurement increased by 2.21053, and the Eta squared value (Eta squared=0.40) shows that the instruction influence was significant.

Descriptive

Tabela 3.1. ***Overview of correct answers for ball on Test 1 and Test 2***

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Correct answers for ball (Test 1)	23	0	2	2	.09	.417
Correct answers for ball (Test 2)	23	0	3	26	1.13	.626
Valid N (listwise)	23					

On the basis of the gathered results through data descriptive analysis we conclude that the total number of correct answers for ***ball*** on the first measurement (Test 1) was 2, their range was from 0 to 2 correct answers per person. The mean value, i.e. the average number of correct answers for ball per person, was 0.09 and the standard deviation from the mean value was 0.417. The total number of correct answers for ball on the second measurement (Test 2) was 26;their range was from 0 to 3. The mean value was 1.13 while the standard deviation from that value was 0.626.

Chart 5.1 – *The representation of correct answers per student for ball on Test 1 and Test 2*

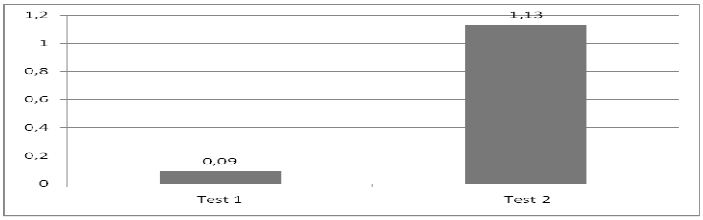


Table 3.2.*Overview of correct answers for cup on Test 1 and Test 2*

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Correct answers for cup (Test 1)	23	0	2	14	.61	.583
Correct answers for cup (Test 2)	23	1	3	33	1.43	.662
Valid N (listwise)	23					

Based on the results of the descriptive analysis we conclude that the number of correct answers for ***cup*** on the first measurement was 14, their range was from 0 to 2. The mean value, i.e. the average number of correct answers per person was 0.61, and the standard deviation from the mean value was 0.583. The total number of correct answers for cup on the second measurement (Test 2) was 33; their range was from 1 to 3. The mean value was 1.43, while the standard deviation from this value was 0.662.

Chart 3.2. – ***The representation of the number of correct answers per pupil for cup on Test 1 and Test 2***

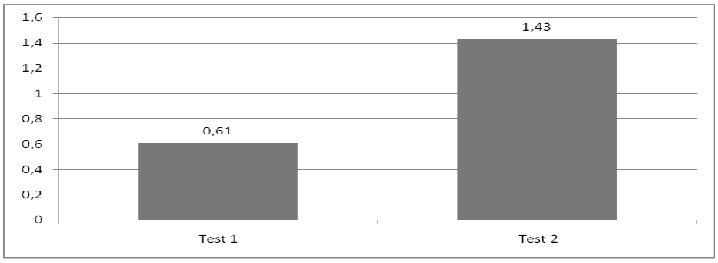


Table 3.3 ***The overview of correct answers for needle on Test 1 and Test 2***

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Correct answers for needle 1	23	0	7	106	4.61	1.971
Correct answers for needle 2	23	2	7	86	3.74	1.322
Valid N (listwise)	23					

Based on the results of the descriptive statistics we conclude that the total number of correct answers for needle on the first measurement (Test 1) was 106. The range of correct answers was from 0 to 7. The mean value was 4.61, and the standard deviation from the mean value was 1.971. The total number of correct answers for cup on the second measurement (Test 2) was 86, while the range was from 2 to 7 answers per person. The mean value was 3.74 while the standard deviation from that value was 1.322.

Chart 3.3.–*Representation of the average number of correct answers per pupil for needle on Task 1 and Task 2*

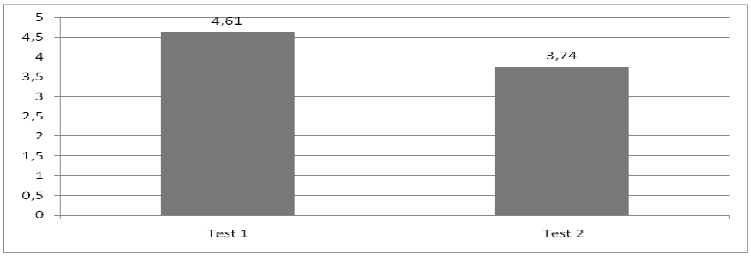


Table 3.4. Overview of correct answers for grain on Test 1 and Test 2

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Correct answers for grain 1	23	0	2	15	.65	.647
Correct answers for grain 2	23	0	3	27	1.17	.887
Valid N (listwise)	23					

On the basis of the results shown in table 4 we conclude that the number of correct answers for ***grain*** on the first measurement was 15, the range was from 0 to 2 correct answers per

person. The mean value was 0.65, and the standard deviation from the mean value was 0.647. The total number of correct answers for grain on the second measurement (Test 2) was 27; the range was from 0 to 3. The mean value was 1.17 while the standard deviation from that value was 0.887.

Chart 3.4. – ***Representation of the average number of correct answers per pupil for grain on Test 1 and Test 2***

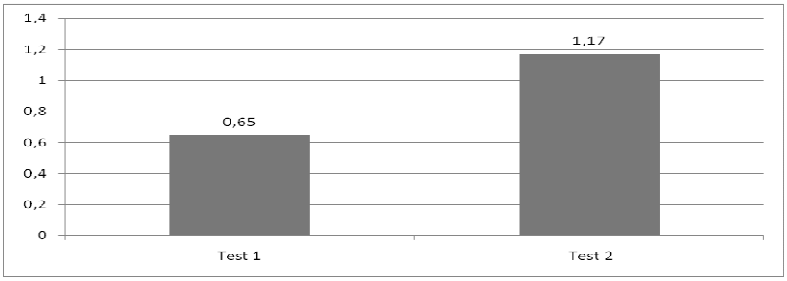
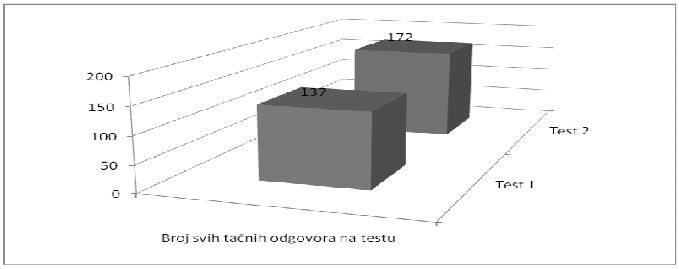


Table 3.5. Correct answer overview on Test 1 and Test 2

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Total_number_of_crrect answers_1	23	0	11	137	5.96	2.364
Total_number_of_crrect answers _2	23	4	12	172	7.48	2.129
Valid N (listwise)	23					

From the given overview of all of the correct answers in Test 1 and 2 we determined that the number of all correct answers in the first measurement (Test 1) was 137, their range was from 0 to 11. The average number of all the correct answers for the first measurement was 5.96, and the standard deviation from that value was 2.364. The number of all the correct answers on the second measurement (Test 2) was 172. The range of correct answers per person ranged from 4 to 12, while the average number of correct answers per person was 7.48, the standard deviation from that value was 2.129. The graphic illustration below shows this clearly.

Chart 3.5. – ***The representation of all of the correct answers on Test 1 and Test 2***



***the total number of correct answers on the test**

Chart 3.6. – *The representation of average answers per pupil for the total number of correct answers on Test 1 and Test 2*

T-TEST – TOTAL NUMBER OF QUESTIONS

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Total_number_of_correct_answers_1	5.96	23	2.364	.493
	Total_number_of_correct_answers_2	7.48	23	2.129	.444

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Total_number_of_correct answers_1 - Total_number_of_correct answers_2	-1.522	3.540	.738	-3.053	.009	-2.061	22	.051

Eta squared=0.16

Sig. (2-tailed) is 0.05 which is the same as the assigned alpha level of 0.05. This would indicate that the value is on the border of statistical significance. These results are the consequence of the small sample of participants. If the number of participants were larger we would have gotten a smaller Sig value on the test. Hence we can conclude that there exists a significant difference findings reached in Test 1 and Test 2.

T-test of paired samples was used to assess the influence of instruction and guidance on student's divergent production. It was determined that the number of all correct answers on Test 2 (M=7.48, SD=2.129) was increased to a statistically significant degree in comparison to Test 1 (M=5.96, SD=2.364), p≤ 0.005.The average number of all of the correct answers on test 2 increased for 1.522, and the eta squared value (0.16) shows that the instruction influence was significant.

The aforementioned findings are in favor of the intention of this paper to study, through an explorative research, the possible positive influence of the NTC system of learning on critical thinking, namely to study the possible positive influence on one aspect of critical thinking –

divergent production. In this way a small step would be made in the research of a significant question for the psychology of thinking in the teaching process, and the results would indicate the didactic reach of the NTC system. We could therefore say that these findings, with all their methodological constrictions – sample size, number of tested variables, could be used as argumentation for the hypothesis that NTC system significantly contributes to the development of divergent thinking. The results of this paper confirm the belief/assumption that there exists a possibility of transfer, the possibility that tasks saturated with processes of creative thinking, creative imagination, inventiveness and divergent production used in the NTC system of learning influence the release from conformist thinking and give greater effects in divergent production. This hypothesis would be in the basis of a wider structural design when it comes to the research of this question.

Concluding thoughts

If we go a step further in the concluding process we will address the importance of the findings which were reached through this small explorative study on the topic of certain cognitive abilities, in this case divergent production as a consequence of the application of the NTC learning system. The findings, with all the borders and fences, confirm the importance of the NTC program didactic approach, instructions and content on encouraging divergent thinking. This could be used to strengthen the argumentation for early stimulus and the neurophysiological belief that that early stimuli are important for early forms of cognitive ability. This is especially true for mathematic logical thinking, as is noted in R. Rajovic's manuals (2009 a, b and 2012 a, b). For these abilities highly specialized functions are needed which are found in the front section of the cerebrum cortex that mature latter. This is a neurophysiological fact that brain regions for mathematic logical thinking complete the melanization process only after the 14^{th}year; hence this is the reason for intensive encouragement in this period.

Neuropsychological research indicates that intellectual ability depend on the number of synapses in the brain. Some authors note that by the age of five 50% of synopsis, by the age of seven 75% and by the age of nine 95% of synopsis (Rajovic, 2009 a). Contemporary neuropsychology while researching the biological basis of different mental functions (perception, attention, memory, imagination…) finds that attitudes and emotions represent a n important basis in the learning process, that every child is different and that an individual approach is needed in education, with the adequate role of the environment. The findings of this research are indicative for the fact which neuropsychology confirmed that genetic potential of IQ depends on the number of nerve cells in the brain and on the number of connections (synapsis) between neurons. Since we can influenced the number of connections between neurons and on the total number of grids in the brain with education, and therefore influence the development of IQ and thinking, especially creative and productive thinking, it is only natural to search for the ways how and when to do this. It has been proven that brain development is the most dynamic until the seventh year of life and that the possibility of enriching the connections between neurons is increased (Rajovic, op.cit). According to Rajovic " In the brain a battle takes place for dominance among neurons, new connections are made between active neurons and new command paths, encouraged is the development of important centers in the brain, a whole network of new pathways is formed" (ibidem). By stimulating the brain in the work with children we enable the increase of the neuron network and in that way increase intellectual ability, IQ, creative and abstract thinking (ibidem).

Although the brain is a great mystery, neuropsychology is bringing us closer to understanding certain functions. Evidence for the importance of how developed the synapsis network is among neurons in the brain for the development of intellectual ability along with the fact that we can influence that network through education – is compatible with the findings of this research, as well as the understanding of the Nobel Prize winner Francis Crick who wrote: "You, your joy and sorrow, your memories and ambitions, your feeling of personal identity and free will, all of that, is nothing other than the behavior of a large collection of nervous cells and from them connected molecules" (Rajovic, 2009 b). This is considered to be the basis of spiritual intelligence, supported by evidence that intellectually more capable individuals can more easily mobilize adequate neural centers in the brain and solve posed problems with less activity of the brain as a whole, which supports adequate encouragement, i.e. supports the findings of this paper.

The awareness of the methodological modesty of this paper does not lessen the motivation for new steps in this field, especially the fact that these findings can serve, if not differently, than at least for hypothetical purposes for new methodological plans, and from a practical standpoint as a confirmation of the didactic value of the NTC system of learning.

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Appendix no.1.

Divergent production tasks

In front of you are tasks which expect you to give as many original and unusual answers as possible. In the below listed examples try to find as many useful usages for a ball, needle, grain of rice, a coffee cup. All of the listed items have their usual usage: You should fill in (list) a few other (different) usages for that object.

For example: a notebook is used for writing homework, but it could be used to light a fire in a fireplace, make a paper boat to play with while taking a bath, lining the underside of drawers with its papers, for cleaning windows with the paper etc. As you know,there exist a lot of such different usages. List as many different usages as possible for each of the listed items below:

ball
for playing

_____
_____
_____
_____
_____
_____

cup
for coffee

_____
_____
_____
_____
_____
_____

needle
for sawing

_____
_____
_____
_____
_____
_____

grain
of rice

_____
_____
_____
_____
_____
_____

If you do not have enough room on the lines, write your answers in the blank space below:

You do not have to write your name. Thank you!

Biographical note

Grozdanka Gojkov**,** born in 1948, has a PhD degree in didactics at the University in Novi Sad. She teaches at the Teacher Training Faculty, Belgrade, teaching department in Vrsac; at the Preschool Teacher Training College „Mihailo Palov" in Vrsac; and at Primary School Teachers Faculty in Uzice. She is also a director of the Preschool Teacher College in Vrsac and an editor of the publishing activities at the same institution. She is a member of many national and international organizations (e. g. ECHA- European Council for High Ability; Central European

Academy of Science; Serbian Academy of Education in Belgrade, etc.) and a visiting professor. Fields of interests and research: epistemological grounds of pedagogic research; giftedness (the factors of transferring potentials into achievements; pluralism in teaching from the angle of the gifted); didactics (strategies of meta-cognition encouragement; docimology, meta-theoretical approaches to didactics).

Ranko Rajovic has graduated from the Medical Faculty in Novi Sad, where he also specialized internal medicine and defended his master thesis from the field of neuro-endocrinology. He works at the Philosophical Faculty in Kopar (Slovenia). He is an author of a number of scientific and professional papers on the application of medical discoveries in pedagogy and he is also the author of the NTC program implemented in 15 European countries. The program is accredited by the Ministry of Education in 7 of these countries. He is an author of 3 books: *IQ of a child, care of parents*; *How to successfully develop intelligence through play* and *Learning is play*; he has also designed several didactic toys. He is an associate of UNICEF for education, founder of MENSA Yugoslavia (today Serbia) and a long-standing member of the Committee for gifted children of the World MENSA (vice president of the same body in the period between 2010 and 2012).

Aleksandar Stojanovic was born in 1970. He obtained a PhD degree in pedagogical sciences from Philosophical Faculty, Novi Sad University. He works at the Teacher Training Faculty in Belgrade and the Preschool Teacher Training College "Mihailo Palov" in Vrsac. He became a senior lecturer of *Didactics* in 2008 in Belgrade. He is teaching *Didactics, General Pedagogy, Pedagogic Research Methodology, Preschool Pedagogy, and Mathematics Teaching Methodology at Preschool Age.* He is a manager of the publishing activity of the Preschool Teacher Training College in Vrsac. Since 2009 he has bee a member of the *Education Council* of the Province of Vojvodina. His fields of interest and research are didactics, preschool upbringing and education, moral education, upbringing and educational methods, giftedness, research methodology.