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THE POSSIBILITIES OF ENCOURAGING STUDENT'S METACOGNITIVE STRATEGIES THROUGH HEURISTIC-METHODOLOGICAL INSTRUCTION

Abstract: In the era of contemporary society, which revolves around the fast information science revolution, the pupil is no longer just an observer in the educational process but rather an active constructor of one's own knowledge. Current didactic theories proclaim teaching, in which the teacher is an instructor and a facilitator, and as such should encourage and help develop the pupil's learning strategies constructed on the basis of intentionality, self-established and self-organized learning.

In this explorative research the possible influence of heuristic-methodological instructions on encouraging metacognitive ability is explored, i.e. the meta-component of elementary school fourth grade pupils. Our goal was to determine to what extent it is possible to encourage the pupil's metacognitive strategies with didactic-methodological strategies based on heuristics and its methods (discovery learning, project method, problem method, work in small groups, teaching in nature). The empirical research was conducted through an experimental program, realized in the experimental group of pupils, while the control group worked in unchanged conditions. In accordance with the gathered research results, we compared the differences between both groups and came to a conclusion that a statistically significant difference in the results occurred, i.e. through the research of the metacognitive abilities of the experimental group pupils in the segments which referred to elaborating and connecting previously acquired knowledge with new, overcoming work difficulties, checking correct answers, method of checking the validity of the answers and determining the main concepts and ideas from the text.

Key words: heuristic-methodological instruction, learning meta-components, triadic learning process.

Introduction

Fast technological development and constant improvement of the existing technologies has significantly changed contemporary society. The development of knowledge, its application and constant improvement have become a characteristic of contemporary development, while modern societies are becoming societies of knowledge (Komnenovic, B., Lazetic, P., Vukasovic, M., 2010). The specificity of scientific and technological development in contemporary society is incomparable to any other previous period, therefore society

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knowledge is a characteristic of any society, to different degrees, regardless of the political and ideological discourse, it influences almost every individual (ibidem). In this day and age knowledge and development are inseparable, which means that efficient economic development is unthinkable without knowledge, and that education is in the center of problems connected to the development of individuals and society. New circumstances demand an answer to the question what education today should be like, in order to answer to the challenges which contemporary life puts before it. A sudden developmental spur in science and knowledge as an unavoidable condition put forth the formation of a new educational paradigm with which an educational system adequate for individual and social needs of the postindustrial time could be created (Milutinovic, J., 2008). The search for new educational paradigms does not mean abandoning the educational ethos and education nor the values of the educational process with which intellectual growth and creativity are nurtured. This only recognizes the need to reevaluate current educational structures in the light of the 21st century demands (Milutinovic, J., 2011).

Emancipation directed didactics, founded on the phenomenologically oriented educational process, stress that the teaching process must be constructed on the basis of the pupil's existing knowledge, and that one should move from that point towards understanding and vocalizing, which is of constitutional importance for self-interpretation and interpretation of the pupil's world (Gojkov, G., Stojanovic, A., 2011). The basis for such an understanding of the teaching process is the postulate of the functional-critical orientation towards the democratization of school and society. In this way a "didactics directed towards the pupil" was formed, whose goal is to include all actors who directly or indirectly participate in teaching into the process of institutional research and leaning (Gojkov, G., 2009, 2014). Heuristic-methodological instruction encourages in a pupil intellectual autonomy, independent research, self-discovery and self-regulation during the learning process, encourages designing and search for one's own learning strategy and opens up the possibility for the development and encouragement of metacognitive learning strategies (Terhart, E., 2001).

In the paper we have presented a smaller part of the empirical research which refers to the effects of heuristic-methodological strategies on the encouragement of learning in fourth grade elementary school pupils. Our goal was to determine to what extent it is possible to influence meta-components of learning through heuristic-methodical instructions – before the start of teaching (construction of a teaching plan); during the teaching process (elaborating and connecting previously acquired knowledge with new, overcoming difficulties while solving tasks by using different problem solving strategies); after the learning process (checking the given results and correct solutions, way of checking the answer, deducing the main concepts and ideas from a text).

Heuristic-methodological instructions for encouraging meta-components of learning

In a constellation with emancipated didactics, we find Freire's conception of a human being as an "unfinished project" , which views the relation between a teacher and a pupil as an occurrence which is not isolated, which indicates that the holistic approach is necessary, i.e. the integrative approach in teaching. The goal of this approach is reflected in making an individual capable of critically reflecting the social reality and identifying the conditions which hinder one's self-fulfillment. P. Freire (1972) pointed out that the essence of research is not gathering and conveying knowledge, but rather in an open dialogue between teachers and

pupils in whom knowledge is created. In other words, both teachers and pupils here are subjects in reality creation and knowledge re-creation.

Guided by Sternberg's triarchic theory of learning, we tried to encourage with heuristic-methodological instructions the triad which refers to the pupils' internal world, their experience and the outer world which surrounds them. This triad further developed refers three different types of components, which are mutually conditioned – 1) meta-components, where executive processes are created (metacognition); 2) components of operationalization – processes of a lower level whose function is to execute meta-components and 3) the components of gaining knowledge, on the same level as the processes of learning ways for solving problems (Sternberg, R. 1989, 2005).

Consequently, we were oriented towards learning strategies which help in the development of metacognitive abilities of the students, and some of them are elaboration, material organization, monitoring and controlling progress, verification of the achieved by checking the correctness of answers and by finding main concepts and ideas from a text, i.e. content which is analyzed (Swanson, L., 1990).

Flavel in his works indicated that a wide range of cognitive production occurs through actions and reactions of four classes of phenomena: metacognitive knowledge, metacognitive experience, goals and aims, and actions and strategies (1979). Metacognitive knowledge and metacognitive abilities do not only refer to the individuals awareness of one's cognitive processes (noticing, remembering, thinking), but also to the awarenessabout when and in what situations can certain learning strategies be efficient and better than some other learning strategies which would better fit some other situation and solve some other problem (Stojakovic, P., 2009). The same author notes that learners who have a better ability to monitor and control not only their cognitive processes but also their learning and problem solving strategies, usually gain better results in learning. Pupils who developed the ability to control their learning strategies and learning achievement as a whole, are capable of controlling the learning process from beginning to end. This type of learning is meaningful and directed towards a goal (ibidem).

In the encouragement of metacognitive learning strategies it is important to pay attention to every part of the learning process, every segment of the triad, i.e. three-phase learning process, as some authors call it (Zimmerman, B. J., & Pons, M. M., 1986). Heuristic instructions which encourage metacognitive skills refer to instructing students how to use learning strategies such as observing, summarizing, making notes; encouraging pupils to use learning strategies which connect new and previously acquired knowledge; giving instructions and elaborations of content (highlighting main ideas and concepts, sketching, making schemes, diagrams, summarizing, comparing, singling out newly learned important information from that which is less important); using the discourse method (dispute, discussion) and critical observation of certain contents; encouraging students to do introspection and metacognitive control of thinking (Sternberg, R., 1984; Veenman, M. V., & Spaans, M. A., 2005; Stojakovic, P., 2007).

Some of the heuristic methodological instructions which can also help on the encouragement of metacognitive skills refer to self-reporting, which includes retroactive verbal reports or/and self-evaluation in a written form, where pupils ask themselves questions during and after the process of learning (Paulhus, D.L. & Vazire, S., 2007). Connected to self-reporting, it is useful

to use the methos of thinking-aloud. This method can be used during the process of solving a problem or retroactively, when the pupil finishes the task (Fonteyn, M.E., Kuipers, B. & Grobe, S.J., 1993). The importance of the thinking-aloud method is reflected in the direct feedback on the metacognitive knowledge and used strategies for solving the problem, as well as the possibility to change the strategies which did not result in a successfully solved task (ibidem).

For our research relevant are the results of the empirical study conducted by G. Gojkov, which refers to the relation between didactic instruction and metacognitive ability. The author paid special attention to the number of meta-statements which the subjects made. The number of statements which could be marked as meta-statements was low. In other words, from the total metacognitive reaction, the subjects were most successful at using abilities which refer to the awareness of the level of understanding and problem analysis (3.8%); observing the problem situation as a whole and connecting the already learned knowledge with the new (3.1%); elaboration and awareness of the usage of previously acquired knowledge (2.9%), and finding optimal structures in the content which is being solved and its organization in main and supporting ideas and activities (2.8%) (Gojkov, G., 2009).

When it comes to monitoring one's own work and activities, metacognitive reactions were manifested in the following activities: awareness of the goal which needs to be achieved (1.9%); the ways through which the goals will be achieved (1.8%); frequently asking new questions and checking (1.5%); reexamining after completing the task about other ways of solving the problem and the possibilities of incorporating old knowledge into the new (0.8%).

Relevant for this paper were also the findings of the same author which refer to the connection between metacognitive reactions and intellectual ability (r=0.56). This relevant connection was also manifested in the problem solving efficiency, and the connection between these two variables was observed according to the number of manifested reactions, where subjects were grouped into three categories. In the first category were subjects with five or more meta-statements, in the second the ones from three to five meta-statements and in the third category the ones with less than three meta-statements. With the Independent Samples T-test the difference between the ones with the highest and the lowest scores in meta-statements was tested. A statistically significant difference was found in favor of the ones with the highest scores on the meta-statements. The differences were expresses in the intellectual potentials, success in problem solving and creativity (Gojkov, G., 2009).

Methodology

In our research[3] we were particularly interested in the segment of metacognitive abilities which refer to meta-thinking (thinking and knowledge of one's own thinking and ability to analyze thinking processes and methods while solving problems) and metacognitive knowledge (knowing what one knows, and does not know; knowledge of one's own mistakes and actions) (Stojakovic, P., 2009).

During the experimental research, subjects in the experimental group were under the influence of the experimental factors, i.e. heuristic-methodological instructions, that is learning strategies. Heuristic instructions incorporated that which leads to discovery, that

[3]The research represents a small part of an empirical research conducted for the needs of a doctoral theses completion.

which is experimental. The accent is on the subjects independent search for principles (laws), while keeping redundancy to a minimum, which holds the core, truth and shortens the time necessary for solving the problem in comparison with other known methods in the research activity (Vilotijevic, M., 2008; Jelavic, F., 2008). During the construction of heuristic classes, the priority was on the student's creative self-realization goals, than on methods and forms of class which ensure productive subject activity organization, and finally, educational content (Ristanovic, D., 2010). We would concentrate on this, heuristic relationship, in which organizational forms and methods of heuristic teaching have priority over content. Klafki stated the importance of the transformation from the didactic triangle to a didactic hexagon, where the gravity center is moved from the question "what to learn" to the question "how to learn" (Gudjons, H., Teske, R., Winkel, R., 1994). In class during the process of solving problems we encouraged the students to use heuristic strategies whose methodological value is reflected in giving general directions, with a maximal decrease of the teacher's participation in the sense of giving solutions and universal rules (Rudd, D., 2010). Heuristic-methodological instructions strongly influence the pupil's self-efficiency, which is reflected in solving the problem in a non-standard way, heuristic thinking and heuristic strategizing (Landa, L. N., 1976). Our goal was to enable the students to use self-regulated strategies (planning, monitoring, resource management strategies) and encourage them to be the constructors of their own knowledge (Ponton, M. K., Caar, P. B., 2000).

Heuristic-methodological strategies in classes incorporated the usage of theproject method, in classes where we considered the content suitable for its realization, interactive work in small groups, ambient learning, student's discovery work and independently reaching new information, discovery learning, problem method with elements of creating problem situations, problem decomposition and finding one and/or more solutions. During the research, the accent was put on monitoring one's own learning, which was realized by keeping a *Weekly Diary* (introspection protocol), in which pupils wrote their insights from class, self-evaluated their learning, noted down what presented a problem while learning and gave suggestions (strategies) and sought for solutions on how to solve the problem.

Research subject is the influence of heuristic strategies and learning methods on encouraging pupil's metacognitive skills in the subject nature and society, as well as the possibility to form an effective activity system with the goal of encouraging higher mental processes: critical thinking, autonomy in learning, self-organization in learning as well as self-efficiency in learning.

Research problems. Transmission of a large knowledge fond from a teacher to a pupil is regarded as unacceptable and so became a subject of harsh criticism by contemporary didactic theories. Educational goals of dominant teaching theories of the contemporary age are oriented towards *learning to learn,* dialogue, heuristic and discourse teaching methods, thinking activation of the student, positive transfer in learning, meta-components in learning and encouraging one's own learning strategies. The research problem refers to the following: To what extent can the pupil's metacognitive skills be encouraged with heuristic strategies from the perspective of explorative learning, self-regulation in learning, in other words to provoke self-organization in work and autonomy in learning with didactic-methodological instructions? We will explore the question of the contributions of systematic usage of didactic-methodological activities (individual and group) in conditions specific for nature and science classes, as well as the possible positive influence of these activities to the development of meta-components in learning. Through metacognitive participation in learning we could ease

the pupils' acquisition of educational content from the subject nature and society and contribute to their better understanding, interpretation abilities and knowledge permanence.

The research goal is to determine to what extent it is possible to encourage the pupils' metacognitive strategies with didactic-methodological strategies based on heuristics and its methods (discovery learning, project method, work in small groups, education in nature).

Research tasks

1. Explore to what extent will the heuristic methodological instructions influence study planning and finding the connections between the previously learned content and information.
2. Examine to what extent the heuristic methodological instructions will encourage self-monitoring in learning realized through detecting difficulties and finding ways to solve them.
3. Explore to what extent the heuristic methodological instructions will influence the checking of given answers, ways of checking and singling out of new concepts and ideas from the covered content.

Research hypothesis was formulated on the basis of expectations connected to solving the problems in the three phases of learning – before, during and after learning.

H1 refers to the assumption that there will exist a statistically significant difference between the groups in tasks where the pupils are asked to write what their study plan looks like and in the task which refers to connecting the previously acquired content with new content.

H2 refers to the assumption that a statistically significant difference will exist between the groups in tasks where pupils need to recognize difficulties in their work and ways in which they could overcome those differences.

H3 refers to the assumption that a statistically significant difference will exist between the groups in tasks in which the pupils need to write whether they check the correctness of the solved tasks, and if they do, how they do it, as well as in the task in which they single out the main concepts and ideas in a text.

Independent variable consisted of heuristic methodological strategies, and **dependent variable** metacognitive ability of the participants followed through the three learning phases – before the learning process, during the learning process and after the learning process. Expected educational effects created under the influence of the experimental factor – heuristic methodological instructions – are development of meta-components induced in the following stages: 1) planning (the possibility that previously acquired knowledge will help in what needs to be learned, in which direction learning and thinking should be headed, what is the first thing that needs to be done, how much time it will take for the problem to be solved or for certain content to be learned); 2) monitoring –control over what is being done and the pace of progress; which question is still left unanswered; whether conversation with the teacher, a friend or a third person can be helpful; how to proceed further, what information is relevant for the following work; what to do and which learning strategies to implement when facing a problem; 3). Self-evaluation (whether the task is correctly completed; whether the flow of thinking, learning and problem solving was successful unsuccessful in comparison to

the expectations; what could have been done differently; in what way is it possible to apply this learning and problem solving strategy in other situations and on different subject matter; should we go one step behind again and check the solution of the task) (Pintrich, P. R., Wolters, C. A. & Baxter, G. P., 2000; Stojakovic, P., 2007, 2009).

Research sample. In this research the subjects were fourth grade elementary school pupils from the city of Pancevo, in the school year 2014/15. In the research participated 146 students from two elementary schools, aged 9-10. The sample consisted of 3 experimental and 3 control groups. In this research we opted for non-probability sampling and consider this sample the most adequate if we take into account the space conditions of the school, organizational advantages, which among other things, include an agreement on the teaching activities of the fourth grade in both schools, along with the usage of recommended books and ordering the teaching topics in the same way as the publishing house recommendation; the pupil's age (if we take into account that technique for following the development of metacognitive ability – introspective protocols and reports – can only be applied after the age of nine), the proximity of the schools to parks (Tamis harbour and the National garden), which were important for the realization of ambient teaching.

The experimental factor was conducted in classes of nature and society, in which intensive work was conducted to encourage the pupil's metacognitive abilities with heuristic-methodological strategies which were incorporated in the curriculum. The research for six months, and the meta-component test represented "the first ground check", that is insight into the differences of meta-component development between students of the experiment and the control group. Our assumptions were based on the assumptions that the pupils in the experimental group would have better results on the development of meta-components test than the pupils in the control group.

The test consists of a set of questions which referred to solving tasks connected to the triad learning process – before the process of learning, during the process of learning and after the learning process. The pupils task was first to read a text about the city of Pancevo, and after that answer some questions. In accordance with this we composed tasks in which we tested whether the pupils had a learning plan, whether they connect the content they are learning with previous knowledge, and if they do which previous knowledge can help them to solve the problem; if they check the correctness of the answer and how they check; singling out the main ideas and concepts in the text. The tasks, that is questions and answers we formulated in categories, and every category, depending on the pupil's answer, contained subcategories. Some of the pupils answers, due to low frequency, and therefore difficult for statistical processing, were not able to form separate sub-categories, and therefore were added to a category which was the closest in meaning.

From the total sample from both groups, from the analysis we excluded nineteen pupils who did not complete the test. The groups were equal in the initial test of knowledge $t(125)=.642$, $p=.522$; on gender structure - $\chi 2(1)=.928$, $p=.335$ and educational status of the parents: mother - $\chi 2\ (2)=3.239$, $p=.198$, father - $\chi 2\ (2)=1.840$, $p=.399$.

Making the groups compatible on the abovementioned three criteria was considered adequate for the following reasons: the initial knowledge test helped the groups be even before the effects of the experimental program, by taking into account the pupils' achievements on a test which tested the knowledge after the completion of one teaching

unit. After these equalizing criteriawe got groups, i.e. classes in which the students were at the approximately same level of knowledge, which was important for the continuation of the research considering the fact that our expectations refer to the assumption that developed metacognitive skills of the experimental group result in better results on tests of knowledge.

When it comes to the gender structure and parent educational status, we considered it important to match the groups according to these criteria, since a larger number of boys or girls could influence the acquired results on the knowledge test, as well on the metacognitive ability tests. The reason why we chose the educational level of the parents to be our third criterion is due to the assumption that pupils whose parents have a higher level of education could encourage meta-components, self-checking during and after the process of learning, separating important from less important facts etc. On the other hand, the assumption with parents with lower educational status (elementary school), is that these students do not possess developed learning meta-components or that they are weakly expressed. Because of this during the process of making the groups compatible we excluded some (extreme) cases so as not to influence the relevancy of the findings.

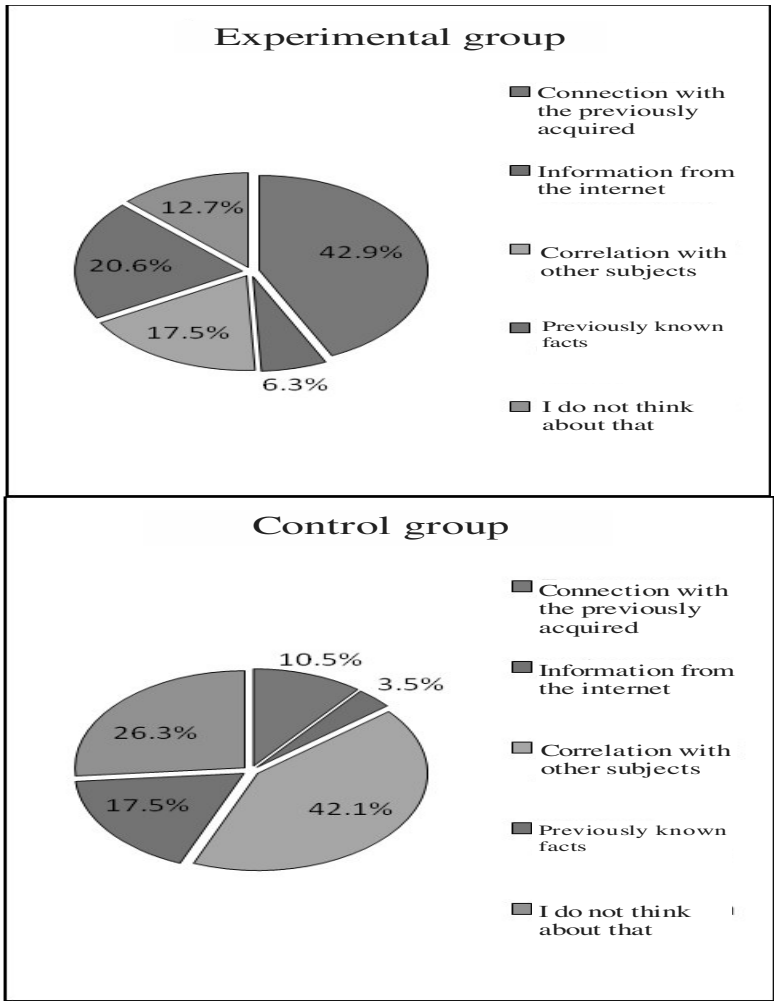
Findings and research results interpretation

In the results representation we start from the questions on the test which refer to planning, that is making a learning plan, which represents the first segment in the learning process. After that, interpretation of the research results will refer to the segments during and after the learning process.

In the task on which the pupils were asked to write whether they had a learning plan, and if they had it what it looked like, the Chi-square test did not show a statistically significant difference between the answers of the experimental and control groups ($\chi 2(6)=4.433$, on the level 0.05 $p=0.618$). Pupils in both groups wrote as answers that their plan for learning was to read the text many times, single out important information, split the text into segments, underline important words etc. however a significant difference between the groups did not exist. We would explain this from two aspects which from our view seem the most plausible. The first aspect is that pupils at this age are still not aware of the importance of constructing plans for further learning, nor the fact that a learning plan could greatly help in time economy and self-organization, and therefore better achievement in content learning. The second aspect refers to the possibility that the pupils did not consider making a plan for the solving of this particular task important. Furthermore, younger children usually start the task immediately and randomly regardless of the task difficulty. Still weakly developed these meta-components leads to students being unable to decide how much time it will take them to solve a certain problem (Stojakovic, P., 2009). One American research monitored the occurrence and disappearance of metacognitive strategies over a period of five years. The results showed that the possibility of using metacognitive strategies varied during the research period. Therefore, some meta-components (planning strategies and self-monitoring) were frequent in the third grade, but were nearly non-existent in the fourth grade, only to become present again in the fifth grade (Annevirta, T. & Vauras, M., 2006).

In the tasks where the students were expected to write how the solution method could be connected to previously acquired knowledge, the chi-square test showed a statistically significant difference in the answers between the pupils in the experimental and control groups ($\chi 2(4)=20.546$, on the level 0,05 $p=0.000$).

Chart 1. – Connection with previous knowledge

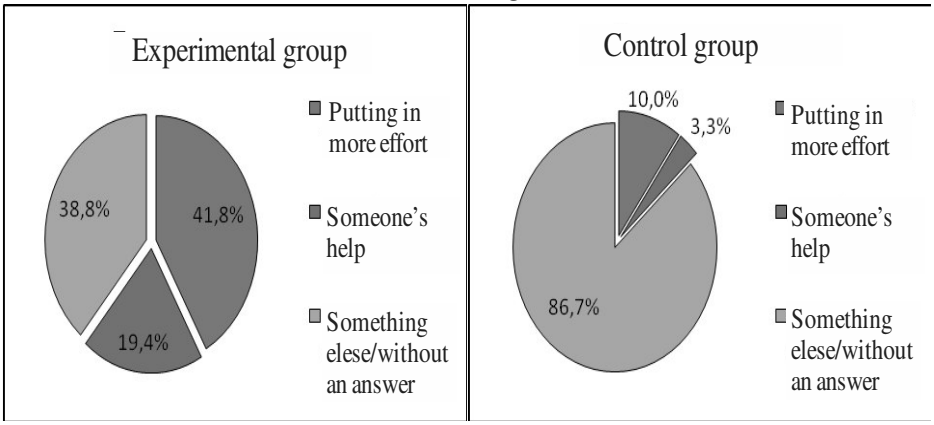


We could therefore conclude that there exists a statistically significant difference in favor of the experimental group when it comes to connecting already acquired facts with the text and test tasks. This indicates that these pupils leaned on previously gained experience. Twice as many students in the control group stated that they do not think about connecting previously acquired knowledge with new. To this subcategory we added the students who stated that they do not find any connections between the previously acquired knowledge and test tasks. In the research of G. Gojkov (2009) on the influence of didactic instruction on metacognitive and creative reactions researched through meta-statements, results showed that subjects were the most efficient, among other things, in those meta-statements which referred to elaboration and consciousness of the ways in which to use previously acquired knowledge, strategies of meaningful material organization and consciousness of the problem, level of understanding and analysis. By comparing our results with the results of the previously

mentioned research we could conclude that subjects which were under the influence of didactic instruction and heuristic strategies showed greater developed meta-components which refer to the connecting of previously acquired knowledge with the new. These subjects stated that they find a connection between the acquired knowledge and the one which is being learned, as well as saying that the old knowledge can help structure the new.

In the category defined on the basis of the task in which the subjects needed to write the ways in which they overcame problems during the problem solving process, the Chi-square test showed that there exists a statistically significant difference between the experimental and control groups ($\chi 2(2)=30.676$, on the level 0.05 $p=0.00$). Pupils from the experimental group in comparison to students in the control group more frequently gave answers that for overcoming difficulties one needs to invest more effort, as well as ask for the help of others. The subcategory which referred to investing more effort for solving a problem we merged with the answers which referred to using schemes, tables, symbols and charts. Furthermore, some students came to a solution by representing the potentially correct solutions in a little drawing, and then through the system of elimination crossed out some answers leaving one or two plausible solutions. On the other hand, the control group left the answer field blank in a larger number of cases (in 86.7% of cases), which we interpreted as a sign that the pupils couldn't/did not know how to define the answer.

Chart 2 – Overcoming difficulties

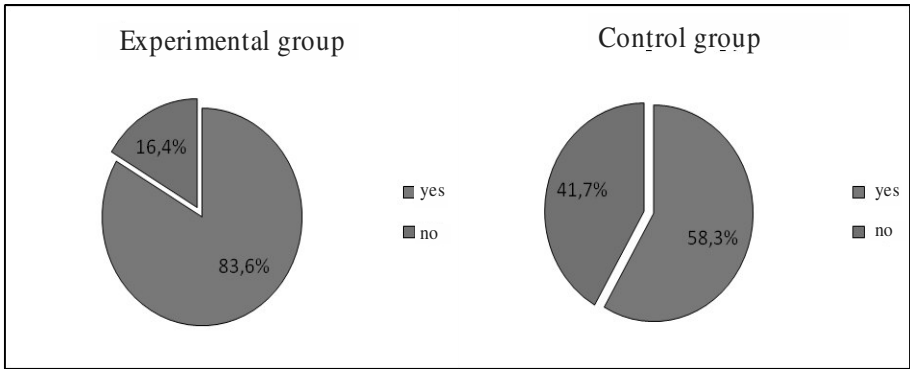


We compared our results with a study which compared the differences between a group in which self-instruction, self-examination and self-monitoring techniques were encouraged and a group which worked in non-experimental conditions (Sweeny, C., M., 2010). Furthermore, the stress was on metacognitive verbalization, where the pupils' used the thinking aloud method during and after the process of solving a problem. The results analysis determined that there existed a statistically significant difference in metacognitive elaboration techniques and self-observation in favor of the experimental group. Experimental group pupils used schematic representations and diagrams in order to eliminate incorrect answers and reach correct solutions. In this research, like in ours, the researchers measured the differences in strategies which the pupils mentioned contributed to overcoming difficulties which came up during the process of solving the task. The results of both studies showed there exist statistically significant differences between the groups regarding meta-components which refer to ways and solutions for overcoming problems, as well as the fact that experimental

group students more frequently used techniques for elaboration by separating the important from the less important, following the flow with self-inquiry and overcoming problems through learning self-organization by making schemas and table representations.

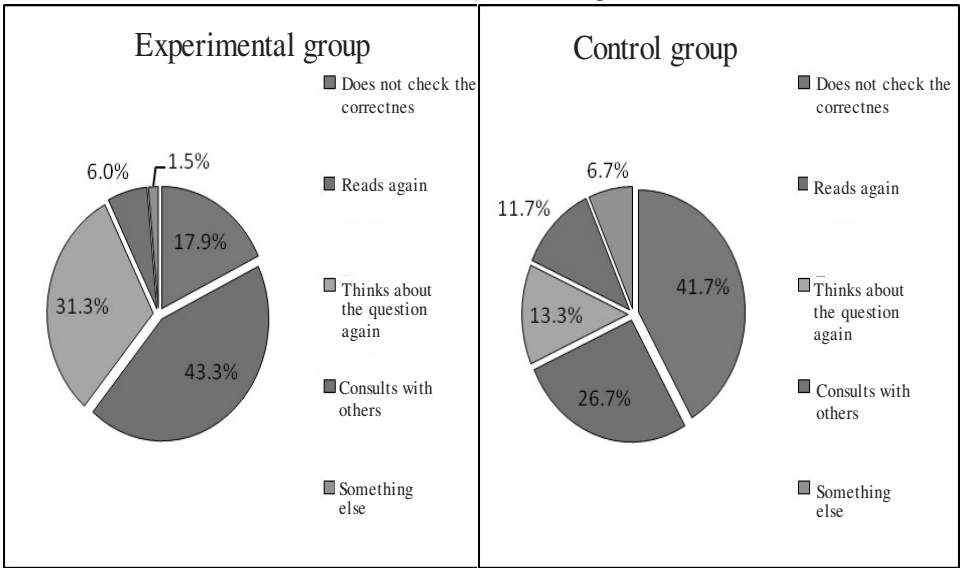
Checking the correctness of the answer was the category in which a significant statistical difference existed between the two groups of students, which was confirmed by the Chi-square test results ($\chi 2(1)=9.935$, on the level 0.05 $p=0.02$). In 87% of cases the experimental group answered that they checked the correctness of the answer, while the control group pupils did the same in 58% of cases. In our opinion such results are due to the effect of heuristic instruction, since during the experimental program the pupils continuously checked the correctness of the answers with their partner, group members, frontally through systematization or feedback on the taught content. Furthermore, with experimental group pupils in classes in which we had whole-class five minute checking the answers were commented on and we indicated the importance of checking answers. We insisted that incorrectly solved tasks and mistake understanding need to be motivation for finding better strategies and methods for solving tasks of a similar nature.

Chart 3 – Checking the answer correctness



In the category which referred to the way in which the pupils checked the correctness of the answers, a statistically significant difference was found in favour of the experimental group, which the Chi-square test confirmed ($\chi 2(4)=16.433$, on the level 0.05 $p=0.02$). The experimental group students more frequently stated they check the correctness of the answers by reading the text again or thinking about the question again. Apart from these answers, the students also stated that they checked the correctness of the answer by consulting the teacher, a partner, using information from the internet, researching texts in a book about the city of Pancevo. Reciprocally, the control group pupils frequently noted that they did not check the correctness of the answer.

Chart 4 – Way of checking

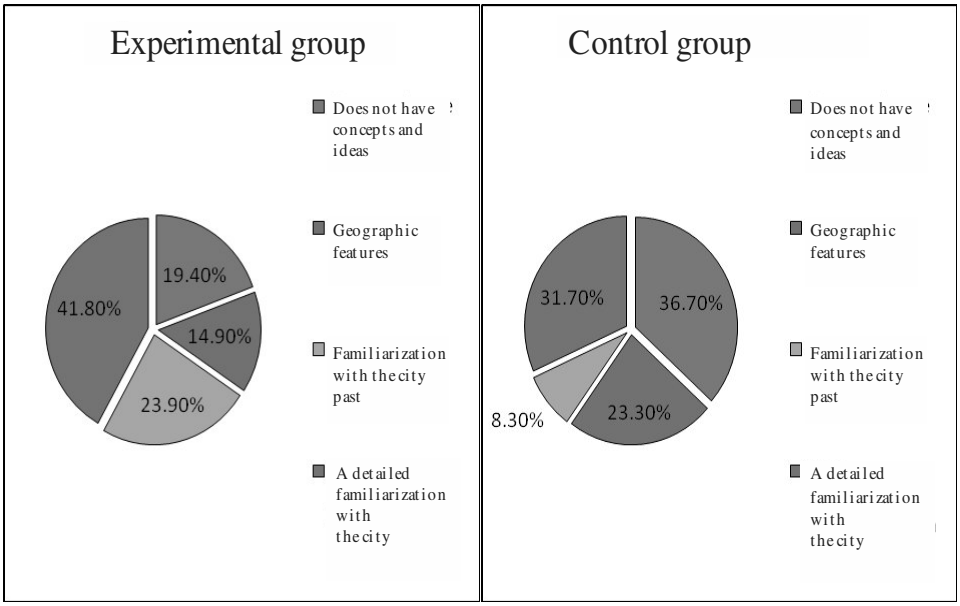


In the already mentioned research (Sweeny, C., M., 2010) the results of the control and experimental group results were compared for tasks which referred to problem solving techniques. The problem solving process was conducted in three steps, which were divided on the difficulty basis (the steps are similar to what is used in our schools as a half-programmed material in the form of articles which change one after another, pupils moves from one article after they have finished the current one). Through the result analysis we determined that the experimental group was more successful in solving all three problem steps – determining the problem, finding an adequate strategy for its solution, checking the answers using helpful information, retrospective problem solving and self-questioning during the report on work on the problem. In the mentioned research conducted by G. Gojkov (2009) it was determined that didactic strategies influenced the participants to do a deeper problem analysis, often pose new questions and to check and reexamine other possibilities and ways of solving the problem after it has been solved.

In our research to subcategories which referred to problem revision and reading the text numerous times we added pupil answers that during the checking of the solutions they decomposed the problem again, analyzed parts of the text starting from what is unknown in the text, thinking whether there exist multiple answers for the problem, and after that structure the parts into a whole. After the analysis of the aforementioned studies and the results of our own we can conclude that students who were exposed to the influence of heuristic didactic instructions showed a higher degree of meta-components which referred to the post-learning part.

In the category in which the pupils needed to single out the main ideas and concepts from the text, the Chi-square test showed a statistically significant difference between the experimental and control group answers ($\chi 2(3)=10.111$, on the level 0.05 $p=0.018$). The control group pupils in a significantly higher number left the answer space blank for this question, while this was significantly less frequent in the experimental group.

Chart 5. – Concepts and ideas



By comparing our results with the results of other studies (Fonteyn, M.E., Kuipers, B. & Grobe, S.J., 1993; Gojkov, G., 2009; Rudd, D., 2010; Sweeny, C., M., 2010) we came to a conclusion that a significant difference exists between pupils who were influenced by heuristic instructions and those who were not when it comes to finding optimal content structures and their organization into main and sub-ideas, singling out important ideas and concepts in the content which was closer explained when the pupils had problems. In an American study (Chalmers, C., 2009), control and experimental group results of third grade elementary pupils were compared, on positive mathematical scores.For three months experimental group pupils were under the influence of didactic instructions which incorporated the encouragement of metacognitive learning strategies, after which they were given tests where they needed to independently define concepts and ideas on the basis of reached results. The pupils named and marked with symbols their metacognitive learning strategies which they had used for the problem decomposition and finding optimal solutions. A considerable difference in results was found in favor of the experimental group. Namely, this group showed an higher level of using elaboration strategies and solution checking, but also defining and singling out the most important concepts and in content processing (Chalmers, C., 2009). The results of our research showed that exoerimantal group pupils gave answers in which they thought up special names for concepts and ideas which they considered the most important. In the same way some pupils represented the main concepts and ideas through small drawings that is symbols, with the help of which they were able to make clearer their separation of the chosen concepts and ideas as the most important. By comparing our results with the aforementioned study we came to a conclusion that heuristic didactic instructions influenced the final part of the learnng process, in which the pupils elaborated their work. Furthermore, experimantal group pupils in both studies showed a higher developmental level of meta-components regarding the systematiyation of the aquired knowledge and techniques for revsison of the given answers.

On the basis of the result analysis we con confirm the second and third hypothesis, which say that there will exist a statistically significant difference in favour of the experimental group in meta-components which refer to elaboration and monitoring ot the learning processes (in the task where the pupil is expected to recognize the difficulties and find ways to overcome them), systematization and feedback after the learning process through self-examination and solution checking, as well as in meta-components where pupils are encouraged to independently single out concepts and ideas in a text. The first hypothesis, which refers to the expectations that there will exist statistically significant difference in favor of the experimental group when it comes to planning of learning and connecting of the previous knowledge with the new content, we can partially confirm. We can confirm the part of the hypothesis which refers to the assumption that the experimental group will have a better developed awareness of connecting previously acquired knowledge with the new. However, in the segment which refers to the planning of the learning process, the Chi-square test did not show a significant difference between the groups, which indicates that this part of the first hypothesis cannot be confirmed.

The control variable in the research in this test was the educational level of the parents. On the basis of this variable, we wanted to check whether the parents' educational level influenced the pupils' answers, which would influence the gotten results, since we would not be able to state that the heuristic-methodological instructions were the determining factor in the development of metacognitive learning ability of the pupils. For every category, task, the Chi-square test was done which should show whether there existed a statistically significant difference in the answers between groups on the basis of the educational level of the parents.

From the analysis of differences based on the fathers educational level we excluded 4 subjects whose father had finished elementary school, and because of the small number of subjects in this category. For the same reasons, we excluded 7 subjects because of the mothers' educational status. Therefore, the differences based on the educational level of the parents included two categories of educational levels – high school/higher education. The difference analyses in the achievement of this test on the basis of the differences of the parents' educational level were conducted separately for the control and experimental groups. In the cases where the number of cells with expected frequencies lower than five was up to 20% the Likelihood Ratio was examined. Chi-square test showed that there were no significant differences in the results of the metacognitive ability test and the parents' educational level in any of the categories which were significant for our work. Therefore, in the experimental and control groups, there did not exist an indicator which would indicate a parasitic influence of this factor.

Conclusion

On the basis of the research results we arrived at a conclusion that heuristic instructions influenced the development of metacognitive learning components in the experimental group, and that these pupils had a better developed learning strategies which referred to self-inquiry, answer comparison, finding new solutions, connecting the new content with previous experience and learned content, singling out the main concepts and ideas, using additional information. The triad learning process was in the center of attention, i.e. the question whether, starting from the learning plan, continuing to the monitoring of one's own learning process, and to the self-evaluation and elaboration of the completed work, it is possible to

influence the development of the learners' meta-components, i.e. the frequency number of meta-statements. Theoretical analysis of the papers which we used as guidance in our research indicated a dependent relationship between heuristic instructions and two aspects of metacognitive knowledge – declarative and procedural. In the same way, the triarhic intelligence theory lead to our expectations in the direction of developing metacognitive learning strategies in pupils who were exposed to heuristic instruction methods. The gathered results on the basis of this research confirmed our assumption that pupils who were exposed to the influence of heuristic methodological instructions, operationalized through discovery learning, the problem method, interactive work, self-evaluation and introspection of one's work, would show a higher level of metacognitive strategy development. These expectations were confirmed on two levels of learning – during and after the process of learning. However, in the part which referred to the planning of learning our assumptions were not confirmed, which we have seen on the basis of the results in the category of questions which referred to the making of a learning plan.

The absence of a statistically significant difference in the results of the control and experimental groups, when making of learning plans is in question, was viewed from two aspects and compared with the theoretical analysis of other authors. This question will remain open for other studies, where we will attempt to define solutions and find answers which would direct us towards finding those heuristic instructions which would make this learning segment more developed, i.e. meta-components which would refer to the pre-learning stage.

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