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METACOGNITIVE AWARENESS OF SCIENCE ORIENTED STUDENTS IN REPUBLIC OF SERBIA

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ABSTRACT: This paper presents an analysis of science oriented students' metacognitive awareness. Research sample consists of about 200 students of both genders that have enrolled in science oriented department in one of four Grammar schools in Novi Sad. Students enrolling Grammar school in Serbia are mainly 15 years old girls and boys. For the need of this research, the questionnaire (that included Metacognitive Awareness Inventory - MAI) was constructed. According to the first framework given by Flavell (1971), metacognitive awareness can be categorized into awareness of: metacognitive knowledge, metacognitive regulation and metacognitive experiences. Knowledge of cognition usually includes three different kinds of metacognitive awareness: declarative knowledge, procedural knowledge and conditional (strategic) knowledge. Regulation of cognition refers to awareness of the need to use certain strategies, such as planning, information management, monitoring, evaluation and debugging in process of thinking and learning. The students, who conceive the experiments (scientific method) in teaching physics helpful for their understanding of the physics contents, have shown higher level of metacognitive awareness. The same could be concluded for the students who are writing down in a notebook the performed experiments (procedure, explanation, conclusions...) and the students who understand experiments and their explanations. If metacognition is defined as the knowledge and control over children's own thinking and learning activities, it is very obvious that metacognition have great impact on learning process.

Key words: physics, science, metacognition, metacognitive awareness

INTRODUCTION

Important problem in teaching science is how to make students think on their own and acquire applicable long-lasting knowledge. Also it is very important to prepare students for lifelong learning. In order to achieve those goals the quality of science teaching must be improved. Contemporary teaching methods enable active participation of the learners in the teaching process, as well as improving the quality of science teaching (Obadovic et al., 2013; Obadovic et al., 2012). There are different ways for improving teaching/learning process. One of factors that influence learning is students' metacognition. High level of students' metacognitive abilities allows students to learn efficiently and to learn in everyday life, not only in school, also, to gain applicable knowledge.

In this paper the analysis of science oriented students' metacognitive awareness and a relation between different aspects of implementation of simple experiments in physics teaching and the level of students' metacognition are discussed

METACOGNITION

Henry Brooks Adams stated, "They know enough who know how to learn". In order to learn how to learn it is

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very useful to understand the concept of metacognition. It deals with questions related to the development of cognitive and affective area; also it can improve understanding and analysis in all areas where the process of self-regulation is included. Metacognition has been subject of studies conducted by many authors since the seventies of the twentieth century. The first study was conducted on metamemory (Flavell & Wellman, 1977). John Flavell (1979) was the first who had used the term metamemory. Later the term metacognition was used with meaning "knowledge and cognition about cognitive phenomena," or simpler "thinking about thinking", "knowledge about knowledge". Concept of metacognition is attributed with different meanings. Most researchers believe that metacognition refers to one's thinking process, monitoring and control of thinking.
Metacognition can be defined as the knowledge and control that children have over their own thinking and learning activities (Cross and Paris, 1988). Kuhn and Dean (2004) gave definition that it is awareness and management of one's own thought. Martinez (2006) declares that metacogniton refers to the monitoring and control of thought. The general understanding of metacognition is that it is activity of monitoring and controlling one's cognition (Weinert & Kluwe, 1987).

According to first framework given by Flavell, metacognitive awareness can be categorized into awareness of:
1. metacognitive knowledge,
2. metacognitive regulation and
3. metacognitive experiences.

Metacognitive knowledge (knowledge of cognition) includes three different kinds of metacognitive awareness:
1. declarative knowledge,
2. procedural knowledge and
3. conditional (strategic) knowledge.

These kinds of metacognitive awareness cover how to do something; skills, strategies and resources required to perform the task (knowledge of how to perform something); and knowledge of when to apply certain strategy, respectively.

Regulation of cognition refers to awareness of the need to use certain strategies, such as (Schraw & Dennison, 1994, Schraw & Moshman, 1995):
1. planning – planning, goal setting, and allocating resources prior to learning,
2. information management – skills and strategy sequences used to process information more efficiently (e.g., organizing, elaborating, summarizing, selective focusing),
3. monitoring – assessment of one's learning or strategy use,
4. debugging in process of thinking and learning – strategies used to correct comprehension and performance errors and
5. evaluation – analysis of performance and strategy effectiveness after a learning episode.

Metacognitive experiences are manifestations of the online monitoring of cognition as the person comes across a task and processes the information related to it. They are the interface between the person and the task. They comprise metacognitive feelings, metacognitive judgments/estimates, and task-specific knowledge (Efklides 2001, 2006)

Metacognitive experiences are for example:
1. feeling-of-knowing,
2. judgments-of-learning and
3. ease-of-learning judgments.

Metacognitive experiences can have influence on students' motivation. If student believe that he/she is able to learn something easily it will make them more willing to learn it. Also feeling-of-knowing can make student self confident…

RESEARCH METHODOLOGY

Research aim was to analyze science oriented students' metacognitive awareness and a relation between different aspects of implementation of simple experiments in physics teaching and the level of students' metacognition.

A research hypothesis was that some aspects of implementation of experiments (demonstrative experiments, simple "Hands-on" experiments) help in developing different metacognitive level.

Research sample consisted of 203 students of both genders that have enrolled in science oriented department in one of four Grammar schools in Novi Sad.

Appropriate questionnaire was constructed, part of it included Metacognitive Awareness Inventory – MAI. In questionnaire students answered on general questions and on questions about teaching physics. They were asked about carried out experiments in physics class. MAI questionnaire is intended to assess metacognitive skills of adolescents and adults and contains items that examine each of the eight components: knowledge of cognitive processes (declarative, procedural and conditional) and regulation of cognitive processes (planning, information management, monitoring, evaluation and debugging in thinking process). MAI is constructed in the early nineties (Schraw & Dennison, 1994). The scale of the instrument has satisfactory validity (accuracy) and reliability, the Cronbach alpha coefficient is 0.90. Of the 52 items with five-point response Likert scale of MAI 32 items appropriate for the selected sample were retained and adjusted. The choice of items was made based on the capabilities of students to understand the items that constitute the scale, which was tested by pilot survey, and based on example of the survey about the children's awareness of metacognition that is proposed for children aged less than 14 years (Junior Metacognitive Awareness Inventory - Jr. MAI; Sperling, Howard, Miller, & Murphy, 2002). Examples of used items:

I ask myself periodically if I am meeting my goals.
I try to use strategies that have worked in the past.
I pace myself while learning in order to have enough time.
I know how well I did once I finish a test.
I slow down when I encounter important information.

Students had one school our to complete questionnaire.
The obtained results were treated statistically.

RESULTS AND FINDINGS

Descriptive statistic of variable students' metacognitive awareness is given in Table 1.

Table 1. Descriptive Statistic of Variable Students' Metacognitive Awareness

Total number	189
Mean	125.376
Median	124.0
Mode	123.0
Standard deviation	12.3198
Variance	9.82634%
Minimum	98.0
Maximum	150.0
Range	52.0
Standardised skewness	-0.143915
Standardised kurtosis	-1.57919

Because of incomplete questionnaires there total number of 189 answered questionnaires was obtained. Mean score was 125.376 (maximum possible sum score was 160). Minimal achieved score was 98 and maximum was 150. Values of standardised skewness and standardised kurtosis indicate that variable *students' metacognitive awareness* has normal distribution.

In analysis of results, Mann-Whitney U Test is performed in order to determine is there statistically significant difference in students' metagognitive level regarding to different aspects of implementation of simple experiments in teaching physics. It is shown that statistically significant difference between the students' metacognition exists regarding to some, but not all, aspects of implementation of simple experiments in teaching physics. It is shown that there is no statistically significant difference in metagognitive level of students whose teacher has performed demonstrative experiments in Physics class. Also, there is no statistically significant difference in metagognitive level of students who performed demonstrative experiments on their own. Different matacognitive levels have shown students that carried out experiments in steps of scientific method and those who did not carry out experiments that way. Students who carried out experiments in steps of scientific method have shown higher matacognitive level. Different matacognitive levels have shown students that answer differently to questions:

Were experiments and their explanations clear?
Were experiments helpful for your understanding of the physics contents?
Did you write down in a notebook the performed experiments (the procedure, explanation...)?

Higher matacognitive level have shown students who understand experiments and their explanations and they who are opinion that experiments in teaching physics (implemented through scientific method) were helpful for their understanding of the physics contents. Also, higher matacognitive level has shown students who are writing down in a notebook the performed experiments (the procedure, explanation...).

CONCLUSION

Metacognition enables students to solve new problem by retrieving and deploying strategy that they have learned regarding to similar context. Metacognition is important for working on cognitive styles and learning strategies. Metacognition implies that the individual has some awareness of his/her thinking or learning processes. Students' metacognitive awareness is very important in effective physics teaching/learning process. Experiments help in improving scientific knowledge and students' motivation. In order to improve students' metacognition it is not enough that teachers choose adequate experiments. Since there is difference between the students' metacognition regarding to some aspects of implementation of scientific method as teaching method it can be proposed that teachers pay more attention on their instructions and way of carrying out experiments.

Results of this research imply that similar researches are necessary in order to better understand relations between the use of experiments in Physics classroom and students' metacognition and that is of great importance in order to improve teaching science.

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