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FOSTERING PRIMARY SCHOOL STUDENTS' METACOGNITION USING PROJECT-BASED LEARNING

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ABSTRACT: Primary school students have difficulties in understanding the physical content due to insufficiently developed abstract reasoning skills and metacognition. Metacognition refers to the processes used to plan, monitor, and assess one's understanding and performance. It is "cognition about cognition", "thinking about thinking", or "knowing about knowing". Metacognition includes a critical awareness of one's thinking and learning, as well as awareness of oneself as a thinker and learner. There are three distinctive components of metacognition: (1) metacognitive knowledge, (2) metacognitive regulation and (3) metacognitive experiences. Since metacognition includes knowledge about when and how to use particular strategies for learning or for problem solving it is very important in learning physics. Project Based Learning can help fostering primary school students' metacognition. Project Based Learning enables students to gain knowledge and skills by investigating and responding to challenging question or problem. Since the projects are focused on student learning goals, including skills such as critical thinking, problem solving and self-management, while working on projects students must use metacognitive activities. Also project design includes that students make decisions how they work on a project and they reflect on learning, the effectiveness of their inquiry and project activities; they discuss the quality of their work, obstacles and how to overcome them. Because of that students benefit in respect of mentioned metacognitive components by the use of project-based learning.

Keywords: metacognition, physics, project-based learning, primary school

INTRODUCTION

Abstract reasoning skills are important for understanding physics contents. A student who has developed good abstract reasoning skills easily uses symbols instead of concrete objects when learning new information unlike the beginning learner who usually needs concrete aids. For example in mathematics, to represent the number "five" the teacher or child might put out five blocks. A child who has made the shift to abstract reasoning understands the concept of "quantity" without relying on objects. So in mathematics, abstract reasoning enables the child to understand that the abstract character "5" might stand for five of any specific object or just the numerical idea of five. Abstract thinking is necessary in physics as well. Physics uses mathematics for solving problems; also, various symbols are used in physics and physics deals not only with classic laws applicable in everyday life but with abstract ideas as well (quantum physics, relativistic physics and similar). Metacognition is related to abstract reasoning performance (Williams & Jones, 1997). Ackerman and Thompson (2014) have developed a framework for understanding metacognitive processes in the context of reasoning. They used the phrase "meta-reasoning" to refer to the processes that monitor and control reasoning, problem solving and decision-making. Also, metacognition enables students to learn efficiently, think on their own and acquire applicable long-lasting knowledge.

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Contemporary teaching methods enable active participation of the learners in the teaching process, as well as improving the quality of science teaching and fostering students' metacognition (Obadovic et al., 2013; Obadovic et al., 2012).

In this paper the idea of using project-based learning for fostering primary school students' metacognition is discussed.

METACOGNITION

Understanding the concept of metacognition is very useful in order to learn how to learn. Metacognition refers to the processes used to plan, monitor, and assess one's understanding and performance. It is "knowledge and cognition about cognitive phenomena," or simpler "thinking about thinking", "knowledge about knowledge" (Cross and Paris, 1988, Kuhn and Dean, 2004, Martinez, 2006).

Metacognitive awareness can be categorized into awareness of: (1) metacognitive knowledge, (2) metacognitive regulation and (3) metacognitive experiences. Metacognitive knowledge (knowledge of cognition) includes: (1) declarative knowledge - how to do something, (2) procedural knowledge - skills, strategies and resources required to perform the task (knowledge of how to perform something) and (3) conditional (strategic) knowledge - when to apply certain strategy. Regulation of cognition refers to awareness of the need to use certain strategies (Schraw & Dennison, 1994, Schraw & Moshman, 1995): planning, information management, monitoring, debugging and evaluation. Metacognitive experiences comprise metacognitive feelings, metacognitive judgments/estimates, and task-specific knowledge (Efklides 2006), for example feeling-of-knowing, judgments-of-learning…

PROJECT-BASED LEARNING

Project-based learning is a dynamic approach to teaching in which students explore real problems and challenges in the everyday world outside the classroom. Project Based Learning engages students' interest and motivation and students are inspired to obtain a deeper knowledge of the subjects they're studying. A well-designed project provokes students to teach content and develop communication and presentation skills, organization and time management skills, research and inquiry skills, self-assessment and reflection skills, and group participation and leadership skills. While working on project students reflect upon their own ideas and opinions, make decisions that affect project outcomes and the learning process in general. Usually project is realized by group of students working together toward a common goal. Evaluation is on an individual basis and takes into account the quality of project realization, the depth of content understanding demonstrated, and the contributions made to the project realization.

Project can be broken down in the following steps:
- Teacher introduces students with real-life problems and they formulate the theme of project they will be doing.
- Students take on the role of project designers.
- Students discuss and accumulate the background information needed for their designs.
- Students accumulate the materials necessary for the project.
- Students create their projects.
- Students prepare to present their projects.
- Students present their projects.
- Students reflect on the process and with teacher they evaluate the projects.

In Project-based learning phases that teacher should assess are following:
1. Project launch
- Do students understand the project?
- Do students "need to know" core content and concepts? Do they know it?
- Do students know the first benchmark and have a clear "next step"?
2. Early phase
- Are students on good direction; are they researching the right things?
- Have the students teams become organized with roles and assigned tasks?
- Is each team member engaged and contributing?
3. Middle phase
- Are students learning and understanding the material they are researching and the variables to consider in their solution?
- Are students making the connections between their research and the project?
- Are teams working effectively with clarity of next steps?

4. Late phase
- Are students evaluating their work?
- Have students mastered the content and apply it both in and outside of the project?

5. Culminating event
- Did students accurately apply the key knowledge and thinking to realize the project?
- Were students able to effectively communicate the elements of their project?
- Did the team collaborate effectively?

USING PHYSICS PROJECTS FOR FOSTERING PRIMARY SCHOOL STUDENTS' METACOGNITION

Project Based Learning enables students to gain knowledge and skills by investigating and responding to challenging question or problem. Since the projects are focused on student learning goals, including skills such as critical thinking, problem solving and self-management, while working on projects students must use metacognitive activities. Also project design includes that students make decisions how they work on a project and they reflect on learning, the effectiveness of their inquiry and project activities; they discuss the quality of their work, obstacles and how to overcome them. Because of that students benefit in respect of mentioned metacognitive components by the use of project-based learning.

It is proposed that during the realization of projects students use instructions (questions) given on the instructional sheet. Following proposal of questions can be given based on the checklists of questions for encouraging metacognition (Schraw, 1998; Miščević, 2006):

• What is my goal?
• What do I have to do?
• What types of information and strategies I need?
• How much time will I need?
• Is everything clear to me?
• What data do I know?
• What details are irrelevant?
• What similar real-life examples I know?
• What materials do I need?
• What should I be aware of during the experiment?
• What do I think will happen?
• Are my assumptions correct?
• Did I achieve my goal?
• Do I need to change something?
• Can the problem be solved in an easier way?
• What was not successful?
• What was successful?

With proposed questions physics project will fostering students' metacognition.

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 learning physics. The paper points out the significance of mini-projects in order to encourage students' metacognition.

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