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Effectiveness of Project-Based Learning Models In Improving The Metacognition Ability Of Elementary School Students

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Abstract:

This study explains the effectiveness of project-based learning models in improving metacognition abilities of elementary school students and explains students' responses to learning experiences using these models for their metalogical abilities. This research is mixed-method research with explanatory sequential design. The participants of this study were 78 students who were divided into experimental and control groups. This research data was collected using quantitative and qualitative approaches. Quantitative data were collected using descriptive tests and qualitative data were collected using interviews. The results showed that the students' metacognition abilities had significantly improved through project-based learning ($p < 0.05$). Qualitative findings also show that with project-based learning they can easily understand lessons, solve problems using strategies, and evaluate problem-solving plans properly. The results of this study contribute to the field of curriculum design and education practitioners to correct disparities in the quality of education and enhance students' metacognition abilities effectively.

Introduction

Thinking skills are an important goal and focus of education in all countries of the world. (Zohar & David, 2009; Brinkley, M., 2012; Griffin, P., Mc Gaw, B., Care, 2012; Kivunja, 2014; Morocco, et. Al., 2008). The thinking skills in question are higher-order thinking skills (Ennis, 1985; Tsaparlis & Papaphotis, 2009). Metacognitive thinking skills are one of the higher-level thinking skills that are an important focus of Education. (Nuryani, 2019; Herlambang, 2018; Thomas, 2012). Metacognition skills are one of the 21st-century skills that must be possessed by every individual because they can produce independent and creative students (Thomas, 2012; Margaret, 2002; Ya-Hui, 2012).

Metacognition is thought that is applied to thoughts (Wells, 2009). The understanding of metacognition can be interpreted as our ability to think about our thoughts. In other words, metacognition is a process of reflection on the thoughts that we have and keeps our pathways focused on the goals to be achieved (Vandergrift & Goh, 2012; Quirk, 2006; Kluwe, 1982; Aiken, 1982; Senomoglu, 2009). In addition to these various meanings, metacognition can also be interpreted as a person's knowledge of their ability to process information, as well as knowledge of thinking tasks, and about strategies for copying similar tasks. In other words, metacognition includes knowledge about learning strategies, assignments, and personal variables or knowledge about self (Flavell, 1979; Hendriani, 2019).

In general, metacognition experts argue that metacognition is the ability to think at a high level (Veenman, 2012; Pintich et al., 2000; Meijer et al., 2006). The ability of metacognition is an important ability that is owned by everyone. This is because of the ability of metacognition as the ability to construct meaningful knowledge. Metacognition ability is the ability to apply declarative, procedural, and conditional knowledge strategies to achieve goals, and overcome problems (Schunk, 2004; Bruning, et al, 2004; Cavanough & Perlmutter 1982). Essentially a declarative knowledge strategy is an understanding constructed from integrating new ideas with existing knowledge. Also, further knowledge is procedural knowledge (how to carry out various cognitive activities), and conditional knowledge (knowing when and why to apply what they know). In other words, metacognitive thinking skills enable students to understand the strategies needed to understand what is seen, heard, and felt (Abidin, 2016).

The ability of metacognition is closely related to the constructivism approach. This is in line with Joyce, Weil & Calhoun (2011, p. 15) which revealed that metacognition is related to constructivism in that many effective learners are increasingly aware of how they learn; they develop devices and observe progress. In line with the above opinion, Anderson & Krathwohl (2014) argues that the focus of meaningful learning is by the view that learning is constructing knowledge. about this conception, Bransford et al (in Abidin 2016, p. 188) state that metacognitive

knowledge is needed in studying each discipline, but its application will vary according to the knowledge structure and content of the discipline.

Metacognition functions as a set of self-instructions to regulate task performance, whereas cognition is a precondition for enabling self-instruction (Sternberg, 1990). There is a correlation between metacognition and cognition (Veenman et al., 2004; Veenman and Spaans, 2005). In practice, cognition focuses on problem-solving, while metacognition focuses more on the problem-solving process, knowledge of how to use thinking and strategies, knowledge of one's learning capacity, and the types of strategies to be used (Weinert & Kluwe, 1987).

Metacognition, in a broader sense, includes basic individual knowledge to recognize basic knowledge related to various cognitive tasks and knowledge of strategies in completing various cognitive tasks by practicing good planning, providing alternative solutions, analyzing, synthesizing, and evaluating problems and applying the strategy used (Tosun & Senocak, 2013; Muhali, 2018; McCormick, 2003; Lai, 2011).

Metacognitive thinking skills are essential skills so that metacognitive thinking skills need to be developed. Metacognitive thinking is an important component in the contemporary education system. In contemporary education, learning that can develop thinking skills, encourage students to be active, creative, independent, and learning-oriented to problem-solving can help students to have multicompetence and skills (Akdere, 2012).

Given the importance of metacognitive thinking skills, it is necessary to do an innovative teaching and learning process that can develop students' metacognitive thinking skills. One way that can be done to develop metacognition skills of elementary school students is to apply innovative learning models. The innovative learning model applied must be a learning model that implements learning steps that encourage students to be active, creative, problem-solving, and encourage students to innovate. One learning model that can develop students' thinking skills and encourage students to be active, creative, problem-solving and critical thinking is project-based.

Project-based learning is a learning model that can empower students to acquire new knowledge, understanding, and skills based on learning activities undertaken (Klein, et.al., 2016; Jones, Ray, Petrie, & Maurell, 2018). The project-based learning model has several advantages including the practice of learning, students are given the freedom to plan learning activities, determine the projects to be made, implement projects collaboratively which will ultimately produce work products (Muliana, Maryani, & Somantri, 2018; Morales, Castillo, Parrilla, García, & Otín, 2015).

In addition to the above advantages, in the learning process, this project-based learning model uses problems as the first stage in exploring students' knowledge

and experiences. of these problems, students conduct inquiry activities to find solutions to problems until students find solutions in the form of products or tools to solve these problems (Sari, Prasetyo, & Wibowo, 2017; Bas & Beyhab, 2017; Mutmainah, 2016; Arshad et al., 2020; Al-Kumaim et al., 2021; Ashraf et al., 2020; Rochman & Majid, 2014). Furthermore, this project-based learning also uses the project as a means to develop aspects of knowledge, attitudes, and skills to be achieved. The project created is certainly a solution to the problem solving that has been investigated (Duffield & Whitty, 2015). Learning activities that provide opportunities to students as widely as possible to determine the problem, explore, investigate, solve problems, and make projects able to develop students' thinking abilities, and creativity (Alharbi, Athauda, & Chiong, 2018; Alafouzou, Lamprinou, & Paraskeva, 2018; Abbas et al., 2020; Abbasi et al., 2020). With some of the advantages of the project-based learning model, it is hoped that it can develop the ecological literacy ability of elementary school students so that environmental problems and challenges can be overcome because of primary-school-age children already have knowledge, awareness, and responsibility towards the environment.

Research on metacognition has been done by several researchers before, but metacognition research is still very rarely done, especially in Indonesia at the elementary school level. Therefore, researchers try to explore how the metacognition abilities of elementary school students in Indonesia.

Method

The research method used in this study is a mixed-methods research method with the type of explanatory sequential design. Mixed methods research is a research model that is applied when researchers have questions that need to be tested in terms of outcomes and processes and involve a combination of quantitative and qualitative approaches in one study to improve the overall pattern (Creswell & Plano Clark, 2011). In a quantitative approach, this study uses a quasi-experimental method with the type of matching pretest-posttest control group design. For a qualitative approach this research uses a case study.

Research Subjects

The subjects of this study were elementary school students in Bandung Regency. A total of 78 grade 5 elementary school students were the subjects of this study. The research subjects were divided into experimental and control groups. Taking the subject of this study was chosen by non-random sampling.

Research Instruments

This research instrument uses a test in the form of a description item to measure students' metacognition abilities, an assessment process in the form of

rubric scoring, interview guidelines, and field notes. The instrument is used to determine the effectiveness of project-based learning models in improving students 'metacognition abilities and explaining students' responses to learning experiences using these models.

The instrument used in this study was validated by 3 experts and the instrument was tested for validity and reliability so it was suitable for use. Indicators of metacognition abilities measured in this study refer to Printrich, et al. (2000) namely (1) knowledge of cognition (KC); (2) monitoring of cognition (MC); (3) regulation of cognition (RC). While the interview question instrument to find students 'views on learning experiences using a project-based learning model created 15 questions to explore students' responses to the learning process undertaken.

Data Collection and Analysis Methods.

Data in this study will be collected through several data collection methods. Quantitative data collection was carried out through a 10-question description test that measured students' metacognition abilities. Then the qualitative data collection is done through interviews and field notes to find student learning experiences that help students improve their metalogical abilities. Quantitative data analysis of this study used statistical tests. Kolmogorov-Smirnov test results of pre-test and post-test data of students who participated in this study were normally distributed (p>. 05). After the normality test, the data were tested for homogeneity using one way ANOVA, and the results were homogeneous. Because both the data are normal and the homogeneous test independent sample test is used to see the difference.

Qualitative data analysis of this research uses content analysis because the research data is in the form of semi-structured interviews. Content analysis is a systematic and reproducible technique where the desired message is identified and conclusions are reached using coding that is carried out according to certain rules (Büyüköztürk, Akakak, Akgün, Karadeniz & Demirel, 2009). Content analysis is used to find concepts and relationships that can explain the data collected, and the analysis is carried out in 4 steps: (1) Data coding; (2) Finding themes; (3) Manage codes and themes; (4) Define and interpret findings (Yıldırım & Şimşek, 2006). To ensure the reliability of qualitative data in this study, two procedures were carried out. First, data that can be represented in each category is quoted directly without comment. Second, expert opinion is sought to determine whether the statement represents the category in question. The identification and interpretation of findings are carried out together with the results of quantitative analysis.

Result and Discussion

Result

In this section, the pretest results of the experimental and control groups are explained. It aims to find out how the initial ability of the metacognition abilities of elementary school students before being given treatment. The following are the results of the pretest in the experimental group and the control group as follows.

Comparison of Pre test Results

Table 1
Summary of the findings

N	Groups	Mean	Mean Difference	Std. Deviation	Normality Test (p-value)	Homogenity Test (p-value)	Independen Sample Test (p-value)
40	Experiment	39.5	0.63	11.124	0.119	0.516	0.820
38	Control Group	40.13		10.040	0.174		

Table 1 shows that the students' metacognition abilities before being given treatment were not significantly different. This is evident from the results of the independent sample test that shows ($p<.05$). The difference between the two groups was 0.63. To see the impact of the treatment given to students then, it can be seen in Table 2 below that is as follows.

Comparison of Post test Results

Table 2
Summary of the findings

N	Groups	Mean	Mean Difference	Std. Deviation	Normality Test (p-value)	Homogenity Test (p-value)	Independen Sample Test (p-value)
40	Experiment	85	7.81	10.197	0.100	0.355	0.002
38	Control Group	77.19		11.734	0.267		

Table 2 shows that there are differences in students' metacognition abilities between the experimental and control groups. This is evident from the average posttest score in the experimental group by 85 while the average value of the control group by 77.19. The difference in the mean scores of the two groups was

7.81. The results of independent sample tests revealed that the significance value was 0.002<0.05.

From table 2 above shows that the increase in the ability of metacognition in the experimental group was higher than the control group. This means that the project-based learning model has a significant and effective impact on improving the metacognition abilities of elementary school students. To find out how much an increase in students' metacognition abilities based on each indicator of their metalogical abilities, the researchers present in the following table.

Table 3. Pretest and posttest results based on indicators of metacognition abilities in all groups

Group	N	Score	Mean of Metacognition Indicators		
			Knowledge of cognition	monitoring of cognition	regulation of cognition
Experimen	40	Pretest	38.7	39.3	40.6
		Posttest	86.2	84.3	84.3
Control	38	Pretest	38.4	42.7	38.1
		Posttest	78.9	74.3	78.2

Based on table 3, it is known that the experimental group that applied project-based learning increased from each indicator of its metacognitive ability. The increase in students' metacognition abilities of each indicator in the experimental group was greater than the increase in metacognition abilities in the control group. This shows that project-based learning has a large and effective impact on improving the metacognition abilities of elementary school students.

Comparison of Pre test and Post test Results

Table 4

Summary of the findings

N	Groups	Mean	Mean Difference	Std. Deviation	Normality Test (p-value)	Homogenity Test (p-value)	Paired sample test (p-value)
40	Pretest	39.5	45.42	11.124	0.119	0.381	0.00
38	Posttest	85		10.197	0.100		

Table 4 shows the results of the pretest-posttest metacognition ability of elementary school students in the experimental group. From table 4 it is known that the average score of students pretest was 39.5 while the average score of the posttest was 85. The difference in the average score of the pretest and posttest was 45.42. The average difference is very large. Paired sample test results also showed that the

significance value was 0.00<0.05 meaning that there were differences in students' metacognition abilities between before and after treatment.

From the explanation above, it can be concluded that the metacognition ability of elementary school students has increased significantly after being treated using a project-based learning model. To see how students respond to the learning process that has been carried out to complete quantitative data, the researchers present a description of the results of interviews with students as follows.

Table 5. Students' views of learning experiences using project-based models

No	Category	Opinions	Field note
1	Initial activity	At the beginning of learning, we were amazed by the teacher's explanation that inspired us about world leaders who created technology that could be useful for humans.	Students enthusiastically listened to the teacher's explanation and saw the video that the teacher displayed.
2	Core activities:		
	Determination of fundamental questions	We are very happy when we are assigned to make basic questions because I can learn what I need.	Students seriously make and determine the fundamental questions they want to investigate further.
	Develop project planning	This project planning activity trains us to think in an orderly and good manner because the project plans we make will be implemented. This activity is good for us.	Students discuss in an orderly manner with a group of friends to plan a project to be implemented.
	Arrange a schedule	Scheduling activities train us to think carefully and thoroughly so that project activities can run smoothly.	Students earnestly arrange schedules in an orderly manner.
	Carry out the project	Activities make this project very fun because we carry out activities according to what we want and what we want to know. This activity encouraged us to think better and be careful.	Students look enthusiastic and enthusiastic in carrying out project activities.
	Monitor project progress	Activity monitoring project progress is very good for us because it can train us to think carefully and work better so that the project is completed according to the planned schedule.	Students carefully check the progress of the project made and evaluate its performance.
	Evaluation of results	The activity of evaluating the results of this project made us confused because we felt the project had been made quite well. But we were helped by the guidance given by the teacher. This activity trains us to think objectively in assessing things.	Students with little hesitation judge the results of the project.
	Experience Evaluation	Experience evaluation activities make this project train us to think carefully because we are assigned to find our shortcomings in making projects.	Students look confused in making experience evaluations.
3	Final activity	At the end of the lesson, the teacher's explanation makes us aware and we become motivated to think and work even better in doing something.	Students seriously listen to the teacher's explanation.

Discussion

Based on the results of the study, there are interesting findings. The findings from this experimental study revealed that students who learn by using the stages of a project-based learning model have better metacognitive thinking skills than students who learn using traditional models. There was a significant difference in the average test results of students' metacognition abilities between the experimental group and the control group at the end of the test. This shows that the project-based learning model has a significant impact on improving students' metacognition abilities.

Project-based learning is a holistic approach to the design of learning environments. The project-based learning model is also a learning model that is directed at project work that fights for constructivist principles that are designed to provide learning experiences for students and train students' thinking skills in solving problems using effective ways through products made by students. Such learning can develop students' metacognitive abilities because students are trained in how to effectively solve problems.

The project-based learning model can improve students' metacognition abilities because in the learning process students are required to compile a project that requires effective and careful thinking activities. This is in line with the results of interviews with students that "when learning to use a project-based model allows us to think better, we must think quickly and thoroughly so that the projects we make are successful and timely." (K4) In line with this explanation, the project-based learning model can improve the metacognition abilities of elementary school students because it provides a learning environment that encourages students to think effectively and efficiently. Besides, it also encourages students to learn to solve problems using strategies (Muliana, Maryani, & Somantri, 2018; Morales, Castillo, Parrilla, García, & Otín, 2015).

The stages of learning a project-based learning model can improve students' metacognition abilities and increase student motivation. This is because in the learning process students are given the freedom to plan learning activities by the problem to be solved, determine the project to be made, carry out the project collaboratively which will ultimately produce a product. These activities will encourage students to have responsibility for the tasks that must be completed. Also, such learning activities can provide meaningful learning experiences because in the learning process students are allowed to carry out problem-solving, analysis, research, and work creation activities. This is consistent with the results of interviews with students that "project-based learning encourages us to determine the fundamental questions according to what we want to know. This makes us happy and we are enthusiastic about completing assignments given by the teacher because it matches what we need. " (K15)

In addition to the explanation above, another thing that makes the metacognition ability of students has increased is that the project-based learning model uses problems as the first stage in exploring students' knowledge and experiences. From these problems, students conduct inquiry activities to find solutions to problems until students find effective solutions in the form of products or tools to solve these problems. Learning activities such as these can support the development of students' metacognition abilities (Sari, Prasetyo, & Wibowo, 2017; Bas & Beyhab, 2017; Mutmainah, 2016; Rochman & Majid, 2014).

Furthermore, this project-based learning also uses the project as a means to develop aspects of knowledge, attitudes, and skills to be achieved. The project created is certainly a solution to the problem solving that has been investigated (Duffield & Whitty, 2015). Learning activities that provide opportunities to students as widely as possible to determine problems, explore, investigate, solve problems, and make projects able to develop students' metacognition abilities and creativity (Alharbi, Athauda, & Chiong, 2018; Alafouzou, Lamprinou, & Paraskeva, 2018).

Conclusion

The project-based learning model has a positive impact on developing students' metacognition abilities. The average value of students before being given treatment was 39.5 while the average value of students after being given treatment was 85. The results of the mean difference test using paired sample test also showed that the value of sig = 0.002<0.05 meant that there were a significant difference in metacognition abilities elementary school students between before and after being given treatment. The findings from the interviews also show that students are interested and happy to learn using a project-based model. This is because project-based learning can train students to think quickly, thoroughly, and in an orderly manner so that the problem-solving process and makes the project run well and smoothly.

From the explanation above shows that the project-based learning model is effective in improving the metacognition abilities of elementary school students. Project-based learning can be used as an alternative learning model in improving 21st-century students' skills, especially metacognition abilities.

Project-based learning models have implications including increasing student activity, enriching student experience, developing thinking skills, and increasing student motivation in learning. This is because the project-based learning model uses a multimodal concept so that learning is more fun for students.

The recommendations proposed by researchers in this study are to improve the quality of Indonesian education in particular improving the students' metacognition abilities. Researchers recommend to the principal and related parties to carry out learning by what students need and give students the broadest opportunity to explore, analyze, and conduct investigations and create works so that students have meaningful experiences.

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