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Implementation of the Stem Learning Approach in Physical Education in The Process of Student Cognition Development

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ABSTRACT

In the 21st Century, students have to be able to think critically in solving problems of everyday life by way of scientific and normative thinking. It aligns with the STEM learning approach, which integrates four disciplines: Science, Technology, Engineering, and Mathematics. This study aimed to determine the impact of implementing the STEM learning approach in physical education on the development of students' cognitive processes at Lab school UPI Junior High School. The research method used is quasi-experimental, using pre-test and post-test designs. Forty-eight students participated. This study used the Cognitive Process Questionnaire in Physical Education (CPQPE) instrument, and the data were processed using SPSS. The results of this study are the probability value of the experimental group $.205 > .05$, which means that the STEM learning approach has no significant impact on the level of students' cognitive development.

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1. Introduction

Humans are unique living creatures. God gives humans more abilities to use the brain to think logically. Cognitive processes and intelligence help humans carry out their daily lives, and humans have logic in running their lives, unlike animals that only have instincts to survive (O'Callaghan et al., 2012). Intelligence, according to Piaget, is a psychological structure that exists at an extraordinary level of development. At the same time, cognition is a thought process or an individual's ability to relate, assess and consider a phenomenon.

Intelligence and cognitive processes are very relevant. Humans think and solve problems with their emotions and intelligence, and humans will also decide the pace and accuracy in solving problems depending on their respective intelligence and cognition (Acebes-Sánchez et al., 2019). However, the intelligence and cognition of every human being should be different. It can happen because of the difference in educational level, understanding level, and heredity.

In several studies that have been conducted, by having good intelligence and cognitive processes, students are expected to have 21st-century skills such as life skills (Saavedra & Opfer, 2012).

Due to differences in cognitive and intelligence levels, humans will not stop learning. It is not only about learning at school but also about learning in everyday life and from experience. Differences in thought processes will lead to diversity (Bybee, 2015), cultural diversity, opinions, and technological progress.

Unfortunately, according to data released by the Indonesian Ministry of Education and Culture in 2016, the quality of education in Indonesia is still not good. In 2015, Indonesia was in the 62nd position out of 72 countries (KEMENDIKBUD, 2016). This happens because education in Indonesia only applies memorization methods instead of the concept of learning (Firdaus & Rahayu, 2019). In the future, the challenges for education in Indonesia will certainly be more complex.

Humans in the 4.0 era have to think realistically and also normatively. Humans can create innovations but must remain by norms and, of course, according to human etiquette. In the era of digital technology, the way humans think is essential because the ultimate goal is that humans are expected to develop intelligence and cognitive abilities to think critically to solve problems in everyday life (Firdaus & Rahayu, 2019).

Many people think that physical education does not need good intelligence and cognitive because physical education is judged only to use psychomotor (Pahliwandari, 2016). However, physical education is a learning process that includes three aspects: cognitive, affective, and psychomotor (Tajamuki, 2016).

The development of intelligence and human cognitive processes can be influenced by all aspects, including aspects of physical education. Jorge Acebes-Sánchez's (2019) research states that physical education is essential in improving students' intelligence. For example, physical education allows students to face challenges, collaborate in teams, and compete with themselves (Ubago-Jiménez et al., 2019). In his article, Richard Bailey (2009) states that a "healthy body leads to a healthy mind," which can be interpreted that with a healthy body, a person will have a healthy mind as well. Increasing physical activity at school will cause several changes in the student body that can boost the development of cognitive processes such as increased blood flow in the brain, arousal, and stimulation of brain development (Shephard, 1997).

From the discussion above, one learning approach seems to fit the problem, namely the Science, Technology, Engineering, and Mathematics (STEM) learning approach, which is projected as an effort to revolutionize future learning. STEM is the integration of 4 fields,

namely Science, Technology, Engineering, and Mathematics. This learning approach aims to prepare students for the era of digital technology 4.0 because the STEM learning approach applies problem-solving-based learning with a scientific way of thinking (Wajciechowski & Hemphill, 2019).

The purpose of this STEM learning approach is that students graduate with the skills, attitudes, and knowledge needed to solve problems, collect and analyze evidence of issues and make relevant information. They also have to be serious in trying to achieve these goals. One is having a healthy body and mind (Erwin, 2017).

STEM is believed to have the potential for educational innovation that can harmonize contemporary education by providing direction and an essential component in education reform 4.0 (Bybee, p. 2, 2015). Many studies have stated that the STEM learning approach can improve students' academics (Barker, 2007), improve critical thinking skills, and solve problems (Fortus et al., 2005).

A study by Chuanxiao Li (2019) states that in 2015 the Hong Kong government incorporated the STEM learning approach into the school curriculum, including physical education. The STEM learning approach can provide more opportunities for integration and innovation in every subject, including physical education, in real life. Developing a STEM learning approach in physical education will reduce marginalization in physical education because physical education must be recognized as an academic subject and science, mathematics, and others (Johns, 1999).

In line with the above background, the research on the STEM Learning approach in Physical Education in the Process of Student Cognition Development was studied further.

2. Methods

The research method used is a quasi-experimental research design with a pre-test and post-test non-equivalent control group design, divided into two groups, namely the experimental and control groups. The group was chosen randomly. Determination of the sample is based on the same or equalized characteristics. That is based on the value of physical education that has been done previously by looking at the highest, lowest and average values.

The program was divided into 14 meetings. The first and last meetings were used for pre-test and post-test, the rest 12 meetings were used for implementing the STEM learning approach in the experiment group, and the control group made the conventional learning approach. Each class was conducted in 90 minutes, and it was held once a week. For every meeting, the class would have different materials.

2.1 Participant

The participants in this study were 8th-grade students of the UPI Lab school Junior High School who met the inclusion criteria and did not include the research exclusion criteria. The selection of research subjects is based on the following:

a. Inclusion criteria:

(1) Grade 8 students of Lab school UPI Junior High School

(2) Students are willing to take part in the research and have signed a letter of approval for the research

b. Exclusion criteria:

(1) Students other than 8th-grade Lab school UPI Junior High School

(2) Not present at the time the research was conducted

2.2 Population & Sample

This research was conducted at the UPI Lab school Junior High School. The population of this research is all 8th-grade students of Lab school UPI Junior High School, with ten female students each for the control and experiment groups and four male students each for the control and experiment groups.

2.3 Instrument

This study used the Cognitive Process Questionnaire in Physical Education (CPQPE) (Solmon & Lee, 1997). The CPQPE could be utilized with systematic observation to investigate relationships between students' cognitive processes and various teaching approaches or strategies at any student level. This instrument contains five main components in measuring the level of cognition: Self-Regulation, Confidence-Efficacy, Attention-Concentration, Willingness to Engage, and Strategy, divided into 33 question items that are asked using a Likert scale with a five-point scale range from 1 (very inappropriate) to 5 (very suitable) is suitable for all levels of students.

CPQPE has a high reliability value, namely Self-regulation (.87), Confidence-efficacy (.75), Attention concentration (.79), Willingness to engage (.72) and Strategy (.66).

The students filled out the questionnaire before and after the treatment in the Implementing of STEM learning approach research.

2.4 Data Analysis

This study performed data analysis using SPSS software to process the collected data. Data analysis includes univariate and bivariate analysis tests. The univariate analysis described students' cognition before and after the STEM learning method treatment. The second data analysis is a bivariate analysis used, namely the dependent t-test, to determine the difference between the students' pre-test and post-test averages. The hypotheses in this study for the dependent t-test are:

Ho: There is no difference in students' cognitive averages before and after giving the STEM learning approach in physical education activities.

Ha: There are differences in students' cognitive averages before and after giving the STEM learning approach in physical education activities.

3. Results and Discussion

From the table below, there are four types of descriptive statistics. The value of N is that there are 14 students in the experimental and control groups. In the pre-test value of the experimental group, the minimum value is 91, and the maximum value is 111, with an average of 100.14 and a standard deviation of 5.803.

In the post-test scores of the experimental group, the minimum value is 90, the maximum value is 118, with an average of 102.64, and the standard is 7.712.

While the value of the pre-test results for the control group is as follows, the minimum value is 96, and the maximum value is 121, with an average value of 101.57 and a standard deviation of 7.197.

And the results of the post-test control group showed that the minimum value is 91 and the maximum value is 109, with an average of 99.50 and a standard deviation of 5.544.

Table 1. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-Test Experiment	14	91	111	100.14	5.803
Post- Test Experiment	14	90	118	102.64	7.712
Pre- Test Control	14	96	121	101.57	7.197
Post- Test Control	14	91	109	99.50	5.544

From the table below, the experimental group Sig. is 0.205, which is more than 0.05 ($0.205 > 0.05$), and in the control group, the value of Sig. 0.118 which is more than 0.05 ($0.118 > 0.05$).

By the decision-making criteria, H_0 is accepted because the probability value of the experimental group is more than the alpha value, which means that there is no significant effect of the implementation of the STEM learning approach on the cognitive development process.

Table 2. Paired Samples Test

		Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Pair 1	Pre Test Experiment – Post Test Experiment	-2.500	7.003	1.872	-1.336	13	.205
Pair 2	Pre Test Control – Post Test Control	2.071	4.632	1.238	1.673	13	.118

4. Discussion

In implementing the STEM learning approach, knowing what goals must be achieved before starting the implementation is essential. The following are the goals proposed by Bybee (2015) in education based on the STEM learning approach:

1. Knowledge, attitudes, and skills to identify real-life questions and problems, as well as explain natural science and engineering and draw evidence-based conclusions from logical thinking related to STEM,
2. An understanding of the characteristic features of STEM disciplines as forms of knowledge, inquiry, and design,
3. Awareness of how STEM disciplines can shape a good intellectual and cultural environment,
4. Willingness to engage in STEM-related issues with the ideas of Science, Technology, Engineering, and Mathematics as a constructive, caring, and reflective citizen.

In physical education learning, the STEM learning approach is relatively new, and only a few countries apply this learning approach in physical education learning in their curricula, such as America, Australia, and the latest in Hong Kong (Li et al., 2019). The STEM learning approach is also considered effective in physical education learning. Because physical education also includes science, technology, engineering, and mathematics.

In science, students learn the importance of movement for the human body and health. For example, in learning physical education in junior high school, students must learn about physical activity in daily activities. In implementing the STEM learning approach, the teacher gives students the opportunity to analyze the importance of moving and living an active life, even if carrying out daily activities such as cleaning the room, house, washing dishes, washing cars, or motorbikes, etc. Then, students can analyze the cause and effect and impact on the body if they do not move. Learning can not be separated from learning about health and the human body in physical education. Therefore, the field of science in physical education is no less critical.

In technology, students apply physical activity in daily activities by making videos. In addition, students are also free to use media such as laptops or gadgets to edit and find references for activities that must be done to meet the assignments. In this digital era,

technological advances have facilitated humans. If students need additional references, they can look for ideas from several applications such as YouTube or other applications that can be easily installed on their devices. Another example is detecting changes in pulse rate and oxygen levels in the blood; stress management has become more accessible. It can be accessed through a smartwatch, and all body activities will be detected.

In engineering, students make assignments in modifying tools or media to facilitate their daily physical activities. For example, students create a tool to lift weights made of brooms and add a load of gallons filled with water on the edges. Another example is that students make balls from waste paper or plastic and use the balls to exercise at home.

Furthermore, students use mathematical concepts when calculating other students' movements, and students can use a speedometer to measure students basic skills. For example, students calculate the level of BMI (body mass index).

After implementing the research on the implementation of the STEM learning approach in the development of student's cognitive processes, from the results of the univariate test, it can be seen that students' cognitive levels before and after being given treatment are in the form of implementing the STEM learning approach in physical education. In the univariate test, it can be concluded that there are differences in the level of student cognition before and after being given treatment. This study shows no difference in students' cognitive averages before and after providing the STEM learning approach in physical education activities.

It happened due to several factors. In this pandemic era, researchers found several obstacles, such as the ineffectiveness of online learning. Physical education is learning that is more practical than theory. Online learning is not effective. Second, many students are less enthusiastic about learning by using an online learning system. For example, students are late for learning activities because of the network and forgetting the lesson schedule. The third is the lack of physical education learning time. In this online era, physical education learning time has been reduced. At the UPI Lab Junior High School, physical education learning is conducted only once in two weeks, with 90 minutes for each meeting. Fourth, the students' inconsistency in filling out the research questionnaire. At the same time, students have to fill out four types of research questionnaires with multiple questions, which can take 45 minutes to an hour. It is one of the most crucial factors because it makes students fill out questionnaires perfunctory, not being read and understood correctly. There are even some fillings with all the same answers. Fifth is the lack of teacher readiness in carrying out the STEM learning approach in physical education. In physical education, the STEM learning approach is still rarely applied. This learning approach has only been used in several studies in countries such as America, Australia, and Hong Kong. The STEM learning approach has not been applied to physical education subjects in Indonesia itself.

5. Conclusion

The STEM learning approach integrates four fields: Science, Technology, Engineering, and Mathematics. This learning approach is suitable to be applied in the 21st Century. In this study, the STEM learning approach was used in physical education learning at the UPI Lab school Junior High School to find the impact of the STEM learning approach in physical education on students' cognitive development. This study shows no impact of the STEM learning approach in physical education on students' cognitive development. It happened because of several factors, such as this research being conducted online, which was considered less effective in physical education learning, the student filled the questionnaire

with perfunctory, lack of student enthusiasm, lack of physical education lesson hours, and lack of teacher readiness in implementing the STEM learning approach in physical education.

Therefore, suggestions for further research are to provide training to physical education teachers regarding the STEM learning approach in physical education. As a result, physical education teachers can optimize this learning approach.

6. Authors' Note

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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