IDENTIFY USE OF EDP TO STRENGTHEN STUDENT'S CRITICAL THINKING ABILITY THROUGH LKS

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Abstract

LKS is a teaching material that is often used by teachers in the learning process. Teaching and learning science based on the Engineering Design Process can train thinking processes well. This study aims to determine how the role of EDP is to strengthen students' critical thinking skills. This type of research is qualitative research using a single case study approach. This research was conducted at SMAN Arjasa, Jember Regency with 6 students as participants. Data were collected by observation, interviews, and documentation. Data analysis used interactive model analysis by Miles and Huberman. The credibility test uses the triangulation technique and member check. The results of this study are the use of EDP in student worksheets provides the strengthening of students' critical thinking skills and the most support is at the define, learn, and plan stages. Meanwhile, at the try, test, and decide stages are the results of developing information that has been obtained in the previous stage but with consideration of joint decisions.

Keywords: *Critical Thinking, EDP, LKS*

1. INTRODUCTION

Physics subjects are closely related to natural phenomena that occur in everyday life with the aim of developing reasoning, analytical, inductive and deductive thinking skills using the concepts and principles of physics (Aini, 2018). Physics learning in the 2013 curriculum emphasizes students' critical thinking skills. The 2013 curriculum is integrated with the STEM (Science, Technology, Engineering, Mathematics) approach that can support students' skills (Murwianto, 2017). Indirectly, the application of STEM education requires teachers and students to think critically in learning activities. Critical thinking is a synthetic process that allows someone to formulate and evaluate their own opinion beliefs (Sutawidjaja, 2011).

Student Worksheets (LKS) are teaching materials in the form of sheets containing material, summaries, and instructions for implementing learning tasks that must be done by students, both theoretical / practical, and referring to the basic competencies that must be achieved (Prastowo, 2016). LKS is a teaching material that is often used by teachers in the learning process. Therefore, the use of student worksheets as a support for students' critical thinking skills to find their own thinking is one of the characteristics of critical thinking skills (Santoso, 2019).

Krajcik (2017) argues that the most important thing in STEM education is design. Involving students in STEM also means involving students in the design process. Design is an integral part of student thinking in the STEM world. Design is an ability that enables students to identify problems clearly, research what is known about the problem, generate solutions, and develop prototypes to show and share and receive feedback from other students regarding the design of these solutions. In the opinion of Henson (2004), some teachers are proven to do practical work while teaching science. However, not based on a constructivist and contextual approach where the emphasis is on increasing students' metacognition in facilitating their skills to solve problems that may not have been well developed. Contextual and constructivist teaching such as practical work and hands-on activities can enhance students' problem-solving skills. Thus, it can be implemented through the application of the Engineering Design Process in science teaching and learning (Schnittka, 2009).

Teaching and learning science based on the Engineering Design Process is an approach that can better train thinking

processes (Syukri, 2018). By participating in learning activities based on engineering designs, students will learn how to analyze situations and gather relevant information, define problems, evaluate and generate ideas creatively, develop ideas to solve problems effectively, and assess and make improvements to solutions. This is in line with the functions and goals of science learning itself, namely developing a scientific attitude through practical and scientific activities among students (Widowati, 2017).

Research on the use of EDP in the learning process has been conducted by several researchers before. Berland's research (2014) was conducted on high school students in the United States by involving the application of mathematics and science content, resulting in that EDP was able to develop students in solving problems and providing solutions, where this was the result of students' own thinking process abilities. Subsequent research conducted by Mifa (2017) resulted that EDP learning could bring out students' abilities in the process of identifying problems, determining problem solutions, designing prototypes, making prototype models of problem-solving tools in either category. Meanwhile, research conducted by Syukri et al.

Based on the description of the Student Worksheet (LKS) and the Engineering Design Process (EDP), the authors are interested in conducting research related to how the role of EDP to strengthen students' critical thinking skills.

2. RESEARCH METHODS

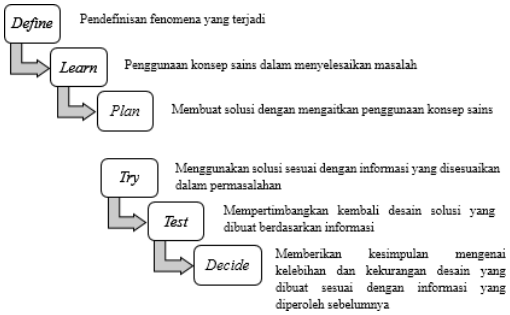
This type of research is a qualitative study using a single case study approach. Researchers are directly involved and deal with certain problems faced by students. This research was conducted at SMAN Arjasa, Jember Regency in February of the 2020/2021 school year. Participants in this study consisted of 6 students consisting of 4 girls and 2 boys. The participants were selected based on purposive sampling (certain considerations). The data analysis technique used is in the form of an interactive model analysis from Miles & Huberman (2009: 20 with the following stages:

1. Analysis of Critical Thinking Ability Data
   a. Reducing data on student work results on worksheets. The data are organized by category, focus on key points, and are important in nature so that they provide a clearer and easier to understand picture.
   b. Presenting data from the reduction results regarding students' critical thinking skills refers to the assessment of indicators of critical thinking skills.
   c. Draw a conclusion.
2. Interview Data Analysis
   a. Transcript verbal interview data.
   b. Reducing Data
   c. Presenting data from the reduction results regarding the students' critical thinking and engineering thinking skills.
   d. Draw a conclusion

The data credibility test used is the triangulation of techniques or methods in the form of data from observations, interviews and documentation. Furthermore, a member check is held to check the accuracy of the reports obtained.

3. RESULTS AND DISCUSSION

The results obtained in this study provide information about students' critical thinking skills in EDP syntax at each stage in the LKS. The EDP stage in the LKS consists of six stages which are adopted fromadopted on a design that has been developed by the STEM Center of Minnesota of University and Purdue University. In the define, learn, and plan stages students work on worksheets individually. While at the try, test, and decide stage, students work on worksheets in small groups.The diagram of the concept of critical thinking in physics learning based on EDP is depicted in Figure 1. below:



Picture 1. Critical Thinking Concept Diagram

a. Define

The analysis obtained at the define stage in defining the phenomena that occurs is the most basic question for students to understand. Because in the problem of understanding the phenomenon that occurs, the answer is used as a reference in answering the next problem. However, from the results obtained, students are still lacking in giving the right answer and only [S1] is able to define the problem well, so that the next questions can be answered correctly and according to the LKS answer criteria. Meanwhile [U1], [A1], and [C2] understand well even though there are misunderstandings in understanding the phenomena that occur so that it can be said to be in the category of high critical thinking. Height category:

[S1], "The farmers in the western agricultural land of the village make small wells near their respective fields with the help of diesel pumps to drain water to their respective fields".

b. Learn

The analysis obtained in tahao *learn* In understanding the use of science and mathematics knowledge (physics concepts) it is obtained according to the understanding of the participants by explaining the reasons for these concepts to be studied and providing appropriate and logical explanations in the high category answered by:

[A1], "Hydrostatic pressure".
Reason: "So that the dam can be designed properly using the concept of hydrostatic pressure. The lower the wall of the dam is getting thicker because the pressure is higher so that the wall is not burst by the flow of water ".

[C2], "The concept of static fluid is hydrostatic pressure".
Reason: "By studying the concept, the engineer will be assisted in the dam making process. Because the lower the fluid pressure is getting bigger, it needs consideration in making the dam foundation ".

This answer provides a clear explanation in providing a function of understanding the concepts of science used.

c. Plan

TAt this point students make solutions, and develop plans to be made in high or low critical thinking abilities. This stage is the participant's temporary conclusion after defining and identifying problems and providing solutions according to client requests. From the results obtained, students 'high critical thinking skills are classified according to the participants' understanding in answering the problems given and the suitability of the previous stage. Some of the answers from participants who were classified as high were by:

[A1], "In making a dam, the materials or materials used are strong and durable. To build the foundation, it requires a physics concept using hydrostatic pressure. The lowest foundation is built thick and wide, while moving upward it can be made like a cone ".

[C2], "Dam making requires an understanding of the construction, materials and raw materials, calculating the size and shape of the dam, combining the physics concept of hydrostatic pressure with a thick foundation on the riverbed in making the dam, and increasing the depth of the river for dam needs"

d. Try

The data obtained at the try stage in providing reasons for the solutions made in the form of group discussion results. From the results obtained, in group 1 by [A1] and group 2 by [C2] gave reasons by applying the appropriate physics concepts and also taking into account the information obtained to meet client requests tailored to the problem. While the statements put forward by [S1], [U1], [D2], and [W2] are statements that do not provide reasons by applying appropriate physics concepts and also considering the information obtained to meet client requests.

Group 1:

[A1] : In my opinion, the materials and materials used must be strong and durable, and to build the foundation, the concept of physics using hydrostatic pressure is also needed. The bottom foundation was built wide and thick, while getting to the top was like a cone but like this [while demonstrating by hand].

[S1] : Then Pascal's Law is also yes as water holding capacity. So during the rainy season the water does not flow out, or in other words it can be stored and during the dry season the water can irrigate the rice fields.

[U1] : Yes, I agree, so the addition of Pascal's Law is also due to that we also pay attention to the capacity in the rainy season so that the water does not spill [Javanese, mbleber = spilled].

In giving reasons about the solution made by considering the concept of physics that is classified as high is [A1].

Group 2:

[D2] : If I want to do this, then we will still pay attention to the concept of Pascal's Law, the dam is long, big, and the water that is being collected is increasing and able to withstand the dry season.

[W2] : If I'm like this, we also have to pay attention to the use of materials on the dam base such as stone, clay soil, and use the right foundation so that the dam lasts a long time.

[C2] : For me, just agree with your opinion, but we have to pay attention to the condition of the river so adjusting the size of the dam doesn't mean the same as the size of the river's condition. The important thing is that the foundation at the bottom of the dam must be thick in order to be strong due to fluid pressure. For other things, it depends on mutual agreement, so we choose which one is suitable for this design.

In giving reasons about the solution made by considering the concept of physics that is classified as high is [C2].

e. Test

The conclusion obtained from this stage focuses on understanding the concepts of physics and the big picture of students' critical thinking skills when discussing. The quote is explained as follows.

1) Best understanding of physics concepts

[A1] : The bottom foundation is built thick and wide, while the higher it is made to form a cone.

[C2] : The hydrostatic pressure with the bottom of the dam is made thicker because the deeper the water pressure is getting bigger.

2) Lack of understanding of physics concepts

[S1] : Using these two concepts, hydrostatic pressure and Pascal's law

[D2] : Using the concept of hydrostatic physics because the base of this dam uses clay, rock, and sand to withstand pressure and reduce water absorption.

[W2] : Using the physics concept of hydrostatic pressure to last a long time with the addition of clay soil.

3) Just follow a discussion discussion on the concept of physics

[U1] : Yes, like earlier, hydrostatic pressure and Pascal's law.

The best understanding of the concept of physics means that it is classified as high critical thinking skills, while less understanding and and only following discussion discussions on physics concepts are classified as low critical thinking skills. The results of the discussion affect students' decisions in their thinking processes. Individually students [A1] and [C2] give the best answers so that they are classified as high critical thinking skills, but when they have finished the group discussion the results differ from their previous thoughts and become joint answers. Meanwhile, students [S1], [U1], [D2] and [W2] do not understand well so they are classified as low critical thinking skills.

f. Decide

Decide is the last stage of the engineering design process. In accordance with the indicators used, in this process students reexamine thoroughly and write conclusions according to the problems and solutions chosen well. The discussion at this stage describes a summary of all the results of the student's critical thinking process starting from the process of working on individual worksheets, group discussions, and individual interviews.

Working on worksheets individually, students' high critical thinking skills are obtained from the answers [A1] and [C2] which are in accordance with the answer criteria and can understand the problems given well to provide solutions to conclusions. Meanwhile, students' low critical thinking skills were obtained from the answers [S1], [U1], [D2] and [W2] which gave a lot of misinformation from the process of understanding the given problem so that the solution given was less relevant if it was related to the understanding process carried out previously. Meanwhile, in the discussion process, opinion groups [A1] and [C2] were superior to other students. This opinion is also used as an excuse to answer the problem by combining other answers to the final conclusion.

The results of the interviews provided the suitability of data from individual and group work but also provided new data. The new data is in the form of an opinion after taking part in the ongoing learning in the form of understanding what concepts are obtained in the engineering design process lesson. The results obtained from the process of understanding the concept of physics by [A1], [D2], [W2], [C2] are in accordance with the information they get, while [S1], and [U1] do not match the information they get after doing

learning engineering design process. Then the understanding of other concepts including understanding the concepts of mathematics, engineering, and technology [S1], [A1], [D2], [W2], [C2] is able to understand well what has been done during the learning engineering design process. .

Data during individual work and group discussions provide different understanding of the information obtained by the participants. Dominant students are more motivated and confident in receiving the information obtained than when working with groups. This is due to the influence of structure and differences of opinion which are combined to produce a common conclusion (Klein et al., 1999). Therefore, [A1] and [C2] are superior to [S1], [U1], [D2] and [W2] in providing answers and opinions. However, when conducting group discussions [A1] and [C2] followed a joint decision but gave an opinion that was in accordance with the information they had previously obtained. Other factors that influence this,

4. CONCLUSSION

The use of EDP in worksheets provides strengthening of students' critical thinking skills and the most support is at the define, learn, and plan stages. Meanwhile, at the try, test, and decide stages are the results of developing information that has been obtained in the previous stage but with consideration of joint decisions.

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