Role of students worksheet in STEM approach to achieve competence of physics learning

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Abstract. In the 21st century, education plays a very important and strategic role in building a knowledgeable society that is literate technology and media, communicating effectively, critical thinking, solving problems and collaborating. The need to emphasize science, engineering, technology, and mathematics (STEM) subjects in school settings to improve 21st-century skills (such as critical thinking, creativity, curiosity, and collaboration) of individuals, began to use appropriate approaches has attracted the attention of a large number of researchers worldwide. In this paper, we report the literature study by searching and evaluating relevant materials to synthesize information from various sources related to the STEM approach in physics learning. The results of this review will be used as the theoretical reference for the development of the student worksheet using the STEM approach for the student in physics learning.

1. Introduction

Nowaday, the people and the nation of Indonesia have entered the gates of the 21st century. We are faced with the demand for the importance of quality human resources and able to compete. Qualified human resources can be a major force to overcome the problems at hand. Education plays a very important and strategic role in building a knowledge society that has 21st century skills. The 21st century challenge requires humans to have the ability of science, technology and media literacy, effective communication, think critically, solve problems and collaborate. Through science-based education and technology, it is expected to emerge humans character, have the will to move forward and develop, and have scientific reasoning [1].

One way to cope with the challenges of the 21st century is to improve the quality of education. Efforts that can be done by the government are changes in curriculum. Now, the curriculum is implemented in Indonesia is the 2013 curriculum. The 2013 curriculum is designed with the aim of preparing Indonesian people to have the ability to live as individuals and citizens who are faithful, productive, creative, innovative, and affective and able to contribute to the life of the world, nation, state and civilization of the world.

One of the lessons in the 2013 curriculum is Physics learning. Physics subject is closely related to natural phenomena and its application in daily life. That effort does by teachers to get graduates who have the ability to link knowledge acquired and apply it in everyday life one of them using integrative approach [2]. An integrative approach is a learning approach done by using multiple disciplines. STEM is a new approach to the development of education that integrates more than one discipline.
STEM is an important issue in education today [3,4]. STEM learning is an integration of science, technology, engineering, and math learning that are suggested to help the success of 21st century skills [5]. In general, the implementation of STEM in education can encourage students to design, develop and utilize technology, be able to hone cognitive, manipulative and affective, and apply knowledge [6,7]. STEM-based education can form a viable and logical, logical, and systematic so they will be able to face global challenges and be able to improve the country's economy [8]. STEM can develop when linked to the environment, so that a learning that presents the real world that students experience in everyday life [9]. This means that through STEM approach, students not only memorize the concept, but rather how students understand and understand the concepts of science and its application in life.

Besides the approach, the teacher must also use the model in physics learning. One of the models in the 2013 curriculum that can be paired with the STEM approach is problem-based learning models. PBL models can give students the opportunity to apply knowledge on issues as a form of problem solving [10,11]. Indirectly, the use of PBL models also encourages students to master the knowledge necessary to solve the problem [12]. This knowledge can be in the form of information or data which is then used as material to solve these problems through logical, critical, and systematic thinking [12]. Therefore, the STEM approach is very likely to be paired with problem-based learning [13].

In addition to using approaches and models in learning, teachers are required to be creative in developing teaching materials. Teaching materials used by teachers greatly affect the learning outcomes of learners. Bappenas (2013) revealed that with the development of teaching materials can improve the quality of education in Indonesia [14]. One example of teaching materials that can be developed is the Student Worksheet (LKPD). LKPD is a worksheet containing tasks done by learners, contains instructions, steps to complete a task of theory or practice [43]. LKPD needs to be developed as it can help teachers deliver materials and help students in achieving the goals of physics learning.

In 2011, Trends in the International Mathematics and Science Study (TIMSS) found that at the secondary school level, the achievement of Indonesian students' learning outcomes in mathematics and science including physics, chemistry and biology had not shown satisfactory results [15]. The average mathematical score was ranked 38th out of 42 countries and the average science scores ranked 40th out of 42 countries with total scores of 386 and 406 respectively. These results are still below the average standard score of 500 [16]. Furthermore, according to PISA data for Indonesian children produce some of the findings among others; low learner literacy achievement, with an average of 32% for all aspects, consisting of content is 29%, process is 34%, and context is 32%; there is a relatively low diversity between provinces of the level of scientific ability of Indonesian students; the ability to solve problems in Indonesian students is very low compared to Malaysia, Thailand or the Philippines [17]. Due to the low learning outcomes and science literacy of Indonesian students, it is necessary to integrate the STEM approach to the learning process, especially Physics learning. The integration of these STEM aspects can support the improvement of students' learning outcomes and science literacy in Indonesia.

Based on the exposure, learning by using STEM approach is very important, because it provides training to learners to be able to integrate each aspect at once. These aspects include science, technology, engineering and mathematics. By applying the STEM approach in the learning process physics is expected to equip students with the various skills required by students in the face of competition in the 21st century.

2. Method

The research method used is descriptive method, that is by analyzing and presenting the facts systematically so it is easier to understand and concluded [18]. Nazir [19] states that the descriptive method is a method of examining the status of a group of people, an object, a set of conditions, a system of thought or a class of events in the present. The purpose of this descriptive research is to make a systematic, factual and accurate description, description, or painting of the facts, traits and relationships between the phenomena investigated. In recent developments, descriptive research
methods have also been conducted by researchers for two reasons. First, from the empirical observations, it is found that most of the research reports are conducted in descriptive form. Second, descriptive method is very useful to get variety of problems related to education and human behavior. There are several methods of descriptive research: survey method, continuous descriptive method, case study, occupational and activity analysis, action research, library research, and comparative research. In this paper the descriptive method used is the library research method. Library research method what is done is to find reference theory relevant to the case or problems found.

3. Results and Discussion

STEM was first launched by the US National Science Foundation in the 1990s as the theme of the educational reform movement in four disciplinary fields, developing a society that is literate STEM, and increase the global competitiveness of the United States (US) in science and technology innovation [20,21,22].

One of the characteristics of STEM education is to integrate science, technology, engineering, and mathematics in solving real problems. However, there are various ways in practice to integrate STEM disciplines, and their pattern and degree of integration depends on many factors [23]. In the context of general basic and secondary education in many countries, including Indonesia, only subjects of science and mathematics are part of the conventional curriculum, while technology and engineering subjects are only minor or even absent in the curriculum. Therefore, STEM education is more focused on science and mathematics [24,46].

STEM has been applied in some developed countries such as USA, Japan, Finland, Australia and Singapore. STEM is an initiative of the National Science Foundation of USA. The goal of STEM application in the United States is to make these four areas (science, technology, engineering, and mathematics) become the main career choice for learners [25,26]. This situation occurs because the country is experiencing a scientific crisis in the field of STEM. To overcome this problem the United States government established a STEM education and provided educational tuition assistance to prospective students who choose one of the STEM fields [27]. But in recent years, STEM has been applied to various fields of study or majors at various levels of education.

The STEM approach can improve students' competence in secondary schools. Competence is something that is owned by students, and is a major component that must be formulated in the learning, which has an important role in determining the direction of learning are: 1) knowledge competence is a competence in the knowledge aspect that students possess including students’ intellectual ability, 2) attitude competence is the teacher’s assessment of student behavior in the learning process, 3) skill competence is an assessment of students skill abilities, such as the ability to give opinions, discussions, reports, and presentation skills [38,39].

STEM has been widely applied in learning [48,49,50]. This situation is shown by the results of research revealing that the application of STEM can improve academic and non-academic achievement of learners. Many previous researchers used the STEM approach in physics learning. In the research there are several aspects that can be improved if we use LKPD with STEM approach. The results of the journal analyzed with the use of student worksheets with STEM approach are shown in Table 1.

| No | Aspects Achieved | Aspect Achievement Achieved | Information | Reference |
|----|-----------------|-----------------------------|-------------|-----------|
| 1  | a. Student's motivation to study | ✓ | After using LKPD STEM motivation in learning increases | [28] |
|    | b. Student Learning | ✓ | After using LKPD |          |
|Activities| STEM learning activities of students increases| After using LKPD STEM ketaif thinking skill increased thinking |
|---|---|---|
|Students’ creative thinking skills| √| [29]|
|Mastery of Student Concept| √| [30]|
|Increase Science Process and Creative Thinking Skills| √| The use of the STEM approach can improve the ability of science and students’ creative thinking skills |
|Student Learning Competencies| √| Teaching materials using the STEM approach can improve the competence of students’ learning |
|The ability of causal reasoning of junior high school students| √| STEM-based learning can be a reference in tracing students’ causal reasoning abilities |
|Ability Control of Variable of Junior High School Students| √| The application of STEM-based learning can improve students’ control of varying ability |

Previous research results show that the application of teaching materials using STEM approach in high school students can give a positive effects [35,36,37], as follows: (a) support the development of thinking abilities and awareness of student learning (b) assist in the development of the ability to think critically (c) increase the interest of students towards learning science and mathematics, and interest in matters relating to STEM; (d) develop curiosity, and problem-solving skills; and (e) provide students with extensive experience about the world around them [40,41,42]

4. Conclusion
Based on literature study that has been done, it is found that the use of STEM approach is effectively used to improve students’ learning competence, namely attitude, knowledge, and skill competence. These results indicate that STEM approach is very important to be used in high school physics learning.

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