



Literature Research: The Use of Science, Technology, Engineering and Math (STEM) In Physics Learning

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Abstract

The STEM approach is an approach that trains to understand the four aspects of it. The four aspects are science, technology, engineering and mathematics. However, the application of this approach is still not optimally developed in the learning process. This study aims to find out the advantages of the STEM approach and the obstacles in learning physics. The method to reach the purpose is literature research. The study reviewed various STEM research journals on physics studies published in the last ten years indexed in Sinta or National Proceedings. The number of journals used is 30 journals. The results showed that the use of STEM has the most advantages in improving student learning outcomes, while the most constraints in STEM learning are in adjusting STEM learning to the curriculum and the need for good time management. The results of this study can be used as input for physics teachers to apply the STEM approach in the physics learning process in the classroom.

Keywords: literature research; physics learning; STEM

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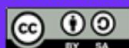
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INTRODUCTION

In a branch of science, there is one branch, namely Physics. Physics is a science in that it teaches about the regular study of natural phenomena through knowledge, facts, concepts, theories, and principles through discovery and scientific attitudes. Physics is not only about memorizing formulas or equations, but in physics, there must be an understanding of basic concepts applied to the solution of problems in systematic daily life. However, in its application, many students still find it difficult to study physics in school (Wijayanto et al.,

2020). In addition, currently, students are less geared towards forming science literacy in problem-solving (Putri et al., 2019). Physics is a difficult, boring lesson. It must memorize formulas so that some students already feel unsure if given a task and will think that they cannot do it (Sulistiyowati et al., 2018). Physics learning aims to develop student's knowledge, understanding, and analytical skills of the environment and surrounding areas (Alifa et al., 2018).

One of the learning innovations that teachers can use attachment system in learning to train science literacy



(Sulistiyowati et al., 2018). Learning that integrates the STEM approach requires students to understand the concept of science and engineering analysis of technology. It is useful for training and supporting students' creative thinking skills (Wibowo, 2018). STEM-based learning is one form of learning that is compatible with the curriculum system that applies in Indonesia (Satria, 2016). STEM is an approach that relates to one science with other sciences. Science requires mathematics as a data processing tool, while technology is an application of science itself. Learning science also requires an *engineering design process*, which is the knowledge to operate or design a procedure to solve a problem (Putri et al., 2020). The STEM approach is applied to learners by obtaining the material and some practices that can facilitate learners in the learning process (Kanza et al., 2020).

In addition, the STEM approach in education with those of Science, Technology, Engineering, Mathematics are integrated into one with the educational process focusing on solving problems in real everyday life and professional life (Putri et al., 2019). According to Johnson (2016) the form of STEM integration in the classroom generally consists of three, including integrated content, integrated content support, or integrated context (Ardianti et al., 2019). The application of STEM-based learning can improve 21st-century skills, especially collaboration skills (Soroko et al., 2020). In addition, it can create efficiency in collaboration skills that impact construction improvement knowledge and problem-solving (Liao et al., 2016).

Learning activities are very important during the learning process. However, there are often various kinds of obstacles that arise that interfere with teaching and learning activities in the process. Learners need learning close to technology and digitization (Caroline &

Syuhendri, 1993). The current generation has a free character, individualist, high dependence on technology and speed of getting information from digital media and the internet (Wibowo, 2018). In context learning, technology also makes it easier for students to overcome difficulties in various subjects: physics (Aulia et al., 2017). The STEM approach is a solution of the approach that educators can choose in classroom learning linking technology with science and others on four aspects of stem approaches (Yulia & Ramli, 2019). STEM education is a top priority in solving global issues and problems facing (Dewanti & Santoso, 2020) today, such as global warming, air and water pollution, clean drinking water, and food security (Afriana et al., 2016). Then, the teaching material for the STEM approach must certainly be adjusted to the characteristics of STEM learning. In addition, STEM learning concepts, principles, and techniques from science, technology, engineering, and mathematics are used in an integrated or connected manner in the development of products, processes, and systems used in everyday life (Wibowo et al., 2020).

Hannover (2011) states that aspects of learning physics using the STEM approach include: (1) the field of science, in the use of knowledge and science process skills in order to understand natural phenomena; (2) Technology Aspect, where technology itself can facilitate human work; (3) Technical Aspect, which in this aspect can operate, design, or assemble concerning science and technology; (4) Mathematical aspects, to analyze, show evidence, solve problems, and interpret solutions from research data and calculation results.

STEM objectives are designed to enhance people's ability in science and innovate on technology products to compete globally (Utami et al., 2017). The use of STEM approaches aims so that students can have the ability and

understanding in all four aspects of STEM (Science, Technology, Engineering, and Mathematics) that are interrelated on one subject. Students are also expected to be able to apply the things they learn in their daily lives or work environment (Srirahayu & Arty, 2018). Students have the ability to literacy science and technology seen from reading, writing, observing, and doing science so that it can be used as a provision for community life and solve problems faced in everyday life in the field of STEM science (Afriana et al., 2016). STEM, in its application, develops thinking, reasoning, teamwork, investigation, and creative skills that students can use in all areas of their lives (Wibowo et al., 2020).

The STEM approach shows learners how concepts, principles, engineering science, technology, engineering and mathematics (STEM) are integrated to develop products, processes, and systems that benefit human life (Wibowo, 2018). The benefits of implementing STEM approaches allow students to solve problems for the better, innovators, inventors, independents, logical thinkers, and technology literacy (Stohlmann et al., 2012). A STEM Education can make students active, collaborative, skilled, and learning can be meaningful, thus expanding the horizon. STEM-based education will make human resources that can reason and think critically, logically, and systematically, for example, in the case of the learning process in *teamwork*. STEM approaches can shape students to be able to think critically, logically, and systematically. As for educators, STEM approaches can allow educators to show learners how STEM concepts, principles, and techniques are used integrated into the development of products, processes, and systems used in their daily lives (Nugraha, 2016). The STEM approach increases motivation attention, assists in

explaining the material, and help students understand the concept correctly (Syuhendri, 2009).

Techniques are directly related to real-world problems. This provides a good context for illustrating other concepts that may be difficult for students to visualize. STEM approaches in physics learning using design processes (such as *engineers*) (Kustijono, 2019). Indonesia better refers to the education system in developed countries whose education has been much better, such as in America. America has long developed STEM learning (Dewi et al., 2018).

According to the problems above, it is very interesting to research the use of STEM in physical materials. In physics itself, the learning process often needs to be integrated with other sciences such as mathematics and technology. However, it is rarely studied about the advantages and disadvantages of implementing the STEM approach in physics learning. I conducted a study entitled "Literature Studies: The Use of STEM (*Science, Technology, Engineering and Math*) in Physics Learning" to answer this question.

METHOD

This research is a type of literature research and uses literature data collection methods. The data used is secondary data obtained from journals relevant to the research. Journal searches were conducted through Google Scholar that met the criteria according to the research. The study reviewed various STEM research journals on physics studies published in the last ten years indexed in Sinta or National Proceedings. The selected journals were 40 journals, and 30 journals were reviewed. 24 jurnal diperoleh dari proceeding dan 6 jurnal terindeks sinta. Figure 1 shows the research path.

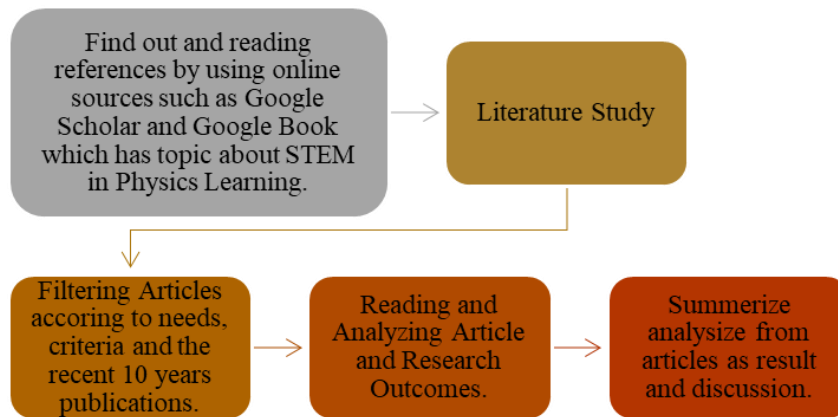


Figure 1 Research path

RESULTS AND DISCUSSION

To facilitate analyzing the use of STEM in physical learning, it is made in the form of a table containing several research titles and results related to stem

use that previous researchers have done. The following research titles and the advantages of STEM in physics learning are presented in Table 1.

Table 1 Research title and advantages regarding STEM in physics learning

Name of researcher	Year of Publication	Excess
Dewi, Kaniawati, & Suwarma	2018	Improve students' problem-solving skills
Muthi'ik, Abdurrahman, & Rosidin	2018	Improving students' learning outcomes
Rahmayani, Irwandi, & Rajibussalim		
Maulidia, Lesmono, & Supriadi	2019	
Sudiatmika	2020	
Aryanta		
Putri, Lesmono, & Ismanto		
Wijayanto, Supriadi, & Nuraini		
Agustin, Lesmono, & Widodo		
Maulidia, Lesmono, & Nuraini		
Musdalifa, Syuhendri, & Pasaribu	2021	
Muyassarrah, Ratu, & Erfan	2019	Improve the achievement of students' motor skills
Muthi'ik, Abdurrahman, & Rosidin	2018	Increase student <i>self-efficacy</i>
Wibowo	2018	Improve students' scientific skills
Maulidia, Lesmono, & Nuraini	2020	Increase student creativity
Kanza, Lesmono, & Widodo	2020	Improve student learning activity
Syukri & Ernawati	2020	Increase students' learning interest
Santoso & Mosik	2019	

Name of researcher	Year of Publication	Excess
Novidya & Kustijono Putri, Pursitasari, & Rubini	2020;	Increase students' critical thinking
Dewi, Mayasari, & Handhika Afifah	2017	Increase students' creative thinking
Almuharomah, Mayasari, & Kurniadi	2019	
Pangesti, Yulianti, & Sugianto Afifah	2017	Improve student learning concepts
Astuti, Toto, & Yulisma Nurbaya, Yuliati, & Sutopo Sasmita, & Hartoyo	2019 2020	
Astuti, Toto, & Yulisma Kiromah, Sudarti, & Rohatin	2019 2020	Increase student learning activities
Handayani, Astuti, & Bhakti	2020	Improve teacher's science process skills
Maulidia, Lesmono, & Nuraini	2020	Improve student understanding
Yusuf & Asrifan	2020	Increase student learning collaborative activities

According to Table 1, it can be seen that some studies proved that how the use of STEM approaches on physics learning is excellent to apply. There is even research that proves that STEM approaches to physics learning can increase students' learning interest which currently, students are less likely to like physics learning. From Table 1, there are five advantages studied in a row, namely: (1) improving learning outcomes (Muthi'ik et al., 2018; Rahmayani et al., 2018; Maulidia et al., 2019; Sudiatmika et al., 2020; Aryanta et al., 2020; Putri et al., 2020; Wijayanto et al., 2020; Agustin et al., 2020; and Maulidia et al., 2020; Musdalifa et al., 2021); (2) improve the concept of student learning (Pangesti et

al., 2017; Afifah, 2017; Astuti et al., 2019; Nurbaya et al., 2019; and Sasmita and Hartoyo, 2020); (3) improve the problem-solving skills of students (Dewi et al., 2018; Lestari, 2019; and Lolanessa et al., 2020); (4) improve the critical thinking of students (Santoso and Mosik, 2019; Novidiya and Kustijono, 2019; and Putri et al., 2020) and improve the creative thinking of students (Dewi et al., 2017; Afifah, 2017; and Almuharomah et al., 2019); and (5) increase student learning activities (Astuti et al., 2019; and Kiromah et al., 2020).

The following research titles and STEM constraints in physics learning are presented in Table 2.

Table 2 Research title and constraints regarding STEM in physics learning

Name of researcher	Year of Publication	Constraints
Maulidia, Lesmono, & Nuraini	2020	It needs regulation and time management so that the STEM learning process runs well.
Maulidia, Lesmono, & Supriadi	2019	Difficulty adapting STEM
Syukri & Ernawati	2020	approaches to curriculum

Maulidia, Lesmono, & Supriadi	2019	Students have difficulty analyzing problems in Student Work Paper (SWP)
Kanza, Lesmono, & Widodo	2020	Students need to be actively involved in the learning process.
Kanza, Lesmono, & Widodo	2020	Teachers need to be firm on the learning process.
Kanza, Lesmono, & Widodo	2020	Time allocation must be appropriate to Teaching Plan
Dini, Maharta, & Suana	2017	The necessary preparations should be more wholly done.
Dini, Maharta, & Suana	2017	Learning time should be longer
Dini, Maharta, & Suana	2017	Learning media that facilitate STEM learning are still limited.

Based on Table 2, it can be seen in its current application that STEM attachments have constraints that make it challenging to apply in the learning process. These constraints are (1) It need regulation and time management so that the STEM learning process runs well (Maulidia *et al.*, 2020); (2) Difficulty adapting STEM approaches to the curriculum (Maulidia *et al.*, 2019; Syukri and Ernawati, 2020); (3) Students have difficulty analyzing problems in LKS (Maulidia *et al.*, 2019); (4) Students need to be actively involved in the learning process (Kanza *et al.* 2020); (5) Teachers need to be firm on the learning process (Kanza *et al.*, 2020); (6) The allocation of time must be following lesson plan (Kanza *et al.*, 2020); (7) The necessary preparation must be more mature (Dini *et al.*, 2017); (8) Learning time should be longer (Dini *et al.*, 2017); (9) Learning media that facilitate STEM learning is still limited (Dini *et al.*, 2017).

The most STEM constraints based on research that has been done are adjusting STEM learning to the curriculum and the need for good time management in its application. In addition, the implementation of STEM approach is constrained in learning media that are still limited. So, by that addition, involving learning media in the implementation of STEM approach.

CONCLUSION

According to the research results, it can be concluded that the application of STEM approaches to physical learning has the most advantages in improving student learning outcomes and has the most obstacles in adjusting STEM learning to the curriculum and the need for good time management.

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