Analysis of need for development of physics teaching materials assisted by a learning house portal integrating STEM and contextual models to improve student digital literacy

Rahmi Laila* and Asrizal
Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, Jl. Prof Hamka, Padang 25131, Indonesia

*rahmilaila07@gmail.com

Abstract. The Industrial Revolution 4.0 in the 21st century is closely related to technological development. Currently the development of science and technology is moving continuously. With this basis, education should be able to develop superior knowledge, skills, attitudes, and values to deal with the industrial revolution 4.0. Currently the world is facing a big problem, namely the corona virus. Indonesia is among the countries that have found many positive cases of the corona virus. The government is making efforts to reduce the spread of the corona virus by carrying out social restrictions. The government makes regulations to work from home. In the world of education known as online schools. Physics Learning uses various types of teaching materials. Teaching materials integrating STEM which can be accessed by teachers and students anytime and anywhere, will assist students in answering challenges in the 21st century and responding to online schools. The purpose is to describe the STEM components contained in the XI grade XI high school physics teaching materials. The method is descriptive method with data collection instruments namely observation sheets. The results of the analysis of teaching materials show that science and mathematics indicators are more dominant in Physics teaching materials, but indicators of engineering and technology have not been seen. Thus, the existence of Physics teaching materials integrating STEM has not been maximized, therefore it is necessary to design a teaching material integrating STEM in Physics learning.

1. Introduction
The advancement of science and technology is influenced by the development of the industrial revolution 4.0 which requires humans to have 21st century skills. The forms of skills needed are the ability to solve problems and the ability to compete with others. Education should be able to prepare students to have 21st century skills so as not to have difficulties in living life later. Education is currently known as education 4.0. Education is expected to balance the digital penetration phenomenon. Education 4.0 prepares students to conquer the digital era. Students who have a creative nature will help them in the various challenges faced today. The strategy of industrial transformation by considering the human resource sector who has competence in their field needs to be considered to be improved by the education and industry sectors (Muhadjir Effendy (Mendikbud)). Human resources who are able to withstand every change in their era are superior and competitive human
resources who are able to develop their knowledge, skills and communicate professionally with other people and other nations in this hemisphere [1]. In other words, in deal with the Industrial Revolution 4.0, qualified human resources who are creative, innovative and have the ability to compete in the 4.0 revolution era are needed.

National Education aims to educate the nation's life and develop human beings as a whole. The Indonesian people should have a prosperous, happy life and have the same position or the same competitiveness as other nations. This competitiveness is formed through the formation of a society consisting of quality human resources (BSNP, 2010). 21st century education is supported by thinking skills and problem solving skills. Thinking skills of various types are a process and behavior of students that are integrated with each other in learning and understanding the content of learning material. In fact, the critical thinking skills of Indonesian students are low, especially in the field of science. This is based on the results of the 2015 PISA, Indonesian students' scientific literacy is ranked 62 out of 69 countries. Therefore the main focus is to train Indonesian students thinking skills in order to create a quality Indonesian nation.

The current problem is not only about technological developments. Currently the world is also facing a big problem, namely the corona virus. Indonesia is one of the countries that has found many positive cases of the corona virus. The danger caused by this virus is death. For this reason, the government is making efforts to reduce residents exposed to the corona virus by implementing social restrictions. The government houses several community activities such as office and school workers. In the world of education it is known as online school. Implementation of online schools is assisted by cellphones (HP) and the internet. Where the teacher will contact all students through social networks such as WhatsApp, google classroom, e-learning, home learning portals and others. Then students access the information provided by the teacher. This information can be in the form of subject matter and assignments. Furthermore, students do the assignments given by the teacher. After completing this work, students will report the assignment via social networks that have been created by the teacher. Thanks to technological developments, the teaching and learning process is still running, it's just that the implementation has not been optimal because it is constrained by the tools and understanding of students in managing information. Thus, learning with high analysis such as physics will be increasingly difficult for students to understand.

Permendiknas No. 22 of 2006 states that learning science is one of the methods carried out by scientific inquiry. The goal is to develop critical thinking skills, work hard and be scientific and emphasize providing direct learning experiences. The development of the creativity of students cannot be separated from the role of educators because it is the educator who knows how the creativity of students is developed [2]. According to Nasution (2005) that educators are the people most responsible for providing the most harmonious learning environment so that the learning process runs effectively. Thus, if educators carry out their functions and duties properly, the resulting output will be of high quality. Conversely, if educators do not carry out their duties and functions properly, the resulting output will not be of high quality. Most educators still apply the lecture method, where the learning process only trains knowledge on indicators of knowing and explaining only, so that when faced with a problem, students will find it difficult to solve the problem (Munandar, 2001). In carrying out learning, teachers are required to have the skills to use technology. The teacher must also be good at choosing a learning approach that can train the thinking skills of students. One learning approach that can be used to train students' thinking skills is the STEM (Science, Technology, Engineering and Mathematic) learning approach.

STEM is a learning process that combines science, technology, engineering, and mathematics. The STEM learning process aims to improve students' creative abilities through a problem-solving process related to material in everyday life. The ability of the 21st century is the ability to learn and provide innovation, among others; critical thinking, creative thinking, innovative, able to collaborate, and skills in using media, technology, information and communication (ICT) [3].

The STEM approach develops with learning that is associated with the environment, so that a direct learning is realized in the face of the real world of students in everyday life [4]. Learning with
integrated knowledge will make students acquire complete knowledge and skills so that learning becomes meaningful [5]. This means that through the STEM approach students can memorize concepts and also students have an understanding of how these concepts are obtained and their relevance in everyday life. In addition to using the right learning approach, the use of teaching materials must also be appropriate so that the thinking skills of students are properly trained.

Physics teaching materials are learning tools and tools that are structured as learning materials, methods, limitations, and ways of evaluating which are designed regularly and attractively in achieving goals. Teaching materials aim to achieve competence or subcompetence with all its complexity. This understanding explains that a teaching material must be designed and written with instructional principles because it will be useful for teachers for learning resources and can support the physics learning process. Physics itself is a science that is directly related to science and technology which explains natural phenomena empirically, systematically, and logically [6]. Details of topics/subtopics in a subject are also called the content of the curriculum in the form of learning materials or materials [7]. The explanation above, it is known that the role of a teacher in designing or compiling teaching materials is critical to the success of the learning and learning process through a teaching material. Teaching materials can also be interpreted as all forms of material arranged systematically that allow students to learn independently and are designed according to the applicable curriculum.

The purpose of writing this article is to analyze the need for developing STEM-based physics teaching materials.

2. Research Method

The method used in this research is descriptive method. Descriptive method is a method used in data collection in a scientific setting using scientific methods, and is carried out by researchers who are scientifically interested. The steps of the descriptive method begin by collecting the data needed for research, analyzing the data and interpreting it. The data collection instrument in this study was an observation sheet. The purpose of this observation sheet is to review the existence of STEM components in Physics teaching materials.

This study collected teaching materials used in schools. The teaching materials consist of books, LKPD and learning videos. Data analysis techniques in this study are divided into two, namely qualitative and quantitative data analysis techniques. The observation sheet used according to Sugiyono consists of two criteria based on the Guttman scale, namely present and non-existent [8]. Then the results of these criteria are converted into quantitative data. The observation sheet to assess teaching materials consists of four indicators, namely science, technology, engineering or engineering and mathematics which are translated into nineteen questions.

Data analysis is the result of observation of STEM-based physics teaching materials in physics learning carried out in several stages, namely determining the highest score, determining the total score of each student by adding up all the scores obtained from each indicator, determining the questionnaire score in the following way:

\[ Value = \frac{\text{Total Score}}{\text{Score Maximum}} \times 100\% \]  \hspace{1cm} (1)

The provisions for assessing the needs analysis for each indicator can be seen in Table 1.

| No | Category | Value  |
|----|----------|--------|
| 1  | Very Good | $90 < x \leq 100$ |
| 2  | Good     | $75 < x \leq 90$  |
| 3  | Simply   | $60 < x \leq 75$  |
| 4  | Less     | $\leq 60$        |
3. Result and Discussion
The results obtained from data analysis are based on observation sheets of teaching materials used in physics learning. Based on the observation sheet for assessing Physics teaching materials based on STEM, it consists of four components, each component has several statements to be assessed. The teaching materials that were assessed consisted of physics teaching materials for SMA class XI semester 1. The results of the analysis of physics teaching materials based on STEM class XI semester 1 can be seen in Figure 1.

![Figure 1. Analysis of STEM-Based Physics Teaching Materials for Class XI semester 1](image)

Based on the data in Figure 1, it can be seen that the four components of the assessment of STEM-based physics teaching materials with the acquisition of each component for science which is denoted by S are 61% and are in the sufficient category. The next component is technology which is denoted by T of 14% in the less category. Then the Engineering component or engineering capability which is denoted by E is 49% with the less category. Finally, the math component or denoted by M is 63% with a sufficient category. Thus, the components that are more dominant in these teaching materials are science and mathematics.

Based on the analysis of physics teaching material used in the first semester, it can be seen that the teaching materials have not fulfilled the four STEM components. The dominant components are science and mathematics. Therefore it is necessary to make joint efforts to improve the technology and engineering components.

Teaching materials have a significant influence on learning. Teaching materials can guide students in learning by arousing student interest in learning, focusing, providing opportunities for students to interact with the environment, supporting independent learning, creating a concrete basis for conceptual thinking, and offering opportunities for students to develop abilities and skills. Teaching materials can also increase memory levels and improve student learning achievement.

The results of previous research indicated that the use of teaching materials in high school had a positive effect on student academic achievement. There is a significant difference in student performance between those who use teaching materials and those who don't. The results of this study indicate that the teaching materials in learning have a significant effect on student performance. Teaching materials that are integrated with the STEM approach to be created are expected to improve students' knowledge, skills and attitudes.

The first component of STEM is science. The study of natural phenomena that involves observation and measurement as a vehicle to objectively explain the ever-changing nature is the notion of science. Some of the main domains of science at the primary and secondary education levels are physics, biology, chemistry, and earth and space sciences (IPBA).

The second component is Technology. Technology refers to human innovations that are used to preserve nature in order to meet human needs, thus making life more peaceful and happier, and not
feeling deprived. Technology makes humans able to accelerate human movement, save time, can communicate directly even from different places, make work easier with sophisticated tools.

Engineering component (engineering) is the third component of STEM. Engineering is the knowledge and skills to acquire and apply scientific, economic, social, and practical knowledge to design and construct machines, equipment, systems, materials and processes that are beneficial to humans economically and environmentally friendly.

The final component is mathematics. Mathematics deals with patterns and relationships, and provides the language for technology, science, and engineering. In learning at school, mathematics is the basic science in understanding material from natural and social science subjects. Mathematics is dominant in arithmetic, which will be difficult for students who don't understand it.

The benefits of the STEM approach make students able to solve problems to be better, innovative, independent, logical thinking, and technological literacy [9]. This benefit exists because in STEM learning, students at the secondary education level need to be challenged to perform authentic engineering tasks as a complement to science learning through project activities that integrate science, engineering, technology, and mathematics [10]. Student worksheets with the STEM approach present problems and questions that encourage students to develop their ability to make assumptions. Before doing practicum, students first discuss to make provisional assumptions or assumptions then start doing practicum to apply a physics concept [11]. STEM-based learning can add to the learning experience through practical activities and apply general principles of the material being studied, so that students who get STEM integrated learning have better learning outcomes [12].

The learning house portal is a portal created and supervised by the Ministry of Education and Culture to collect learning materials. Interesting content such as interactive learning materials equipped with animations, videos, images of supporting media, and simulations. With this portal, it is hoped that the teaching and learning process will be easier. The learning house portal can be accessed by teachers and students anywhere and anytime. The learning house portal is the official learning center of the Ministry of Education, with the address http://belajar.kemdikbud.go.id, this portal provides various learning materials as well as communication and interaction facilities between the educational community, also contains learning materials students, community activities / forum rides, question bank and learning media catalog. This portal is intended for students, teachers and the wider community, and anyone who wants to learn.

Several researchers have investigated the relationship between physics teaching materials and digital literacy. The development of digital literacy-based teaching materials was carried out by Paramita (2017) and Nugraha (2017). The relationship between physics module development and scientific literacy has been carried out by Nurjannati (2017). Other research deals with learning physics based on digital literacy.

The difference between the research that will be carried out with other research is the integration of the scientific context of the industrial revolution 4.0 and digital literacy into high school physics textbooks. Digital literacy (digital literacy), namely functional literacy, scientific literacy, technological literacy, information literacy, cultural literacy, and global awareness. These six components of literacy are new things to answer the challenges of the industrial revolution 4.0.

Initially literacy was often associated with reading and writing skills. With the development of civilization and technology today, literacy can be linked to a person's ability in certain fields such as science and technology. Literacy refers to a basic competency in a given area. For example, reading literacy is the ability to read at a functional level. Means literacy with respect to basic abilities in a particular field.

Data literacy is aimed at improving the ability to read, analyze, and use information in the digital world. Technological literacy aims to provide an understanding of how machines work and technology applications. Digital literacy is related to communication, collaboration, critical thinking, creative and innovative skills. Digital literacy is expected to create competitive graduates so that they can face today's changes and beyond.
4. Conclusion

Based on the results of the analysis of stem-based physics teaching materials, we can see that the teaching materials in schools are not yet capable of supporting 21st century education. Training materials in new schools make students know that learning is being taught by the teacher, they have not yet reached the problem solving stage of the subject matter that he has learned. Teaching materials cannot be a source of learning for students to have 21st century skills. In other words, students have not been able to face the industrial revolution 4.0. Therefore, a teaching material is needed that integrates STEM components and contextual models in it so that students are familiar with scientific knowledge, the ability to engineer, the ability to analyze a problem and solve the problem. Teaching materials should be technology-based so that they are easily accessible and improve students' digital literacy.

Reference

[1] Asrizal, Hendri A, Hidayati, dan Festiyed 2018 Penerapan Model Pembelajaran Penemuan Mengintegrasikan Laboratorium Virtual dan Hots untuk Meningkatkan Hasil Pembelajaran Siswa SMA Kelas XI. JURNAL PDS UNP. Vol 1, pp 49-57.

[2] Bayindir N and Inan H Z 2008 Theory into practice: Examination of teacher practices in supporting children's creativity and creative thinking. Ozean Journal of Social Science Vol. 1, No. 1, pp 191-96.

[3] Winarni J Zubaidah S and H S 2016 STEM: Apa, Mengapa, dan Bagaimana. Pros. Semnas Pend IPA Pascasarjana UM. Vol 1, pp 976-984.

[4] Subramaniam M M Ahn J Fleischmann K R and Druin A 2012 Reimagining the role of school libraries in STEM education: Creating hybrid spaces for exploration The Library Quarterly. Vol. 82, No. 2, pp 161-182.

[5] Asrizal, Amran, Ananda, Festiyed, and Khairani, S 2018 Effectiveness of adaptive contextual learning model of integrated science by integrating digital age literacy on grade VIII students. Jurnal IOP Conferences Series: Materials Science and Engineering Vol. 335, pp 1-8.

[6] Festiyed et. Al 2019 Desain Modul Interaktif menggunakan Aplikasi Course Lab berbasis Pendekatan Saintifik Pada Materi Usaha Energi dan Momentum Pillar of Physics Education. Vol. 12, No. 3, pp 443-440.

[7] Ruhimat T 2011 Kurikulum dan pembelajaran (Jakarta: PT Raja Grafindo Persada).

[8] Sugiyono S 2012 Metode Penelitian Kuantitatif Kualitatif dan Kombinasi (Bandung: Alfabeta).

[9] Morrison J 2006 TIES STEM education monograph series, attributes of STEM education Baltimore MD: TIES 3.

[10] Bybee R W 2013 The case for STEM education: Challenges and opportunities (United States of America : NSTA press).

[11] Lestari D A B Astuti B dan Darsono T 2018 Implementasi LKS dengan pendekatan STEM (science, technology, engineering, and mathematics) untuk meningkatkan kemampuan berpikir kritis siswa. Jurnal Pendidikan Fisika dan Teknologi. Vol. 4, No. 2, pp 202-207.

[12] Roberts A and Cantu D 2012 Applying STEM instructional strategies to design and technology curriculum. PATT 26 Conference; Technology Education in the 21st Century Stockholm Sweden. No. 073, pp 111-118.