Need analysis in development of student books based on STEM approach

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Abstract. Curriculum-2013 was developed by perfecting critical learning patterns. The implementation of learning, including Physics, needs to emphasize the process of developing students' attitudes, knowledge, and skills through various approaches, such as STEM (Science, Technology, Engineering, and Mathematics) that integrates four scientific disciplines. Through STEM, students are expected to have skills to think critically, creatively, innovatively, and be able to communicate and collaborate. Furthermore, books as teaching materials and learning resources are seen as important in determining the success of physics learning. A preliminary analysis was conducted at SMAN 1 Luhak Nan Duo and SMAN 2 Pasaman about the characteristics of students, teacher competencies, and student books. This Analysis uses the Plomp’s Development Model. Data is taken from results of questionnaires and interviews with teachers and students. It shows that teachers have not used books based on STEM yet, only use common textbooks and worksheets. Some teachers still use a lecture method so that students have not received learning that guides them to think critically. Students are less interested in reading and have difficulty understanding Physics concepts from textbooks. This is used as the basis to developing student books based on the STEM approach to improve critical thinking skills.

1. Introduction

Education was rooted in the nation’s cultural life to build the present and the future. Preparing students as qualified human resources for the future is the main task of a curriculum towards the 21st Century and The Industrial Revolution 4.0 era. It is because the revolution and advancement of science and technology brings conclusions and impact on progress and life of the nation in the future [1]. Therefore, the Curriculum-2013 was developed with improvement and strengthening the student-centered learning, interactive learning, learning networks, active learning-seeking, and critical learning patterns [2]. Implementation of education have emphasized the development of students' attitudes, knowledge, and skills through a variety of approaches. The development of 21st Century education requires skills that include logical thinking skills, analytical, critical, and creative [3]. These skills essential for students to connect concepts and materials that are able to understand and solve problems in the classroom. Implementation of Curriculum-2013 could be integrated with STEM approach (Science, Technology, Engineering, and Mathematics) to support development of these skills. The application of STEM characteristics on curriculum will be maximal and can motivate teachers so as to provide a positive impact on activity and learning outcomes [4]. STEM is an approach that relate to each other
and integrated subjects to create a problem-based learning daily life in order to train students in applying knowledge to the phenomenon that occurs in the real world [5]. The application of STEM learning activities consist of 4-C namely creativity, critical thinking, collaboration, and communication.

Physics as one of the subjects on education intended that students are able to develop an attitude of curiosity, honesty, responsibility, logical, critical, analytical, and creative. In studying physics, except formulating the problems related to the phenomenon, conduct experiments, analyze the concepts, principles and laws of physics, students are required to be able to design a simple project or create a simple product related to the physics concept [7]. Learning physics through STEM approach requires students to understand concepts of science and engineering analyzes of a technology that is useful to train and support critical thinking skills.

Some of previous studies show that learning science in context of technological and engineering potentially increase science literacy. Students can interpret the deeper significance of science for technological development, and vice versa. Implementation of STEM to the junior high school in learning can be done in order to prepare competent human resources for the of the 21st Century challenges [8]. The utilize of STEM at learning as models, teaching materials and student worksheets can give a good impact to improve students reasoning skills [9] and students ability to think creatively [10], increasing the understanding of concepts and students critical thinking skills [11]. Through STEM learning could help students solve problems and draw conclusions from previous learning by applying science, technology, engineering and mathematics. These circumstances make students gain complete knowledge, more skilled in dealing with real life issues and develop critical thinking skills[12]. A metanalysis showed that application of teaching materials using the STEM approach in high school gave positive effects for students as follows: (a) develop thinking abilities and awareness in learning (b) develop ability to think critically (c) increase student interest on learning of Physics and matters related to STEM; (d) develop students curiosity and the ability to solve problems; and (e) provide broad experience of the students about the world around [13].

2. Method
This study was conducted in Senior High School at Pasaman Barat with research subject of two school SMAN 1 Luhak Nan Duo and SMAN 2 Pasaman (each one 25 students and 2 teachers). This study use Plomp’s development model [14]. This model consists of three phases: a preliminary analysis, the prototype and the assessment. Of the three phases, this study uses only the initial phase.

Data collected by interview and using questionnaires. Questionnaires was an efficient data collection techniques if researchers know for certain variables to be measured and knowing what to expect of respondents [15]. And then, questionnaires analyzed by using a Likert Scale with score and category (1) never (2) sometimes (3) frequent and (4) always. Technique of data analysis use equation (1) [16].

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\text{score} = \frac{\text{score gained}}{\text{max score}} \times 100\%
\]

Analysis of data to assess of each indicator analyzed with the conditions in Table 1.

| Table 1. Analysis Category |
|---------------------------|
| Score (%) | Category |
| 76-100 | Good |
| 51-75 | Enough |
| 26-50 | Not good |
| 0-25 | Not good |
3. Results and Discussion

This analysis conducted on 17-18 June 2019 by using questionnaires and interviews. Analysis of teachers' understanding of STEM and books are shown in Table 2.

Table 2. Analysis of Teacher’s Understanding of STEM and Books

| Aspect                                      | Percentage (%) |
|---------------------------------------------|----------------|
| Teacher’s understanding at the STEM approach| 0              |
| Teachers apply STEM approach in teaching    | 0              |
| Teachers use instructional books in physics learning | 100           |
| Teachers use books based on STEM            | 0              |
| Available books are based on STEM           | 0              |
| Available books are loaded Science Literacy | 100            |
| Available books are loaded Technology Literacy | 25             |
| Available books are loaded Engineering Literacy | 0             |
| Available books are loaded Mathematics Literacy | 100            |
| Teachers make books/materials based STEM    | 0              |
| Teachers want to use the physics book based on STEM | 100            |

From Table 2, it can be seen that teachers have not applied STEM approach yet in physics learning. Based on interviews, teachers often use lecture method in class and students have not been directed to think critically. Learning more on explaining and application formulas to settle the problems. Teachers recognize can not give examples the application of physics in technology and engineering much more.

In addition, based on Table 2, teachers have not taken advantage nor made a book based on STEM approach, only use books that are available at the school. This is due to STEM-based books are not available yet and teachers had not enough time and lack of competences to create physics book based on STEM. Whereas, books as one of the ingredients plays an important role in the success of learning. Teaching materials with difficult language to understand causes a lack of self-learning encouragement and less explored the students capabilities [14].

Table 3. Analysis of Student Characteristics

| Aspect                                      | Percentage (%) |
|---------------------------------------------|----------------|
| Interesting to physics                      | 53             |
| Involved in physics learning actively       | 56             |
| Liked physics with practical learning process | 78            |
| Teachers use the lecture method             | 82             |
| Teachers use teaching materials such as books or worksheets | 82          |
| Using other learning resources such as internet and web | 32        |
| Utilize of book in learning process         | 52             |
| Enjoys reading physics books                | 35             |
| Easy to understand physics concepts with book | 62            |
| Books utilized to support learning process  | 60             |
| Liked physics when linked to the phenomenon in life | 73          |
| Requires an innovative book                 | 80             |
| Applying the physics concepts in life       | 35             |
| Applying the physics concepts in technology | 32            |

Analysis of student characteristics can be seen in Table 3. From Table 3, it can be seen that only 53% of students who are interested in studying physics but 78% liked learning through practical process. This proves that the students liked to actively involved in learning process and student-centered method. Through engineering of STEM, students were expected to learn through practical process and make learning more enjoyable for them.

As many as 62% of students admit that they are easier to understand physics concepts by using books, but only 35% prefer reading physics books. This is because the books they used less attractive and can
not give connection between physics concepts and phenomenon that occur in life, where as many as 73% of the students liked it. Thus, the selection of appropriate text books are needed to develop and improve students literacy and quality of education. In learning activities textbooks play an important role in developing the literacy of students as well as providing long-term learning in science [17]. Furthermore, 80% of students in need of innovative books so that they enjoy in reading and able to apply the physics concepts in technology and life.

Table 4. Analysis of Students Thinking Ability

| Aspects of Critical Thinking | Percentage (%) |
|-----------------------------|----------------|
| The ability of students to identify assumptions given | 53 |
| The ability of students to formulate the problem issues | 43 |
| The ability of students determine the result of a provision taken | 42 |
| The ability of students to detect any bias based on a different viewpoint | 52 |
| The ability of students to use data/definition/theorem to solve problems | 53 |
| The ability of students to evaluate the relevant arguments in problem solving | 42 |

Average 48

Analysis of students ability to think critically can be seen in Table 4. Based on Table 4, it can be seen that the average critical thinking ability of students is still low at 48%. It is also recognized by teachers based on interviews that teachers have not accustom to increase students critical thinking skills in learning and assessment process. This efforts can be done by applying STEM approach aided teaching materials. Teaching materials with STEM-Integrated includes student activities to observe, interpret, analyze, and concludes to support the development of critical thinking skills. This is convenient to the results of the study [18], [19] and [10] that the use of STEM approach in learning process increase critical thinking skills. And implementation of teaching materials with STEM approach could improve students' critical thinking skills [20]. Moreover, STEM evokes an attitude of curiosity and students critical thinking skills [21].

4. Conclusion

Based on results of the preliminary analysis, interviews and observations that have been carried out, author may conclude there is necessity of the development of students book based on STEM approach in physics learning to improve students' critical thinking skills.

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