Preliminary research in the development of smartphone-based e-module learning materials using the ethno-STEM approach in 21st century education

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Abstract. Education is the most important aspect in building knowledgeable and skilled human resources in the field of technology and 4C Skills known as the 21st century learning paradigm. In addition, education based on local culture related to scientific fields also needs to be considered as it is hoped that the emergence of new knowledge adapted from the local culture. Physics learning should lead students towards the desired learning goals and the role of teaching materials can also influence this. This study aims to obtain information related to the application of smartphone-based E-module using the Ethno-STEM approach. This research is a descriptive study conducted through direct observation at 3 schools with the research sample being students of class XI MIPA and 2 physics teachers in grade 11th and used an instruments in the form of questionnaire and interview sheets. The results of the data analysis show that the application of the Ethno-STEM approach has never been applied in learning. The need for teaching materials that support learning has to be up-to-date, namely smartphone-based E- Modules. Due to this, it is necessary to carry out further research in the form of the development of a smartphone-based Physics E-Module using the Ethno-STEM approach.

1. Introduction

The Industrial Revolution era 4.0 is an era that is currently being faced, significantly on industry, technology and even education. In order to face the challenges of the industrial revolution era 4.0, as educators, certainly we have an important role in it. The industrial revolution era 4.0 in education is known as 21st century learning which has the principle of understanding societal change [1]. One of the 21st century learning objectives is to produce human resources who have scientific skills, communication skills, critical thinking skills, problem solving skills, and collaboration skills. These skills are included as 21st century learning paradigm that emphasizes the ability of students [2].

The government has made several efforts to answer the challenges of 21st century learning, one of which is by improving the quality of education by changing the previous curriculum, namely the KTSP curriculum to the 2013 curriculum. The 2013 curriculum emphasizes the principle of student character that prepares the best graduates to have the ability to live as individuals who are creative, critical, innovative, and able to contribute positively to society. Physics are one of the lessons contained in the 2013 curriculum. Physics lessons are science that study natural phenomena around us. 21st century learning in physics is greatly related to innovating science and technology. Science and
technology-based learning can create human resources who have competent scientific reasoning skill, and the ability to develop for the better [3].

In addition to making curriculum changes to improve the quality of education, educators also play an essential role in this. One way is to apply appropriate learning approaches and answer the challenges of 21st century learning. One approach that can be applied in learning physics is the Ethno-STEM approach. The Ethno-STEM approach is an approach that collaborates the Ethnoscience approach and the STEM approach. The Ethno-STEM approach involves four aspects of STEM (science, technology, Engineering, and Mathematic) which are based on local culture and knowledge of the surrounding community to make students develop critical, creative, innovative and collaborative attitudes [4].

The Ethno-STEM approach is said to be a significant approach because the science applied in an area must be in accordance with the local culture or unique knowledge in the surrounding community that can help achieve the success of 21st century learning. The STEM aspect of this approach requires students to memorize only concepts, but this approach emphasizes students on how the concept of science and its relationship as well as the role of science in technology and our everyday’s life [5].

The application of the Ethno-STEM approach that is suitable in learning will certainly require students to think creatively and critically. As the students are required to be more competent, the teachers are also demanded to be more creative in developing teaching materials and also the techniques in teaching so that learning can run smoothly and in accordance with what is expected. The use of teaching materials in learning will certainly affect student learning outcomes. One of the teaching materials that can be used in physics learning is a Module.

Module teaching materials are systematically crafted teaching materials that adhere to a certain curriculum so that it can be designed accordingly to enable students in study independently in a certain time unit [6]. According to Asrizal [7], the module is a systematic teaching material that is in accordance with the objectives to be achieved in accordance with the characteristics and needs of students, so that students can learn independently or without guidance from the teacher. In the industrial revolution era 4.0, the use of technology in everyday’s life is inevitable. This, definitely, applies in education. The use of technology in education will certainly have a positive impact as it is in accordance to the expected learning objectives. The use of technology in learning can of course be used in teaching materials such as electronic modules or what is called an E-Module. E-Modules or electronic modules are alternative media that provides systematic learning so that students can learn independently to achieve certain learning objectives which is presented in electronic form, such as animation, video, interactive audio [8]. One of the advantages of E-Module is that the teaching material can be used on a smartphone, so that the teaching material is efficient and portable.

Based on this explanation, learning Physics using the Ethno-STEM approach is very important in 21st century learning. The use of smartphone-based E-modules can also support the process in 21st century learning. Therefore, this study aims to describe the students’ initial knowledge and learning styles using smartphones, the application of the Ethno-STEM approach in learning, and the use of teaching materials used in physics learning. So from this it can be useful as a basis for developing a smartphone-based E-module using the Ethno-STEM approach.

2. Research Method

This preliminary study research is a descriptive study conducted in three schools, namely SMA Negeri 1 Padang, SMA Adabbiyah Padang, and SMA Negeri 12 Padang. The subjects of this study consisted of 29 students of grade 11 Mathematics and Natural Sciences and 2 physics teachers in grade 11th from each school. This research was conducted in February 2020. Data collection techniques in this study are student questionnaires, teacher questionnaires and teacher interviews. The results of student analysis and analysis of learning activities will be displayed in graphs and analyzed descriptively.

The questionnaire scale uses a Likert scale consisting of four answers that are presented. The value obtained from each questionnaire statement will be processed with the following equation [9].
The value categories can be classified in Table 1 below.

| No. | Score      | Category       |
|-----|------------|----------------|
| 1   | $90 > \text{score} \leq 100$ | Very Good (A)  |
| 2   | $75 < B \leq 90$          | Good (B)       |
| 3   | $60 < C \leq 75$          | Less (C)       |
| 4   | $\leq 60$                 | Very Less (D)  |

3. Result and Discussion

The results of this study are the percentage of student analysis, analysis of learning activities and analysis of interview results related to teaching materials and the Ethno-STEM (Ethnoscience - Science, Technology, Engineering, Mathematics) approach. The results of the analysis that have been carried out are as follows.

3.1. Analysis of students

Analysis of student was carried out using a questionnaire which was divided into several indicators, namely student knowledge, student skills, student learning interests, and student learning styles using smartphones where each indicator consisted of each statement. The results of the student analysis can be seen in Figure 1 as follows.

Based on Figure 1, it can be seen that the analysis of students in various indicators and each school has varying values. In SMA Negeri 1 Padang, the highest indicator lies in student interest in learning with a percentage of 81% in the good category, while the lowest indicator is on students' knowledge with a percentage of 68% in the unfavorable category. The average analysis of students at SMA Negeri 1 obtained a percentage of 77% in the good category. Analysis of students at SMA Adabbiyah Padang has the highest indicator of student skills with a good percentage of 76% and the lowest indicator is on student knowledge with a percentage of 62%. The average analysis of SMA Adabiyah Padang students has a percentage of 70% who are in the good category.

For the analysis of SMA Negeri 12 Padang students, the highest indicator was in the indicator of student learning style using a smartphone with a percentage of 70% in the good category and the lowest indicator was on the indicator of student knowledge with a percentage of 57% who were in the very poor category. The average analysis of SMA Negeri 12 students has a percentage of 66% in the
less category. Especially in the learning styles of students using smartphones, it can be seen that students from the three schools have a tendency to use smartphones in learning.

3.2. Analysis of Learning Activities
The analysis of learning activities carried out in this study includes several indicators such as elements of preliminary activities, application of the Ethno-STEM approach, learning resources and elements of closing activities. The statement of each of these indicators leads to 21st Century learning and the Ethnho-STEM approach. Analysis of learning activities can be seen in Figure 2 as follows.

Figure 2 shows the results of the analysis of learning activities for three schools. The analysis of learning activities carried out at SMA Negeri 1 obtained the highest indicator on the closing activity element indicator with a percentage of 83% in the good category and the lowest indicator on the indicator for the application of the Ethno-STEM approach with a percentage of 67% in the less category. For the analysis of learning activities in SMA Adabiyah Padang, the highest indicator was found in the preliminary activity element indicator with a percentage of 81% in the good category, while the lowest indicator was on the indicator for the application of the Ethno-STEM approach with a percentage of 57% in the category of very less.

The analysis of learning activities at SMA Negeri 12 obtained the highest indicator on the element indicator of preliminary activities with a percentage of 70% who were in the less category, while the lowest indicator was on the indicator of the application of the Ethno-STEM approach which had a percentage value of 54% in the very less category. From the analysis of the learning activities of the three schools, it was found that the indicators for the application of the Ethnho-STEM approach were minimal in class, followed by indicators of learning resources which indicated that learning resources in learning Physics needed to be enhanced.

3.3. Interview Result
The technique of collecting data through interviews uses a question sheet which is used as a reference for questions. The questions posed to each of the two teachers in each school are questions related to the implementation of learning Physics in class, learning using the Ethno-STEM approach, the constraints and causes of problems in learning Physics, and the use of E-Module teaching materials in learning. Regarding Physics learning in class in general, the three schools have implemented learning well, but the methods used are still not varied and mostly use the lecture method. In solving the concept the teacher has directed students to find their own concepts, but there are still obstacles related
to how to find these concepts. In terms of implementing the Ethno-STEM approach in learning, the three schools have never applied this approach. Learning in the classroom is still fixated based on teaching materials such as books and student worksheets which are libraries, but from the indicators of the Ethno-STEM approach, Science indicators have been applied. The Ethno-STEM approach has never been heard of and has not been understood. After the researcher explained the Ethno-STEM approach in general, teachers from the three schools gave a positive response so that the approach could be applied in certain chapter learning Physics.

For the constraints and causes faced in learning Physics as a whole, the obstacles faced by the teacher is the students lacking in understanding Physics learning and less in imagining the phenomenon. One of the causes is the lack of availability of media as an efficient and effective learning resource or teaching material to assist students in capturing physics phenomena related to learning. Due to this, the interviews with each teacher were continued with questions related to the E-Module Physics teaching materials. From the interviews conducted, it was found that teachers from the three schools had never used Physics E-Module teaching materials and had not yet implemented the Ethno-STEM integrated Physics E-Module. Teachers from the three schools are also interested in developing an integrated E-Module of the Ethno-STEM Approach in Physics learning, but the E-Module must be efficient, effective and in accordance with the desired learning objectives and in accordance with 21st Century learning.

Based on the results of the analysis that has been carried out, there are problems in the learning resources used that are not yet in the good category in the two schools. For the Ethno-STEM approach, the three schools are still in the very less category. From the results of the interviews, the teachers were interested in developing E-Module teaching materials as an effort to improve students' thinking skills. This is also supported by Sujanem [11], that the application of E-Module in Physical learning can improve student learning outcomes effectively. According to the students’ analysis, the use of smartphones in learning from the three schools is fairly high, This indicates that students are more interested and tend to use smartphones in learning. Therefore, this is an opportunity to make teaching materials that can be used by students via smartphones. Thoroughly, based on input from teachers, the teaching material must be effective, efficient, and in accordance with the desired learning objectives and in accordance with 21st Century learning.

4. Conclusion
Based on the preliminary study that has been conducted, it was found that the three schools have never applied the Ethno-STEM approach and smartphone-based E-Module teaching materials in physics learning. In order to support 21st century learning, smartphone-based teaching materials are needed, namely E-Module which is integrated with the Ethno-STEM approach. E-Module teaching materials developed must be effective, efficient and in accordance with the learning objectives, so that students can easily understand physics lessons on E-Module presented in learning.

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