Preliminary study of development of physics e-module using smartphone-assisted inquiry based learning models to support 21st century learning

M Risma* and Yulkifli

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

*mutiarisma10@gmail.com

Abstract. The 21st century requires use of technology in learning. One technological device is smartphone. Smartphone-assisted learning materials are expected to increase the independence and competence of students. In addition, the learning model used must also be adapted to the curriculum and characteristics of the subjects. Facts at school show that learning hasn’t fully utilized technology. The learning material used is still in printed form and hasn’t been integrated with the learning model. This causes the student's competency achievement to be less than optimal. Starting from the explanation, it takes learning materials in the form of e-modules using the Inquiry Based Learning model assisted by smartphones to facilitate students learning wherever and whenever. The purpose of this study was to analyze the development of the Physics e-module using a smartphone-assisted Inquiry Based Learning model for class X. The analysis conducted in this study was in the form of an analysis of needs, student characteristics, learning materials, and task analysis. The instrument used was a questionnaire sheet. The research method used was a quantitative descriptive study with the study sample were students of SMAN 3 Padang, SMA Pembangunan Laboratorium UNP and SMAN 12 Padang. The results of this study are descriptive data.

1. Introduction

The 21st century is a century marked by the rapid development of science and technology. As a result, all aspects of life experience progress and acceleration, which is marked by the fusion of time and space factors due to the use of technology. Indirectly, this condition demands the formation of quality human resources through quality education as well. For this reason, all educational devices must be able to positively balance the rapid development of science and technology[1]. An example is the use of various information and communication technology tools in education, especially in the learning process.

One of the information and communication technology devices is a smartphone. There are four main principles of 21st century education, including: a) Student centered learning, b) Collaborative, c) Contextual and d) Integrated with everyday life[2]. If these four indicators are well mastered, the learning objectives will be maximally achieved. Learning can be said to be good if it can give birth to students who have high-order thinking skills, creativity, communication skills (both verbal and written) and research skills with the aim of problem solving[3].

The use of smart phones in learning is expected to increase students’ independence and interest in learning physics. 21st century learning requires technology integration as a learning medium to
develop learning skills. Moreover, when the Covid-19 pandemic hit the world, the use of smartphones and smartphone-assisted learning materials greatly helped the implementation of the learning process. In addition, learning using smartphones can also support learning independence in 21st century learning.

With regard to the explanation that has been presented, in order to improve the quality of human resources and education, various efforts have been made by the government, one of which is through curriculum changes and improvement of the learning process. The KTSP curriculum was refined into the 2013 curriculum. The development or refinement of this curriculum is at the same time changing the learning paradigm that was originally centered on educators towards student-centered learning. This is so that students can develop their competence thoroughly, actively and responsibly in responding to the demands of the 21st century.

Having been involved in 21st century education, of course, the learning model used must be adjusted in order to meet the demands and challenges of life in the 21st century. The 21st century learning model cannot be separated from the characteristics of 21st century learning itself. The characteristics of 21st century learning have implications for the learning model used. The characteristics of learning in the 21st century are a) Information can be obtained easily so that the model used must be able to increase the activeness of students in exploring information, b) Work becomes easier with the use of technology so that the model used must motivate students to solve problems independently, c) All work can be completed so that the model used must be able to train analytical thinking skills, and d) Communication can be done anytime and anywhere so that the model used must train students' collaboration and communication skills. One learning model that fits the characteristics of 21st century learning is inquiry based learning.

Inquiry is the process of defining and investigating problems. Inquiry can also be interpreted as a way to gain knowledge through the inquiry process. The inquiry based learning model is a learning model that aims to obtain and obtain information by making observations or experiments to find answers to a problem using critical and logical thinking skills. By using this inquiry based learning model, students are required to seek information from various learning sources, be able to think critically and creatively in problem solving, be able to integrate technology in learning, and have good communication and collaboration skills in accordance with the characteristics of 21st century learning. The steps of the inquiry based learning model include orientation (stimulating curiosity about the topic and providing learning challenges through statements), conceptualization (raising theory-based or hypothesis questions), investigation (the process of planning experiments, collecting and analyzing experimental data), conclusion (drawing conclusions) and discussion (communicating the results). From this explanation it can be said that physics learning which is carried out using the inquiry-based learning models can increase competence and help to achieve 21st and K13 century educational goals.

The learning process is said to be effective if it uses the right learning materials. Learning materials are all forms of materials used to assist educators / instructors in carrying out learning activities. One of the learning materials is a module. The module is a series of complete learning activities, which are structured to make it easier for students to achieve learning goals. Similar to modules, e-modules or electronic modules are a form of independent learning materials that are systematically arranged to achieve learning objectives presented in electronic format. E-module contains at least learning instructions, competencies to be achieved, material content, supporting information, practice questions, student worksheets, evaluation, feedback, pictures, videos, animation and audio.

The facts found in schools indicate that the modules used are still in print and have not fully utilized technological devices in the learning process. In fact, the modules needed are modules that are attractive and integrate study manuals, multimedia and even online sites that can be accessed by students. In addition, learning is still centered on educators who are dominated by the lecture method. In fact, the 21st century requires learning that prioritizes and presents the active participation of students. Starting from the explanation, it is necessary to develop physics learning materials by applying appropriate learning models that can be operated using technological devices to make it easier for students to learn.
One solution to this problem is to develop an electronic module (e-module) of physics using an inquiry-based learning model that can be operated using a smartphone. The object of this research is a physics e-module using an inquiry-based learning model. Before carrying out development research, an initial analysis is needed as a basis for research. Therefore, a preliminary study research was carried out which aims to describe the initial analysis of the development of a physics e-module for grade X high school students using a smartphone-assisted inquiry learning model to support 21st century learning.

2. Research Method

This study used a qualitative descriptive research method which was conducted in February and March 2020. The purpose of this study was to analyze the needs and characteristics of students for e-module physics in 21st century learning. The research instrument used was in the form of teacher and participant observation questionnaires. The research samples were students of class X at SMAN 3 Padang, SMAN 12 Padang and SMA Pembangunan Laboratorium UNP. The data obtained from this research is qualitative data that is processed in percentage form and explained scientifically.

3. Result and Discussion

3.1. Results

Problems encountered during the preliminary study can be overcome by developing e-modules using the Inquiry Based Learning model. Data analysis was performed using a needs analysis questionnaire and a student observation questionnaire. The needs analysis carried out consists of several aspects, including performance analysis, graduation standards, and learning difficulties analysis. Analysis of student criteria from several aspects, including interest and motivation to learn, learning styles and student competencies.

3.1.1. Result of Need Analysis

Needs analysis is a very important initial stage in developing a learning product, in this case a scientific literacy integrated e-module of physics. If the needs that support the learning process have been fulfilled, it can be said that education is of good quality. The results of the needs analysis can be described through performance analysis, analysis of graduation standards and analysis of learning difficulties of students.

3.1.2. Results of Performance Analysis

The purpose of performing a performance analysis is to obtain an overview of the performance that students should master after the learning process takes place. Performance analysis is viewed from the identification of teachers and the completeness of existing facilities and infrastructure in the educational environment. Students can form a good performance if the identification of good teachers and adequate infrastructure. Based on the results of data processing, it was found that the performance analysis carried out in SMA N 3 Padang, SMAN 12 Padang and SMA Pembangunan Laboratorium UNP was as shown in Figure 1.
Figure 1. Performance Analysis

The ability of the teacher to create an attractive learning atmosphere is very dependent on the learning model and learning materials used, as well as the role of the teacher in the learning process. Based on Figure 1, it can be seen that the teacher's ability to create a good learning process has not been optimally realized. This can be seen from the average percentage value of teacher identification at SMAN 3 Padang, SMAN 12 Padang and SMA Pembangunan Laboratorium UNP, which is 55.80%. The results of the questionnaire analysis of the facilities and infrastructure in the three sample schools showed that the facilities and infrastructure in the school were quite good, however, the completeness of the facilities and infrastructure was still lacking in terms of the use of physics laboratory equipment for practicum activities. Physics practicum activities are rarely carried out. In addition, most of the learning materials used in schools are only printed learning materials and the limited use of school wifi for students. This is in accordance with the results of data processing shown in Figure 1, the percentage of completeness of the facilities and infrastructure in the three schools observed was 58.40%.

The teacher's ability to create an attractive learning atmosphere is very useful in the learning model and learning material used, as well as the teacher's role in the learning process. Based on Figure 1, it can be seen that the teacher's ability to create a good learning process has not been optimally realized. This can be seen from the assessment of the proportion of teachers in SMAN 3 Padang, SMAN 12 Padang and SMA Pembangunan Laboratorium UNP at 56.75%, 54.68% and 55.98%. The results of the questionnaire analysis of the facilities and infrastructure of the three sample schools showed that the facilities and infrastructure in the school were quite good, but the complete facilities and infrastructure were still lacking in the use of physics laboratory equipment for practicum activities. Physics practicum activities are still rarely done. In addition, most of the teaching materials used in schools are only printed materials and the use of school wifi for students is still limited. This is in accordance with the results of data processing shown in Figure 1, the proportion of completeness of facilities and infrastructure in the three schools observed was 60.04%, 58.31% and 56.86%.

3.1.3. Results of Graduation Standards Analysis
Analysis of graduate competency standards is an assessment guideline in determining whether students pass or not. According to the government regulation of the Republic of Indonesia number 19 of 2005, the competency standards for graduates are competencies that must be possessed by graduates that include attitudes, knowledge and skills. The following is the average value of the competence attitudes, knowledge and skills of students from the three schools described in Figure 2.
Figure 2. Graduation Standards Analysis

Based on Figure 2, the results of the analysis of the competency standards of graduates in the three sample schools show varying scores. Among the four existing indicators, the attitude competence of students has the highest percentage compared to knowledge and skills competencies. Of the three schools that were observed, the average competence for spiritual attitudes and social attitudes was 80.12% and 72.68%. The percentage of knowledge obtained is 59.35%. Meanwhile, the lowest competency percentage was skills competency, which was 55.68%. In the physics learning process, the skills of students can be trained through discussion activities in class and practicum in the laboratory.

Meanwhile, the competence of students' skills is not optimal due to the inadequate implementation of practicum activities in schools. This certainly affects the direct learning experience of students, so that it also impacts on the lack of maximum competence obtained. Based on the data obtained from student questionnaires, physics practicum or demonstrations in class cannot be done for every Basic Competency that is learned because of limited time and inadequate physics practicum tools. Starting from this explanation, a more effective practicum method is needed, one of which is by doing a virtual practicum. Practicum is virtually very effective in terms of time and the practicum tools used.

3.1.4. Results of Learning Difficulty Analysis

One of the things that is very important in the preliminary study is the analysis of learning difficulties. The purpose of the analysis of learning difficulties is to determine the factors that cause learning difficulties of students and to find alternatives to minimize these difficulties. One solution to minimize learning difficulties is to take advantage of technology in learning and use appropriate, interesting and effective learning materials for students. One of the learning materials that can be used in physics learning is a module.

The Covid-19 pandemic requires students to keep learning but must keep their distance from each other. Thus, electronic modules can be the main alternative that students can use to learn independently. Digital learning that utilizes technology in the learning process is in accordance with the demands of 21st century learning. In addition, one of the learning models that can be used in learning physics is the Inquiry Based Learning model. This is because physics is a natural science whose development cannot be separated from the results of scientific research, so it is very suitable if this inquiry-based learning model is used in physics learning.

The results of the analysis of the average learning difficulties faced by class X students based on the aspects of the learning model used, the learning materials (modules) used and the technology in learning can be seen in Figure 3.
Figure 3. Learning Difficulty Analysis

Based on Figure 3, it can be understood that the learning difficulties of students are caused by the application of learning models, learning modules and technology in learning that are not optimal. The percentage of the implementation of the learning model according to the 2013 curriculum was obtained at 54%. Furthermore, the module used has a percentage of 60% and the application of technology in learning has not been maximized with a percentage of 52%. In order for learning difficulties to be resolved properly, the three indicators according to Figure 3 must be implemented optimally. Therefore, the electronic module uses the right learning model to achieve optimal learning goals.

3.1.5. Results of Characteristics Analysis of Students

Analysis of the characteristics of students is one of the important indicators that must be considered and taken into account by the teacher in designing learning. This is because every human being has unique and different characteristics. There are several indicators that can be used to analyze the characteristics of students. These indicators include: interest and motivation of students towards learning physics, learning styles and competence of students. The competence of students consists of three aspects, namely the competence of attitudes, knowledge and skills. The results of the analysis of the characteristics of students in the three sample schools are shown in Figure 4.

Figure 4. Characteristics Analysis of students

Based on the results of data analysis in Figure 4, it can be seen that the interest and motivation of students towards learning physics has not been maximal. This is indicated by a percentage of 63%.
The low interest and motivation of students in these three schools is caused by the lack of curiosity of students towards learning physics. Why is that? This is due to the thinking of students who think physics learning is learning that is difficult to understand so that students are less interested in solving physics problems.

Furthermore, in terms of learning style aspects, students have varied learning styles. However, the similarity lies in a higher interest in learning physics by using technological devices and learning media in the form of videos, thus enabling students to better understand the material. 70.81% of students stated that learning physics using technological devices and instructional media in the form of video was more attractive to students than learning which focused more on educators and only recorded what the teacher said.

Finally, the analysis of the characteristics of students is seen from the overall competence. Among the three existing competencies, attitude competency obtained the highest percentage, namely 78%. This shows that the attitude competence of students is better than the competence of knowledge (69.03%) and skills (68.23%). Based on this explanation, it is necessary to improve the quality of learning. Knowledge and skills competencies should be better so they can contribute to the life of the 21st century.

3.2. Discussion
Learning in the 21st century cannot be separated from the use of technology. For that, like it or not, various aspects of education will involve technological devices in it. This requires proficient and technologically responsive aspects of education. Learning activities will be of higher quality if all components or aspects involved support one another. These aspects of education are teachers, students, the learning process that includes materials and methods, tools / media, facilities and infrastructure as well as learning evaluation[14]. Educators as regulators of the course of learning must be able to create a pleasant learning atmosphere using learning models and learning materials that are also interesting. One type of learning material is a module. Good modules are arranged according to the 2013 curriculum rules. The modules used in schools are generally still in the form of print modules so that they do not support the digital learning process which requires the use of technology in learning.

Furthermore, the learning model used must be in accordance with the characteristics of the subjects. Physics is a science that is closely related to the collection of knowledge, ways of thinking and investigation[15]. Learning model is a pattern or learning steps to achieve learning objectives[16]. Educators must have an understanding and the ability to apply a model in learning to make it fun for students. One type of learning model that suits the characteristics of physics learning is inquiry based learning. Inquiry based learning is an inquiry based learning model. This model demands the activeness of students, where students carry out their own investigations or experiments and the teacher is only a facilitator. The investigation in question is a practicum activity in a laboratory that aims to investigate or prove the truth of a physics concept that has been studied. However, in fact, the learning model used in schools is still centered on educators so that it does not involve students in it.

Physics practicum activities can be carried out if the facilities and infrastructure to support the implementation of the practicum are completely available at school. From the preliminary studies that have been carried out, it is found that the facilities and infrastructure available in schools are still inadequate for practicum activities. Physics practicum activities at schools cannot be carried out optimally because of the incomplete physics practicum tools in schools, both in terms of the number and quality of tools that are no longer suitable for use. Apart from the limitations of the tools, the cause of the not optimal implementation of practicum activities is the limited time or hours of study, 3 hours for class X. So that practicum activities are needed in a virtual way as a substitute for real practicum in the laboratory.

The learning activities carried out should be able to increase the overall competence of students, both knowledge, attitudes and skills. Therefore, we need a learning module with an appropriate model to help increase these competencies. Determination of the learning model to be used must be adjusted
to the characteristics of students. In this case, the characteristics of students have been analyzed which include aspects of interest and motivation to learn, learning styles, as well as competence attitudes, knowledge and skills of students. Indirectly, one aspect affects other aspects. If the motivation and interest of students are good, the competence of students will also be better.

Based on the results of the analysis of the characteristics of students, it was found that the students’ learning interest and motivation were still low. In addition, the competence of attitudes, knowledge and skills of students is still not good and not optimal. Therefore, this preliminary study research can be used as the basis for developing a physics e-module using a smartphone-assisted Inquiry Based Learning model to support 21st century learning.

4. Conclusions
The results of preliminary studies or preliminary analyzes that have been carried out show that the implementation of the physics learning process for class X SMA is not yet fully in accordance with the demands of the 21st century. This is evidenced by the results of the needs analysis and analysis of the characteristics of students which are still low. Therefore, it is necessary to develop an integrated physics e-module in an inquiry based learning model that can be operated using a smartphone to increase the overall competence of students, be it attitudes, knowledge, and skills.

Acknowledgments
The author would like to thank lecturers who have provided motivation and constructive suggestions for the perfection of this article. In addition, the authors also express gratitude to the extended family of SMAN 3 Padang, SMAN 12 Padang and SMA UNP Laboratory Development who have given permission and assistance during the research. Hopefully the results of this research can be useful for readers and can be used as well as possible.

References
[1] Khairul A, Dadi R, Ida K and Sparisoma 2018 Profil Pembelajaran dan Pengajaran Fisika yang Sesuai Abad 21 Jurnal Paedagoria 8 (2) 16-23.
[2] Nicols and Jennifer 2013 4 Essential Rules Of 21th Century Learning. 1-3.
[3] Tri S, Zulhendri K and Asrizal 2018 Pengaruh Model Pembelajaran Kontekstual Adaptif Pada Tema Kesehatan Pencernaan Terhadap Kompetensi IPA Siswa Kelas VIII SMPN 8 Padang Pillar of Physics Education 11.
[4] Anjarsari P 2014 Literasi Sains dalam Kurikulum dan Pembelajaran IPA SMP. Prosiding Semnas Pensa VI Peran Literasi Sains.
[5] Kemendikbud 2014 Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia Nomor 59 Tahun 2014 Tentang Kurikulum 2013 Sekolah Menengah Atas/Madrasah Aliyah (Jakarta: Depdikbud).
[6] Indran F T 2012 Model Pembelajaran Inquiri (Dinamika Edukasi Dasar).
[7] Hebrank M 2000. Why Inquiry-Based Teaching and Learning in the Middle School Science Classroom? (Center for Inquiry-Based Learning Dept.of Biology: Duke University).
[8] Depdiknas 2008 Panduan pengembangan bahan Ajar (Jakarta : Direktorat pembinaan Sekolah Menangah Atas).
[9] Nasution S 2008 Modul Berbasis Pendekatan dalam Proses Belajar dan Mengajar (Jakarta: Bumi Aksara).
[10] Daryanto 2013 Menyusun Model Bahan Ajar untuk Persiapan Guru dalam Mengajar (Yogyakarta: Gava Media).
[11] Muhammad A 2019 Peran Bahan Ajar Digital Sigil Dalam Mempersiapkan Kemandirian Belajar Peserta Didik Jurnal Teknodik 23(2) 99-110.
[12] Slameto, Wardani N S and Kristin F 2016 Strategi Belajar Mengajar (Jakarta: Rineka Cipta).
[13] John Alfin 2015 Analisis Karakteristik Siswa Pada Tingkat Sekolah Dasar In Prosiding Halaqoh Nasional & Seminar Internasional Pendidikan Islam.

[14] A. Falah, "Studi Analisis Aspek-Aspek Keberhasilan Pembelajaran Pendidikan Agama Islam di SDN 01 Karangmalang Gebog Kudus," Jurnal Elementary, Vol. 3, No. 1, Pp. 171-194, 2015.

[15] N. Fitriani, Gunawan And Sutrio, "Berpikir Kreatif Dalam Fisika Dengan Pembelajaran Conceptual Understanding Prosedures (CUPS) Berbantuan LKPD," Jurnal Pendidikan Fisika dan Teknologi, Vol. 2, No. 4, Pp. 1-7, 2017.

[16] Asrizal, A. Amran, A. Ananda and Festiyed 2018 "Development Of Adaptive Contextual Teaching Model Of Integrated Science To Improve Digital Age Literacy On Grade VIII Students," Journal Of Physics: Conference Series, Pp. 1-9.