Preliminary analysis of physics lab textbooks using project based learning model to improve the scientific skills of high school students

Yosi Dwi Anggreni\textsuperscript{1,2} and Yohandri*\textsuperscript{1}

\textsuperscript{1}Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, Jl. Prof Hamka, Padang 25131, Indonesia
\textsuperscript{2}Physics Teacher, SMA N 2 Bukittinggi (Senior High School Number 2 at Bukittinggi City), Jl. Jend. Sudirman no. 5 ABTB, Bukittinggi, Indonesia

*yohandri.unp@gmail.com

Abstract. Physics lab textbook are guides that can help students in physics practice. According to the 2013 curriculum, physics learning requires students to develop 21st century skills, namely Learning and Innovation Skills. One of the learning models in accordance with the demands of this curriculum is Project Based Learning. Through this learning model, students can develop their skills in critical thinking, creative, collaboration and able to communicate to design experiments to produce products in physics practice. Through physics practicum, students should be able to develop scientific skills. The reality was found out, there was still a lack of physics practicum teaching materials, so physics was studied only theoretically. The study goals are to survey the analysis of the needs of teaching materials in schools that are needed in physics practical. This type of the research is analysis descriptive. The instruments research consist of questionnaires and observation sheet. The result of this study prove that it is necessary to develop teaching materials in the form of practical teaching book based on the Project Based Learning model to improve students scientific skill.

1. Introduction

Twenty First Century National Education aims to realize the ideals, welfare and happiness of the people, an honorable position and live in line with other nations in the international world through a society with quality human resources. Education should be able to create a generation of gold that is able to compete according to the demands of an increasingly competitive era and increasingly advanced technology. The world of education has always undergone changes in terms of curriculum, until the 2013 curriculum was implemented in accordance with twenty first century skills.

2013 curriculum requires teachers to change their teaching habits. Learning that is usually teacher-centered must change patterns to be student-centered. According to Permendikbud No 22 of 2016 states that the learning process in educational units is held in an interactive, inspirational, fun, challenging, motivating students to actively participate, and provide sufficient space for initiatives, creativity, and independence according to their talents of interest, and physical and psychological development learners. The teacher must act as a facilitator, encouraging students to think critically using various strategies. One focus of the implementation of the revised edition of the 2013 curriculum according to
the Ministry of Education and Culture 2016 is to realize 21st century learning namely character quality, literacy, and 4 C (critical thinking, creativity, collaboration and communication).

Physics learning is one of the lessons that can provide students with 21st century skills, namely learning and innovation skills. The purpose of physics learning in accordance with the 2013 curriculum is to master the concepts, principles of physics, have the skills to develop knowledge and attitudes of confidence as provisions to develop knowledge (Abidin, 2014). This means, students are not only required to be able to master the physics concept but also must be able to apply the concept to develop their scientific skills. Scientific skills are related to scientific work (scientific), scientific methods and scientific attitudes of students. It starts from students formulating problems, hypothesizes, designing experiments, conducting experiments, processing data, analyzing data, and drawing conclusions. Students will not only learn physics but also train their ability to innovate to create physics products.

Physics learning that can develop students' scientific skills is learning through practical activities. In fact, there are many theoretical learning physics. Students are continuously trained to be able to work on only the questions, which are seen only results without seeing the process. While the process in practical activities provides many benefits, because the true nature of physics is a product and a scientific process. Practical activities should be done varied, so that the demands of the curriculum in accordance with 21st century skills are achieved. The constraints faced by physics teachers are the lack of availability teaching materials or practicum guides, so that practicum activities are not carried out properly. Students also rarely meet teaching materials that explain the physics experiments that produce a product based on the concepts they learn. Teaching materials used in learning are not in accordance with the learning needs of students. Teaching materials provided have not made students think critically and creatively in accordance with curriculum objectives.

One of the learning models that can be applied in accordance with the demands of the twenty first century skills is Project Based Learning. Through this learning model, students can develop 21st century skills in designing experiments to produce products through physical practicum activities. This learning model provides opportunities for students to be creative and innovative. Students really work doing experiments and producing real products. Therefore we need teaching materials in the form of practical textbooks. So in this study an analysis of the process of high school physics learning was carried out using practical textbooks using on Project Based Learning model to develop scientific skills.

2. Research Method
This study uses descriptive analysis methods. This descriptive study aims to survey the needs analysis of teaching materials needed in physics practicums in schools. Data taken in this study were obtained from interviews and observations with physics teachers and students of class XI MIPA 1, XI MIPA 2, XI MIPA 3, XI MIPA 4, and XI MIPA 5 and direct observation. This research was conducted at SMAN 2 Bukittinggi.

The research instrument used consisted of a questionnaire sheet and an observation sheet. Data collection techniques were also carried out by direct interviews with the teacher about the problems encountered in learning physics. The questionnaire contains 5 aspects, namely the carrying capacity of physical practicum activities, the implementation of physics practicums, physical practicum barriers, physical material analysis, and analysis of teaching material requirements. Data regarding the carrying capacity, implementation, and constraints of physical practicum using the dichotomy scale, yes or no. Furthermore, the data obtained were categorized and analyzed descriptively to obtain data as needed. The material analysis of physics is done by analyzing Basic Competencies. The analysis of the needs of teaching materials is used to find out effective teaching materials used in learning. Data obtained from analysis in the form of percentages.

3. Results and Discussion
Interviews and direct observations with educators and students are carried out on the stairs June 15, 2019. Based on the results of interviews conducted it turned out to have the same problems. The results of the analysis of interviews with teachers can be seen in table 1.
Table 1. Analysis of interviews with teachers

| No | Question | Response |
|----|----------|----------|
| 1  | Based on your experience teach physics, what are the learning outcomes of students? | Many students have not been completed and remedial |
| 2  | What learning methods do you usually use to teach physics concepts? | Lecture and discussion |
| 3  | How many times have you practiced physics? | Very rarely, once a semester |
| 4  | According to you, is physics required for teaching materials? | Very necessary as a learning resource |
| 5  | What teaching materials have you used? | Diktat, handouts, and modules |
| 6  | What are the weaknesses of the teaching materials that you have used? | Not interesting and not yet in accordance with curriculum requirements |
| 7  | What kind of teaching material do you need to teach physics concepts according to the 2013 curriculum developing 21st century skills? | Teaching materials that can stimulate students to be active, creative, and innovative in learning |
| 8  | In physics learning that you teach, can students produce simple products based on the concepts that you teach? | Not yet, still around 5% |
| 9  | According to you, are teaching materials about physics practicum already available at school? | Not yet |
| 10 | According to you, can scientific skills be developed by students through physics learning? | So far not yet |
| 11 | What are the obstacles of you in teaching physics concepts through practicum? | There is no guide or book specifically practicum |
| 12 | What do you expect after using teaching materials that are in accordance with the curriculum? | Students have 21st century skills |

Based on the analysis of interviews with educators, it was concluded that the physics learning objectives that were in accordance with the 2013 curriculum had not been maximally achieved. Learning still uses lecture and discussion methods. The experimental method through practical activities has not been implemented properly. Learning is still teacher-centered because students cannot yet realize learning and innovation skills in learning. This is due to the unavailability of teaching materials as a practical guide. Teachers still find it difficult to teach physics through scientific performance because learning resources are still inadequate.

Analysis of questionnaires distributed to 178 students regarding the carrying capacity of the school towards physics practicum activities can be seen in table 2. below:
Table 2. Analysis of school carrying capacity for physical practicum activities

| No | Item                                                                 | Students Responses Percentage (%) |
|----|-----------------------------------------------------------------------|-----------------------------------|
|    |                                                                       | Yes  | No   |
| 1. | The school has a physics laboratory                                  | 95,6 | 4,4  |
| 2. | The laboratory is equipped with a practicum manual                   | 8,5  | 91,5 |
| 3. | Practical textbooks available at school library                       | 10   | 90   |
| 4. | Practical equipment as needed                                         | 15   | 85   |
| 5. | The teacher has mastered good practical methods                       | 25   | 75   |

Based on the analysis results above, the school already has a physics laboratory, but it has not been maximized for practical activities. About 91.5% of students stated that practicum guidebooks were not yet available in the laboratory, and 90% of students who stated that practicum textbooks were also not available in the library. Practical equipment was not available as needed, students who stated this was around 85%. Students also stated that 75% of teachers had not mastered a good physics practicum method. This is the obstacle to learning physics through practical activities that have not been implemented optimally.

Analysis of the implementation of physics practicum activities in schools can be seen in table 3. below:

Table 3. Analysis of the implementation of practical activities

| No | Item                                                                                     | Student responses percentage (%) |
|----|-------------------------------------------------------------------------------------------|----------------------------------|
|    |                                                                                           | Yes  | No   |
| 1. | Practicum is implemented for every Basic Competency skill                                | 10   | 90   |
| 2. | Practicum is carried out to conduct experiments                                          | 42   | 58   |
| 3. | Practicum is carried out to make a device / product of physics                           | 4,5  | 95,5 |
| 4. | Practicum is held 1-2 times per semester                                                 | 48   | 52   |
| 5. | Practicum is held 5-6 times per semester                                                 | 0    | 100  |
| 6. | Practicum has never been carried out in one semester                                     | 40   | 60   |

The description of the implementation of physics practicum activities can be seen from the table above. It is seen that practicum is not carried out at the Basic Competency Stiak in the aspect of skills. As many as 58% of students stated that the practicum was not for conducting experiments, even 95.5% of students stated that there were no physical products produced through practicum. Practicum is held, only in very few frequencies, namely 1-2 times in one semester. It was seen that only 48% of students
said that, even some students had never practiced in one semester. From this analysis, it can be concluded that students have not been able to improve their scientific skills, because the dominant learning in the classroom is by learning theories and practice questions.

Obstacles to the implementation of practical activities in learning can be seen in table 4 in the following. The main obstacle felt by students was the absence of a practical guidebook that was in accordance with the demands of the 21st century skills (98%). In addition, the absence of a guidebook for making tools is also a dominant obstacle in the implementation of practical activities. Approximately 96% of students experience difficulties in applying physical concepts in real terms. So that the enthusiasm and interest of students learning physics becomes reduced. It is seen that only 30% of students are motivated to learn through lecture and discussion methods. Students are interested in learning physics by jumping directly into an actual experiment or experiment (85%). As many as 75% of students are motivated to learn through practical activities.

Table 4. Analysis of barriers to the implementation of practical activities

| No | Item                                                                 | Student responses percentage (%) |
|----|----------------------------------------------------------------------|---------------------------------|
| 1. | Inadequate collaborative space                                       | 75                              |
|    |                                                                      | 25                              |
| 2. | Laboratory equipment is not as needed                                | 60                              |
|    |                                                                      | 40                              |
| 3. | There is no practical manual                                        | 98                              |
|    |                                                                      | 2                               |
| 4. | Students have difficulty in applying physics concepts                | 96                              |
|    |                                                                      | 4                               |
| 5. | There are no manuals for making physical devices / products         | 98,5                            |
|    |                                                                      | 1,5                             |
| 6. | More interested in the lecture and discussion methods               | 30                              |
|    |                                                                      | 70                              |
| 7. | More interested in the experimental method / experiment             | 85                              |
|    |                                                                      | 15                              |
| 8. | Students lack motivation in practicum activities                     | 25                              |
|    |                                                                      | 75                              |

The material analysis of physics is done by looking at the achievements of each basic competency that demands the skills of students in practicum and making tools. The results of the analysis can be seen in table 5 below:

Table 5. Analysis Physics material

| No | Material Class X | Conduct an experiment and present the results of an experiment | Material Class IX | Conduct an experiment and present the results of an experiment |
|----|------------------|----------------------------------------------------------------|------------------|----------------------------------------------------------------|
| 1. | The Nature of Physics and the Scientific Method                    | Yes                                                           | Rotational Dynamics and Firm Balance | Yes |
| 2. | Measurement                                                   | Yes                                                           | Elasticity       | Yes |

5
Based on the table above, it can be seen that all of the basic competencies in classes X and XI that can improve students' scientific skills through practical activities. The basic competency demands of these aspects of skills are students able to design and conduct experiments and produce works in the form of tools or products.

The analysis of teaching material requirements can be seen in Table 6 below:

| No | Item                                                                 | Student Responses Percentage (%) |
|----|----------------------------------------------------------------------|----------------------------------|
|    |                                                                      | Yes | No  |
| 1. | A physics physics textbook is required                              | 96  | 4   |
| 2. | Project Based Learning model is required in developing teaching materials | 87  | 13  |
| 3. | Interesting and colorful teaching materials                         | 98  | 2   |
| 4. | Teaching materials include material, questions, practical guidelines | 87  | 13  |
| 5. | Instructor is equipped with a tool making guide                     | 85  | 15  |
| 6. | Teaching materials are in line with the demands of the 2013 curriculum in achieving 21st century skills | 87  | 13  |

According to the table above, students need a practical textbook using Project Based Learning model. Teaching materials should be made interesting and colorful to increase student’s motivation. This can be seen by the percentage of about 87-98% of students who answered yes.
4. Conclusion

Based on the results of the preliminary analysis by conducting interviews and observations at SMAN 2 Bukittingi, the authors concluded that practicum textbooks were needed with the Project Based Learning model to improve the scientific skills of students. This is done so that the demands of the curriculum in accordance with the objectives of the twenty first century national education can be achieved well.

References

[1] Abdidin, Y. 2014. Desain Sistem Pembelajaran dalam konteks kurikulum 2013. Bandung: PT Refika Aditama.
[2] Binkley, M., Erstad O, and Rumble. Defining Twenty-First Century Skills. Springer Dordrecht Heidelberg London New York.
[3] Djamarah, SaifulBahri and Aswan Zain. 2002. Teaching and Learning Strategies. Jakarta: Rineke Reserved
[4] Fitriya S, Drs. Albertus Djoko Lesmono, M.Si, Sri Wahyuni, S. Pd., M. Pd. 2012. The Development of Instructions on The Physics Virtual-Laboratory Based Practicef or Physics. https://repository.unej.ac.id (accessed on July 2019)
[6] Hofstein,A & Lunnet,a, V N. 2004. The Laboratory in Science Education: Foundation for the Twenty First Century. Science Eduacation.
[7] Mathelitsch, Leopold, 2013. Competencies in science teaching - In: CEPS Journal 3, 3, S. 49-64 - URN: urn: nbn:de:0111-opus-82628
[8] Suharsimi, Arikunto. 2010. Fundamentals of Educational Evaluation. Jakarta: Earth Literacy
[9] Wijayanti, A. 2014. Pengembangan Autentic Assesment Berbasis Proyek Dengan Pendekatan Saintifik Untuk Meningkatkan Keterampilan Berpikir Ilmiah Mahasiswa. Jurnal Pendidikan IPA Indonesia. JPII 3 (2) (2014) 102-108