Virtual laboratory learning media development to improve science literacy skills of mechanical engineering students on basic physics concept of material measurement

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Abstract. This study aims to determine the description of virtual laboratory learning media development to improve science literacy skills of Mechanical Engineering students on the concept of basic Physics. Quasi experimental method was employed in this research. The participants of this research were first semester students of mechanical engineering in Majalengka University. The research instrument was readability test of instructional media. The results of virtual laboratory learning media readability test show that the average score is 78.5%. It indicates that virtual laboratory learning media development are feasible to be used in improving science literacy skill of Mechanical Engineering students in Majalengka University, specifically on basic Physics concepts of material measurement.

1. Introduction

The importance of science literacy relates to how students are able to use their scientific thinking, knowledge, and the process of science in understanding a phenomenon so they are able to make decisions in solving the problems. Science literacy is the capacity to use knowledge and scientific ability, to identify questions and draw conclusions based on existing evidence and data in order to understand the universe and to help in making decisions related to changes that occur because of human interaction with nature [1].

The results of the scientific literacy measurement which conducted by PISA in 2009 and published by OECD (Organization for Economic Cooperation and Development) show that the level of Indonesian students’ science literacy is low. It was ranked 66th of 74 OECD member countries with average score 383. Meanwhile, Indonesian’s rank was 71 out of 72 countries in 2012. It increased in 2015, which was in 64 ranks out of 72 countries. The low level of science literacy of Indonesian students can affect the quality of graduates who will enroll higher education level [2].

From the results of observation at the Faculty of Engineering in Majalengka University, it is found that the ability of students’ science literacy is still low. Basic physics lecture is expected to improve the ability of students’ science literacy. On the other hand, it is not adequate. This is caused by the
process of lectures that have not been optimal. Moreover, practicum activities have not been done well, specifically in the material measurement. The other factor is lack of measurement equipment used for practice. Most of them are broken so it cannot be used by large number of students. The following table 1 shows the result of questionnaire in a preliminary study which filled out by the students who took basic Physics course.

**Table 1.** The percentages of students’ responses result

| Statements                                                                 | Average (%) | Category |
|---------------------------------------------------------------------------|-------------|----------|
| Students’ perception about their interest in physics subject              | 36.67       | Disagree |
| Students’ interest in learning model applied by the lecturer             | 73.88       | Agree    |
| Students’ opinion about the need for interactive learning media          | 78.83       | Agree    |
| Students’ perception about physics (physics is abstract and has many mathematical formulas) | 100         | Agree    |

Students’ interest in basic Physics courses is very low. This is caused by the lecturers who tend to use mathematical approach in teaching physics concepts. Therefore, to make it simple, innovation is needed. One of the innovations in lecturing is by integrating information and communication technology in the form of interactive multimedia e.g. virtual laboratory.

The use of multimedia interactive learning in physics can assist students in understanding abstract concepts [3]. According to previous research related to the use of virtual media, the results of the research indicates that there is improvement in the students’ conceptual understanding [4]. Other research uses reconstruction digital building model technique, Virtual Reality improves the learning processes and facilitates the understanding of its users about the building context and connects them to each physical detail of the building, specifically the appreciation of the construction details and chronological order of events in the history of past civilizations [5]. The use of multimedia through instructional approach – Concrete Representational Abstract (CRA) on the subject of linear program can improve students' learning achievement [6]. Students’ responses to learning media developed to support independent learning which shows average score of 3.23 on a likert scale means very excellent [7]. Virtual laboratory can improve the competence of vocational school students in terms of cognitive (minds-on), and psychomotor [8].

Based on the results of previous research, it can be concluded that multimedia based learning can improve students’ competence, students’ concept comprehension, learning achievement and learning independency. Thus, the problem in this study is "How is the development of virtual laboratory learning media to improve students’ skills of science literacy on the basic Physics concept of Material measurements in Mechanical Engineering Study Program, Majalengka University?"

2. Methods

This research employed quasi experimental method. The population in this study is all of the first semester Engineering students in one of the University in Majalengka. Specifically, the sample in this research is one experiment class. The domains of experimental science literacy are science content, science process, application context of science. In accordance with PISA 2000 and 2003 divide science literacy into three domains large, scientific content, scientific processes, and application science context. The following Table 2 is data collection technique:

**Table 2.** Data Collection Techniques

| Types of Data                        | Data Collection Technique | Description                 |
|--------------------------------------|---------------------------|-----------------------------|
| Validity of virtual laboratory media development | Readability Test          | Conducted before learning process |
| Instrument analysis of literacy skills of science | Test of science literacy  | Conducted before learning process |
3. Results and Discussion

3.1. Readability of Learning Media

Learning media need to be evaluated before used widely. It can be evaluated in terms of material, educative side, and in terms of software engineering. Therefore, it can fulfill the prerequisite to be used in the learning process [9]. Evaluation is intended to determine whether the media which developed can achieve the purposes or not. This is very important to make sure that the learning media is good and applicable. The initial testing process can be done by having experts’ judgments through the validity process. After completing this process, it can be determined whether it is feasible or not. Then, the next step is formative evaluation, one to one and small group evaluation. At this stage, the media were tested in small groups which consist of 10 students from low, medium, and high achiever with gender diversity. The assessment is interactive learning media readability test. Furthermore, the media is implemented in a wider scale which consists of 30 people as the sample. The results of readability test are shown in the following Table 3.

| No | Indicator | Percentage (%) | Description |
|----|-----------|----------------|-------------|
| 1. | Interest in materials description | 80 | High |
| 2. | Interest in visualize of media | 78.3 | High |
| 3. | Interest in laboratory work in media | 75.8 | High |
| 4. | Illustrations, pictures and animation used in learning media can help to understand more | 80 | High |

Average 78.5 High

The average of media readability which was filled out by the students on the four aspects of the assessment is 78.5%, the score is categorized as easy. It means that the students as user are easy to understand the content of the material delivered by the lecturer. In addition, the quality of illustrations, images and animations available are very helpful. The assessment of media readability if it is ≥ 50%, then it can be stated that the users or readers are able to understand the contents of the reading easily.

Virtual laboratory learning media development which created has the advantage in assisting students in improving their science literacy skills because the media which presented were in line with the materials, pictures and science literacy skill questions, as well as laboratory works simulation, as shown in the following figures:

**Figure 1.** Display information from the development of learning media.

**Figure 2.** Display of learning materials from the development of learning media.
3.2. Result of analysis of instrument test of science literacy
Trial test conducted on semester 1 students of Faculty of Engineering Majalengka University. Aspects of literacy ability of science that measured the aspects of content, context, and the process of science. Problem test of science literacy ability tested amounted to 16 items in the form of multiple choice. Based on the calculation of the validity of the grains about the ability of science literacy which amounted to 16 items with multiple-choice questions obtained the reliability of the science literacy ability test of 0.55 which is included in the medium category. About the science literacy capability test is contained in the virtual media. Data on validity, distinguishing, and difficulty test results can be seen in Table 4 and the number of questions in each aspect of science literacy ability can be seen in Table 5.

Table 4. Result of validity test, distinguishing power, and difficulty level about ability of science literacy

| Number Test | Validity value | Validity criteria | Difficulty index value | Difficulty index category | Difficulty level value | Difficulty level criteria | The selected test | Valid test number |
|-------------|----------------|-------------------|------------------------|--------------------------|------------------------|--------------------------|------------------|------------------|
| 1           | 0.59           | Valid             | 0.75                   | Easy                     | 0.50                   | good                     | √                | 1                |
| 2           | 0.36           | Valid             | 0.73                   | Easy                     | 0.35                   | Enough                   | √                | 2                |
| 3           | 0.35           | Valid             | 0.63                   | Medium                   | 0.35                   | Enough                   | √                | 3                |
| 4           | 0.33           | Valid             | 0.78                   | Easy                     | 0.25                   | Enough                   | √                | 4                |
| 5           | 0.48           | Valid             | 0.48                   | Medium                   | 0.35                   | Enough                   | √                | 5                |
| 6           | 0.69           | Valid             | 0.88                   | Easy                     | 0.25                   | Enough                   | √                | 6                |
| 7           | 0.61           | Valid             | 0.55                   | Medium                   | 0.40                   | Enough                   | √                | 7                |
| 8           | 0.36           | Valid             | 0.23                   | Difficult                | 0.25                   | Enough                   | √                | 8                |
| 9           | 0.48           | Valid             | 0.25                   | Difficult                | 0.30                   | Enough                   | √                | 9                |
| 10          | 0.17           | Invalid           | 0.43                   | Medium                   | 0.05                   | Not Good                 | -                | -                |
| 11          | 0.69           | Valid             | 0.28                   | Difficult                | 0.55                   | Good                     | √                | 10               |
| 12          | 0.67           | Valid             | 0.53                   | Medium                   | 0.65                   | Good                     | √                | 11               |
| 13          | 0.33           | Valid             | 0.88                   | Easy                     | 0.25                   | Enough                   | √                | 12               |
| 14          | 0.39           | Invalid           | 0.53                   | Medium                   | 0.35                   | Enough                   | √                | 13               |
| 15          | 0.25           | Invalid           | 0.28                   | Difficult                | 0.05                   | Not Good                 | -                | -                |
| 16          | 0.49           | Valid             | 0.83                   | Easy                     | 0.25                   | Enough                   | √                | 14               |
Tabel 5. The test number of each aspect of science literacy

| No | Aspect Of Science Literacy | Test Number | Amount |
|----|---------------------------|-------------|--------|
| 1  | Content                   | 1, 5, 8, 12 | 4      |
| 2  | Context                   | 2, 3, 4, 7, 10 | 5      |
| 3  | Process                   | 6, 9, 11, 13, 14 | 5      |

4. Conclusion
It can be concluded that virtual laboratory learning media which has been developed is feasible to be used to improve the students’ science literacy on the basic physics concept of material measurement in Mechanical Engineering study program, Majalengka University.

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