Expedience analysis of student worksheets (LKM) to support nuclear physics learning on the topic of natural radioactivity

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Abstract. Based on the observations, data from student's response shown that the nuclear physics was an abstract material, so it needs visualization in the learning process. The facts found that in the process of nuclear physics learning have not supported by virtual laboratory activities yet. The virtual laboratory is needed by the students to visualize the abstract material of nuclear physics. This research aims to develop valid and practical student worksheets (LKM) as a support of the virtual laboratory activities using PhET simulation on the topic of natural radioactivity. The method that used in this research is Research and Development (R & D) by applying the ADDIE model by steps: analyze, design, development, implementation and evaluation. The results of this research shown that student worksheet that have developed are valid and practical to supporting virtual lab activities.

1. Introduction

Field facts found in the learning process that not all learning activities balance between cognitive and skills. Based on the observations that have been done in the State University of Padang at the physics department in November 2017, nuclear physics learning haven’t supported by laboratory activities both real and virtual. Meanwhile, students need skills such as observing, measuring, interpreting data, classifying, communicating, and conducting experiments in stages in order to provide understanding in accordance with the level of thinking ability and subject matter that is in accordance with the curriculum to give greater emphasis on aspects of the process. In nuclear physics learning, it takes not only face-to-face learning process, but also need practicum or laboratory activities. One of nuclear physics learning topics that become main topic is natural radioactivity.

Laboratory activities are a form of practicum activities carried out in an adapted environment that aims to encourage students and planned learning, interact with equipment to observe and understand phenomena[1]. Laboratory activities can be done in real and virtual (virtual). One of the right alternatives for students to keep practicing in order to give a great emphasis on the aspects of the process, it is better to do virtual labs or virtual laboratory activities. Several factors can be an obstacle to the implementation of real laboratory activities in nuclear physics learning, such as limited tools and costs for conducting laboratory activities for nuclear physics learning, especially in natural radioactivity topic. To conduct nuclear physics laboratory activities on natural radioactivity topic is very difficult because in addition to the limitations of tools and costs, there are also limited time and place to conduct laboratory activities. However, virtual laboratory activities on natural radioactivity
topic are very possible. Virtual laboratory activities for natural radioactivity topic can be done one of them by using the PhET application.

Virtual laboratory activities are one form of experiment or practicum with unreal tools and materials. Virtual laboratories can be done with computers, laptops, etc. Virtual laboratories can simulate physical concepts from the limitations of the physics laboratory and other limitations, such as the implementation of laboratory activities with long time spend or very short occurrence as well as the macro and micro conditions of the material to be practiced. Virtual laboratories is one of learning media that are used to help understand a subject and can provide solutions to the limitations of laboratory equipment[2]. Virtual laboratories are not considered substitutes or competitors for real laboratories, but virtual laboratories is an alternative to do practicums that are not realized in real laboratories with affordable costs, presenting interactive models, exploratory learning tools to support lectures, and research. In a more specific, virtual laboratory can be defined as a practicum or experiment using computer technology and the experiments done by using electronic devices (computers, laptops, macbooks, etc.). It has a series of laboratory tools so that users can do experiment or practicum as if they were in the real laboratory.

One of virtual laboratory that can be used to support nuclear physics lectures is by using PhET simulation application. PhET is a computer application package that contains a simulation of laboratory or practicum activities that can be operated by students in real terms so that students can experiment virtually in front of a computer[3]. The PhET application is very easy to get by downloading it on the web page https://phet.colorado.edu. The PhET simulation package has more than 80 titles of virtual laboratory activities. By using PhET simulations or other computer simulations, students are expected to be able to better understand learning material in depth, using the ability to observe, analogize, retrieve data, create graphics, and process data in order to draw conclusions and present later. Doing experiment with PhET will be difficult if not supported by instructions or worksheets to do the practicum. So that a worksheet is needed for students to operate PhET which can facilitate students in carrying out virtual laboratory activities.

Student worksheets are sheets containing assignments that must be done by students. Usually contains instructions or steps to complete a task[4]. The worksheets is included in one of the teaching materials to support learning activities. The objectives of the worksheets are as follows: (1) preparing the condition of students to be ready to learn before the implementation of learning activities, (2) guiding students to process their learning outcomes (finding or proving the concepts they learned), (3) motivating students to study independently, (4) enrich the concepts students have learned (learning outcomes) to be applied in real life[5]. The existence of worksheets that support virtual laboratory activities can help nuclear physics learning because the nuclear physics learning discusses something microscopic and abstract.

Based on the advantages that have been explained, researchers decided to create student worksheets that can support laboratory activities in nuclear physics learning. In general, the purpose of this research is to develop student worksheets to support virtual laboratory activities on nuclear physics learning. In particular, the purpose of this study is to see the validity and practicality of student worksheets to support virtual laboratory activities in the natural radioactivity topic.

2. Research Method
The research method that used in this study is research and development. This research method aims to produce certain products, test the validity and effectiveness of the products produced[6]. Products produced by researchers are student worksheets to support virtual laboratory activities on natural radioactivity topic. Research and development procedures are carried out using the ADDIE model. The ADDIE model is a systematic development model based on the theoretical foundation of learning design [7]. There are 5 important stages in this model, namely analyze, design, development, implementation, and evaluation. In this study the research stages were done until the development stage. The chart of the ADDIE model procedure can be seen in Figure 1.
The first research procedure is the analyze. This stage aims to see the learning capabilities that students want to achieve, know the characteristics of the product users, and to find out the substance that need to be developed. The next procedure is the design stage which aims to design student worksheet based on the characteristic of users, the abilities they want to learn and how to make the learning material well-studied.

The third procedure in this research is the development stage which is intended to produce student worksheet products to support virtual laboratory activities on natural radioactivity topic in accordance with the design and prototype or storyboard that has been created. Student worksheets that support virtual laboratory activities assessed by experts and development testing [8]. Experts provide suggestions based on the assessment of the worksheet supporting virtual laboratory activities that are used as input to revise the worksheet. To conduct the research process, researchers used validity test questionnaires and practicality test questionnaires as research supporting instruments. A product is declared valid if the product is able to provide the desired substance appropriately and declared practical if the user considers the product attractive and can be used in normal conditions. Validity test is carried out by lecturers who are experts in the field of nuclear physics and the field of physics learning media and practicality test is carried out by nuclear physics lecturers who will use the worksheet to support virtual laboratory activities in the learning process. The score is given on a scale of 1-4, answer 1 has a score of 1 with a bad category, 2 has a score of 2 with a fairly good category, 3 has a score of 3 with a good category, 4 has a score of 4 with very good category. The indicators on the validation instrument are: content, presentation, graphic and language of the student worksheet. Likewise, the practicality test uses the same range of scores as indicators on practicality instruments, such as: ease of use, appearance, benefits, and implementation opportunities of student worksheet in the learning process.

3. Research Results and Discussion

3.1. Research Results

The product produced in this research is the student worksheet (LKM) which can support virtual laboratory activities on one of the nuclear physics topic, namely natural radioactivity. The parts contained in these student worksheet are cover, title, identity, instructions, learning achievement, objectives of practicum, completion time, brief information, preliminary assignments, work steps, independent assignments, assessment, glossary and bibliography.

There are three student worksheet subtopic that had been made for natural radioactivity topic. The worksheet products are developed to support virtual laboratory activities that use the PhET application. The PhET application used is Radioactive Dating Games with three virtual laboratory activities on the application.

After making the student worksheet product, the next step that has been done is the feasibility test of the product itself. The product feasibility test is limited to two types of feasibility tests only; validity test and practicality test. The validity test of this worksheet uses an instrument in the form of a validation questionnaire that has been validated by the supervisor. This questionnaire consists of
several aspects of assessment including content, presentment, graphic and language of the student worksheets.

Based on the value of the four aspect assessment indicators, the result of the overall worksheets validation can be seen in Table 1. The average value of validity obtained from the validity test questionnaire data analysis is 92. Thus it can be concluded that the student worksheets as supporting laboratory activities in natural radioactivity topic is very valid to be used as a support in nuclear physics learning.

| No. | Assessment Aspect | Validation Value | Criteria |
|-----|------------------|------------------|----------|
| 1   | Content          | 91               | Very Valid |
| 2   | Presentment      | 94               | Very Valid |
| 3   | Graphic          | 94               | Very Valid |
| 4   | Language         | 88               | Very Valid |
|     | **Average**      | **92**           | **Very Valid** |

The next feasibility test is the practicality test of student worksheets as a support in virtual laboratory activities. This worksheet practicality test uses an instrument in the form of practicality questionnaire. This practicality test questionnaire consists of 4 aspects of assessment, including ease of use, appearance, benefits, implementation opportunities of student worksheets in learning process.

Based on the practicality values of the four assessment indicators, the average value is 89. The practicality of the student worksheet is in the very practical category. Thus it can be concluded that the student worksheets in supporting laboratory activities in natural radioactivity topic is very practical to be used in learning process. The overall results of the worksheet practicality test can be seen in Table 2.

| No | Assessment Aspect                          | Validation Value | Criteria |
|----|-------------------------------------------|------------------|----------|
| 1  | Ease of Use                               | 84               | Very Practice |
| 2  | Appearance                                | 88               | Very Practice |
| 3  | Benefits of student worksheet             | 100              | Very Practice |
| 4  | Implementation Opportunities              | 84               | Very Practice |
|    | **Average**                               | **89**           | **Very Practice** |

3.2. Discussion

In the discussion will be presented the results achieved during the research process, the obstacles faced during the study, as well as solutions that can be used to overcome these weaknesses. The results of this study include the results of the validity of the student worksheets as supporting virtual laboratory activities on the topic of natural radioactivity by experts and the results of practicality by lecturers as practitioners after using the student worksheets in supporting virtual laboratory activities on natural radioactivity topic.

The results of the validity of student worksheets in supporting virtual laboratory activities on natural radioactivity topic by experts are in the valid category in accordance with the eligibility criteria based on the Ministry of National Education (2008). This shows that student worksheets products are valid for use in the learning process.

Based on the results of the validity test by experts, it can be concluded that the student worksheets product supporting virtual laboratory activities on natural radioactivity topic has a validity value with an average value of 92 in the very valid category for use in the nuclear physics learning process. With the values of each assessment aspect as follows, (1) the feasibility of the content of student worksheets is 91 with very valid category, (2) the feasibility of presentment student worksheets is 94 with very valid category, (3) the feasibility of graphic student worksheets is 94 with very valid category, and (4) the language feasibility of student worksheets is 88 with very valid category. Based on these data it can be concluded that this student worksheets has complete content, good presentation, good graphics,
and proper language use. Thus, student worksheets as supporting virtual laboratory activities on natural radioactivity topic have a high level of validity.

Furthermore, the results of the practicality data analysis by the lecturers at the student worksheets as supporting virtual laboratory activities on the topic of natural radioactivity are in the very practical category. With the value of each assessment aspect as follows, (1) ease of use of student worksheets is 84 with a very practical category, (2) appearance of student Worksheets is 88 with very practical category, (3) the benefits of student worksheets in the learning process is 100 with very practical category, and (4) the implementation opportunities is 84 with very practical category. Based on these data it can be concluded that these student worksheets are easy to use in learning, the student worksheets's appearance is attractive, student worksheets are very useful in the learning process, and the opportunities of student worksheets implementation is high. Thus, student worksheets as supporting virtual laboratory activities on natural radioactivity topic are used in learning is accordance with the eligibility criteria of teaching materials contained in the Ministry of National Education (2008).

The disadvantage of this student worksheets is when it is used, the practitioner must have the JAR (Java Application Runtime) application first to be able to do virtual laboratory activities. In a wide range of usage, it will be difficult and take more time to install one by one to the laptop or PC. To make it easier to use, the JAR application is uploaded to Google Drive so that it can be accessed using the internet and directly installed by each practitioner of this virtual laboratory activity. So it doesn't take long enough to start virtual lab activities.

4. Conclusion
The results of research and discussion show that the MFIIs developed to support virtual laboratory activities on natural radioactivity material are valid and practical to be used in core physics lectures.

References
[1] Usman, R. (2008). Model Pembelajaran Inkuiri Dengan Kegiatan Laboratorium Untuk Meningkatkan Keterampilan Berpikir Kritis Siswa Pokok Bahasan Fluida Statis. Semarang: Tesis Magister PPs UNS.
[2] Razi, P. (2013). Hubungan Motivasi Dengan Kerja Ilmiah Siswa Dalam Pembelajaran Fisika Mengguankan Virtual Laboratorium Kelas X SMAN Kota Padang. Jurnal Teknologi Informasi Dan Pendidikan, 119-124.
[3] Setiadi, Rahmat dan A. Ainun Muflika. (2012). “Eksplorasi Pemberdayaan Courseware Simulasi PhET Untuk Membangun Keterampilan Proses Sains Siswa SMA”. Jurnal Pengajaran MIPA.2, 258 – 268.
[4] Departemen Pendidikan Nasional. 2008. Pan-duan Umum Pengembangan Bahan Ajar. Jakarta: Direktorat Pembinaan Sekolah Menengah Atas.
[5] Sumiati, A. (2007). Metode Pembelajaran. Bandung: CV Wacana Prima.
[6] Sugiyono. 2012. Metode Penelitian Kuantitatif, Kualitatif, dan R&D. Bandung: Alfabeta.
[7] Tegeh Made, d. (2014). Model Penelitian dan Pengembangan. Yogyakarta: Graha Ilmu.
[8] Rochmad. 2012. “Desain Model Pengembangan Perangkat Pembelajaran Matematika”. Jurnal Kreano. Vol. 3 No.1 Tahun 2012