The development of multi representation practicum modules with PhET in Hooke’s law concept

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Abstract. The development of practicum modules is one of the ways to facilitate the path as a practicum. This research is aimed to find out the results of teachers’ development and responses towards multi representation modules through the use of PhET Simulation media in Hooke’s Law concept. The method used in this study is research and development (R & D) with the ADDIE (Analysis, Design, Development, Implementation, and Evaluation). The population sample used in this study are all teachers at Banda Aceh Senior High Schools. The sampling technique used is random sampling. The sample in this study includes six physics teachers. The instrument used in this study is module feasibility assessment reviewed by media and educational expert, then were analyzed based on descriptive-qualitative. The results show that multi-presentation module with PhET which has been developed by the author obtained very feasible assessment by experts to test in practicum. The teachers’ approval of the developed practicum module is also categorized as a very feasible category to be applied in practicum.

1. Introduction

Physics as a part of Science includes two scopes, namely physics as a product and physics as a process. Physics as a product is the result of findings from scientists in the form of facts, concepts, and principles. Whereas physics as a process is a way of doing and the attitude of scientists to obtain these products [1]. The purpose of learning physics in secondary schools in general is to provide provision of knowledge about physics, abilities in process skills, and improve creativity and scientific attitude [2]. Thus, learning Physics does not require familiarity with mathematics, but furthermore students are expected to be able to comprehend the concepts of physics.

One of the physics learning strategies that can support learning is by using the Multiple Representation approach. Multiple representations are representations of the same concept with different formats, including verbal, image, graph, and mathematical [3]. The physics lesson that becomes the focus of this research is the Hooke’s law, the characteristics of the Hooke’s law concept, the use of mathematical and unit symbols, graphs of various relationships between variables and mathematical formulas on their application, therefore students must develop the ability of representation in pictures, graphics and mathematics.

Students could form representations to show their thoughts by writing and using different modes like diagrams, pictures and images [4]. Representations contain the interpretation and explanation of a scientific idea or concept by using modes like analogies, verbal statements, written texts, diagrams,
graphics and simulations [5]. Even if different classifications are made for different purposes, the common general opinion about the modes are the categories being expressed with different demonstrations of the same concepts and operations representationally (texts, graphics, charts, tables), figuratively (pictorial, metaphorical, analogical), experimentally and mathematically.

Representations in physics learning can be employed to minimize students’ difficulties in learning physics. Successful problem-solving process depends on the skills of representing problems such as constructing and using mathematical representations in words, graphs, tables and equations, completion and symbol manipulations. This is because multiple representations can provide three main benefits, namely as complementary information, limiting interpretations and constructors of understanding [6]. Thus, we can conclude that multiple representations are a way of expressing a concept through various ways and forms.

There are two aspects that are most prominent in the learning process namely the method of use and learning media as learning aids. The choice of media must be based on an analysis of the learning objectives. Physics Education Technology Simulation (PhET) is one of the media that is considered appropriate in this study. According to several studies, PhET Simulation is able to assist teachers in facilitating the delivery and explanation of abstract physics lesson and is able to provide real examples in everyday life and has been proven to be effective in overcoming physical problems [7,8]. Some students have a learning style by direct practice, learning by discussion, taking pictures, watching videos, and others. On the other hand learning resources used in schools only contain textbooks and do not have other learning resources such as modules, both learning modules and practicum modules.

Learning resources can increase learning productivity by way of speeding up the pace of learning and helping teachers to use maximum time and reduce the burden of the teacher in presenting information, so as to foster and develop student understanding. The learning process that lacks teaching materials is classified as less quality. Quality learning can take place if the communication process runs smoothly, so teaching materials are needed as learning aids. One teaching material that supports student learning activities is the Practicum Module to improve student learning achievement.

Based on the results of observations and initial interviews of researchers with regard to the process of learning physics at Senior High School of Banda Aceh, as information obtained that the school had a laboratory to conduct exercises in accordance with the subjects, while the available practicum module is only one since laboratory room firstly existed or using practicum steps contained in the textbook used by the teachers whose method of operation was still done manually.

The development of this practicum module uses the ADDIE development model, because it has systematic stages so that it fits the characteristics of media development, especially the practicum module on Hooke’s law concept. Based on the background, the objectives of the problem in this research is to find out the development result and teachers’ response towards the development of multiple representation modules through the use of PhET Simulation media in Hooke’s Law material.

2. Method

2.1. Methods and Research Design

The method used in this study is research and development (R & D) it is a research method used to produce certain products and examine the effectiveness of these products in education and learning [9]. The products produced in this study are in the form of modules of Hooke’s law concept. This development uses a model that has been developed by experts, one of which is the ADDIE model. The ADDIE model consists of five main stages that are adjusted to the name they have, which includes the stages of Analysis, Design, Development, Implementation, and Evaluation. Concluded that ADDIE is shorthand for describing any process-based approach to developing instructional content [10]. It also argued that the very acronym is virtually interchangeable with the term instructional design, and that many different design frameworks but have same abbreviation. What is important about ADDIE, though, is that it is iterative, involving review and revision throughout the design process. This recursive nature is called the input-process-output paradigm. This structure allows those designing instruction to incorporate feedback. This development research was carried out in the odd semester of the 2018/2019 learning year. The location of this study was in three State Senior High Schools in
Banda Aceh. The development of learning media in the concept of Hooke's Law uses the ADDIE model development procedure which consists of five stages, namely:

2.1.1. Analysis. The analysis stage usually includes the implementation of needs analysis, identification of problems from students and expectations to be achieved. Analysis of students’ needs is useful for determining problems and finding appropriate solutions and by determining the competency of students [3].

The analysis stage, carried out by means of observation and interviews based on an analysis of the needs and problems of learning that occur at school. School needs learning media, that is why the authors are eager to develop a learning media in the form of a Practicum Module.

2.1.2. Design. Learning media is designed in such a way so that the developed media can improve the consolidation of concepts and activeness of students so that learning objectives can be achieved properly and create a pleasant learning atmosphere in the learning process.

2.1.3. Development. This stage is done by making a module. Module making is developed based on the design that has been designed, after the module making process, then validation was carried out towards the developed module with an assessment of the media format, visual aspects, aspects of media functions, and aspects of media clarity in presenting the concept, so that the decided product is feasible or not to be used. The module was validated by two experts conducted by the lecturers of the MPIPA (Science Master Postgraduate) Postgraduate Program at Universitas Syiah Kuala.

2.1.4. Implementation. At this stage the researcher conducted a trial at State Senior High Schools in Banda Aceh. This stage is done to find out how students' perceptions towards practicum module which has been developed during the trial.

2.1.5. Evaluation. Based on the results obtained during the implementation of the module developed by measuring participants' perceptions, then an analysis is carried out to determine the feasibility of the module developed.

2.2. Data Collection

The instrument used in this study is module feasibility assessment instrument reviewed by two media expert lecturers and education lecturers, then analyzed as a descriptive-qualitative so that it can be concluded as the validity of learning media in the form of module.

\[
\text{Feasibility Percentage} = \frac{\text{Observation Score}}{\text{Maximum Score}} \times 100\%
\]  

(1)

2.3. Instrument Data Analysis

The module assessment was gained based on the validation of the experts, by using a closed questionnaire instrument with the choice of answers 1 to 4. The data obtained was later calculated as the average answer from the questionnaire. Due to the questionnaire used is a closed questionnaire, the data obtained is qualitative data in the form of input from experts described narratively. Quantitative data obtained from questionnaire data analysis in the form of numbers calculated or measured can be processed by adding, compared to the expected number and obtained a percentage value for the feasibility of the module. The eligibility percentage is calculated using the following formula:
3. Modules.

Teachers’ response to multiple representation based lab modules was developed in the questionnaire. Based on a trial conducted at three Senior Schools consisting of 6 Physics teachers. Data on teachers’ response to multiple representation based lab modules was developed in the questionnaire responses cover several aspects including; benefits, material, language, motivation and display of modules. The average score of each teacher on the implementation can be seen in the following Table 3.

### Table 1. Feasibility Criteria of Module

| Achievement percentage | Value Scale | Feasibility Category |
|------------------------|-------------|----------------------|
| 81 - 100               | 4           | Very Feasible        |
| 61 - 80                | 3           | Feasible             |
| 41 - 60                | 2           | Feasible Enough      |
| 21 - 40                | 1           | Less Feasible        |
| 0 - 20                 | 0           | Not Feasible         |

### 2.4. Questionnaire data analysis

The data analysis technique in this study is a descriptive analysis technique by describing the results of product development in the form of modules, testing the level of validity and product feasibility to be implemented in physics learning in the Hook’s Law concept. Validators involved were 2 Physics lecturers completed the quality assessment questionnaire sheet product. Validation is done to perfect products that are still lacking. A product that is feasible is used if the expert is based on his experience stating that the product is suitable for use. The first validator is an active lecturer in the Physics Education Study Program of Universitas Syiah Kuala, contributing to validate in terms of checking the accuracy of language usage, material, images and appearance in the module, the feasibility of presenting and the instructions for using the module. The second validator is also an active lecturer in Physics Education Study Program of Universitas Syiah Kuala. The qualitative data obtained is then converted into quantitative data using a Likert scale. Likert scale has gradations from very positive to very negative which can be in the form of words, which in this study include: Very Feasible (SL), Feasible (L), Not Feasible (TL), and Very Infeasible (STL) [10]. Later, the existing answers are converted in the quantitative analysis in the form of weight level of value score used as a measurement scale, namely: 4,3,2,1.

The obtained research data is converted into quantitative data, by looking at the weight of each selected response for each statement. Next, calculating the average score of the assessment results of each component of the Physics Practicum Module on the Hook’s law materials using the formula:

\[ P = \frac{f}{N} \times 100\% \]  

(2) 

Where: 
- \( P \) = percentage
- \( f \) = frequency of respondents
- \( N \) = number of respondents

Furthermore, the allotment of the questionnaire scores to the average value of the frequency distribution results can be seen in Table 2

### Table 2. Feasibility Category Based on Rating Scale [2]

| No | Achievement Rating (%) | Criteria |
|----|-------------------------|----------|
| 1  | 8                       | Excellent|
| 2  | 6                       | Good     |
| 3  | 5                       | Sufficient|
| 4  | 4                       | Minus    |
| 5  | 0–                      | Failed   |

### 3. Results and Discussion

Based on a trial conducted at three Senior High Schools consisting of 6 Physics teachers. Data on teachers’ response to multiple representation based lab modules was developed in the questionnaire responses cover several aspects including; benefits, material, language, motivation and display of modules. The average score of each teacher on the implementation can be seen in the following Table 3.
Table 3. Average scores for each teacher on the implementation of the multi-representation module through the use of PhET media.

| No. | Teachers’ Response | Percentage |
|-----|--------------------|------------|
| 1   | Teacher I          | 100%       |
| 2   | Teacher II         | 94%        |
| 3   | Teacher III        | 100%       |
| 4   | Teacher IV         | 100%       |
| 5   | Teacher V          | 94%        |

Based on the average percentage of teacher response results obtained at 98%. The level of achievement in accordance with Table 3 is classified as very interesting / very feasible. This shows that the teachers give a positive response to the multiple representation based practice module that has been developed. This positive response provides an indication that the practicum module based on the multiple representation approach has been effective and is very well used in the physical practicum process in the Hooke’s law concept. The importance of the use of modules in a practicum can be proven by the positive response from teachers and students during the implementation. This illustrates that the teaching materials produced by the development can enhance the ease of practicum [11]. Effective practice must be planned properly. If the development of all practicum modules is carried out completely and correctly, then it will be able to contribute towards cognitive development [12].

This positive response provides an indication that the practicum module based on the multiple representation approach has been effective and excellent to be used in the physical practicum process in the Hooke’s law material. The importance of the use of modules in a practicum can be proven by the positive response from teachers and students at the time of implementation [13]. This illustrates that the teaching materials produced by development can improve the ease of practicum. The effectiveness of practice must be planned properly. If the development of the entire practicum module is done completely and correctly, it will be able to contribute towards cognitive development. Based on the results of the implementation that has been developed it is stated that the module based on the Multiple Representational approach is feasible to use. This was concluded based on the results of the average percentage of the module validation questionnaire, and the teacher’s response as well as the results of cognitive identification

4. Conclusion
Based on the results of the research that has been done, it is concluded that practicum module based on multi representations through the PhET media approach that has been developed by the authors obtaining a very feasible assessment by experts to be tested in its use in practicum. And the teachers’ response towards the practicum module developed at the trial stage is categorized as very feasible to be implemented in practicum.

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