

Developing Basic Physics Teaching Materials by PhET Simulation-Assisted for Faculty of Engineering Students at Universitas Islam Syekh Yusuf

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Abstract. This research is focusing on developing basic physics teaching materials assisted by PhET simulation. This study aims to produce a product of basic physics teaching materials that contains material, practicum, and practice questions. The research method used research and development method. It is the Borg and Gall model. This study uses the R&D research method which in its reporting uses qualitative and quantitative approaches. The qualitative approach describes the results of the development of teaching materials and a quantitative approach is for presenting data to make it easier to present using numbers. The results of this study are teaching materials that contain material, practicum and exercises. The validation of the study was executed by 3 experts with a validation value of 75%, validation by media experts is 79.19%, and validation by learning experts is 77.08%.

Keywords: Teaching Materials Development; Physic Materials; PhET

1 Introduction

Teaching materials have major contribution to the success of the learning outcomes. By having and applying appropriate teaching materials, lecturers will find it easier to hold teaching and learning activities in the class and it will be more helpful as well as easier to execute [1]. Teaching material is one of the factors that has a very important role in the success of learning. The reasons to develop teaching materials include the suitability of teaching materials with curriculum demands, target characteristics, and learning problem solving demands. The suitability of teaching materials with curriculum demands must be accompanied by consideration of students needs. If the teaching materials developed are in accordance with student's needs, then the target characteristics and learning problems in the field can be solved. In order to vary the teaching materials, it is necessary to pay attention to the facilities and conditions of the learning environment. In fact, based on data from study program graduates, almost 50% are not linear with the chosen of study program. Another fact is the unavailability of a physics laboratory to support basic physics lectures. These analysis

results need to be concerned in the preparation of teaching materials, because if the students come from different backgrounds, it is necessary to equalize the basic concepts of the material to be studied, and then be accompanied by looking at the availability of supporting facilities. Thus, the authors offered the development of basic physics teaching materials assisted by PhET simulations. For the first step, equating student concepts can be done during virtual experiment. Doing virtual experiment due to the unavailability of a physics laboratory.

2 Materials and Methods

Teaching materials in general are something that contains information and knowledge that can be learned by its users. In learning activities, teaching materials have a role as media that mediate the process of delivering knowledge and skills from the source persons to the learners. Teaching materials are a set of learning tools or devices that contain learning materials, limiting methods, and methods that are designed systematically and attractively in achieving the expected outcomes which meets the competencies or sub-competencies with all aspect of teaching and learning. Teaching materials are useful to assist educators in carrying out learning activities. For teaching materials, educators are responsible to give clear and concise instructions or directions of all the activities which are taught to students in the learning process [2]. In general, books are divided into four types as follows [3]:

- a) Source Book; it is a book that can be used as references, references and sources for the study of certain sciences, usually containing complete scientific studies
- b) Reading book; refers to the books that only function as reading material, for example stories, legends, novels, and so on
- c) Handbook; which is a book that can be used as a guide for teachers or instructors in carrying out the teaching process
- d) Books of teaching materials; refers to the books compiled for the learning process that contain learning materials.

The use of teaching materials in any form must be able to facilitate the ongoing learning process of students. There are four indicators that can be used as references to assess the effectiveness and efficiency of the use of teaching materials [4]:

- a) Able to improve student learning outcomes
- b) Able to motivate students to carry out the learning process continuously
- c) Able to improve students' memory or memory of the content or material that has been learned
- d) Able to make students play an active role in applying knowledge and skills

While teaching materials according to their nature can be divided into four types, namely as follows [5]:

- a) Print-based teaching materials
- b) For example: Pamlet books, student study guides, tutorial materials, student workbooks, maps, charts, photos from magazines or newspapers, and so on.
- c) Technology-based teaching materials
- d) Examples: Audio cassettes, radio broadcasts, slides, film strips, films, videotapes, television broadcasts, interactive videos, tutorials, and multimedia.
- e) Teaching materials used for exercises or projects
- f) For example: science kits, observation sheets, interview sheets
- g) Teaching materials needed for human interaction purposes (especially for distance education purposes) For example: telephone, cell phone, video conferencing, and so on.

The facts found in the field of basic physics courses include the varied backgrounds of the students, the unavailability of a physics laboratory, and the unavailability of appropriate teaching materials. Previous research related to PhET simulation discussed the effectiveness, implementation strategies in the learning process and the advantages and disadvantages of PhET simulation. PhET simulation has the benefit of helping students understand the learning materials [6]. To support the basic concept equations in basic physics courses, the development of appropriate teaching materials and in accordance with student needs is carried out. Creative development can be assisted by PhET simulation and the quality that exists in students [7]. In contrast to previous research, research on the development of teaching materials will be carried out with the help of PhET simulations in each material. Starting from the presentation of the syllabus at the beginning, then continued with learning materials related to the PhET simulation accompanied by work instructions and equipped with practice questions at the end. Regarding some of the facts mentioned earlier, PhET simulation is expected to be a solution to the current problems. This simulation can be accessed free of charge at <http://PhET.colorado.edu>. PhET simulation was made by the University of Colorado which contains simulations of learning physics, biology, chemistry for the benefit of learning in the classroom or individual learning [8]. Users can manipulate activities related to experiments. So it is not only able to build the concepts, PhET can also be used to develop science process skills [9]. Based on the previous statement, the Development of Basic Physics Teaching Materials Assisted by PhET Simulation will be implemented.

This research was conducted at the Informatics Engineering Study Program, Faculty of Engineering, Sheikh Yusuf Islamic University, which is located at Jalan Maulana Yusuf No. 10 Babakan Village, Tangerang District, Tangerang City, Banten Province. The approach used to solve the problem is by developing the previous media and continuing the feasibility test for using learning media. The method used in this research is research and development method (R&D). Research and development is a process or strategy for developing new products or improving existing products. Products are not always in the form of objects or hardware such as books, modules, learning aids in the classroom or in the laboratory, but can also be in the form of software such as computer programs for data processing, classroom learning, libraries or laboratories [10]. The present study applied Borg and Gall Development Model. There are three stages on this Development research, includes: (1) studying research findings (preliminary studies and needs analysis), (2) developing products, and (3) field testing and revisions. Research Cycle shown on Figure 1.

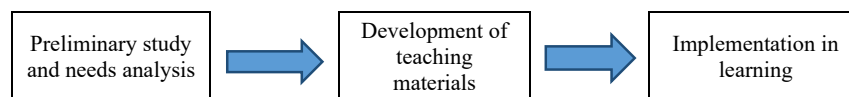


Fig.1 Chart of the stages of research on the development

This study applied R&D (Research and Development) method which in its reporting uses qualitative and quantitative approaches. The qualitative approach describes the results of the teaching materials development and the quantitative approach was used to present data. So, that it is easier to deliver using numbers. The data were obtained from the results of validation tests by material experts and media experts as well as field trials to students and educators using Likert scale with a range of 1-4 points [11]. Likert scale is shown in Table 1.

Table 1. Likert Scale for rating

No	Alternative Answer	Score
1	strongly agree	4
2	agree	3
3	disagree	2
4	strongly disagree	1

The formula used to analyse quantitative data from material expert responses using the feasibility calculation formula according to [12] is as follows:

$$\text{eligibility formula} = \frac{SH}{SK} \times 100 \% \quad (1)$$

Note:

SH : Score Calculation

SK : Score Criteria/Ideal Value

Furthermore, after getting the average expert assessment with the above formula, the results of this average assessment can be classified into four eligibility categories using the Percentage Scale is shown in Table 2:

Table 2. Score in the percentage of feasibility tests

Score In Percentage	Eligibility Category
<40%	Not feasible
40% - 55%	Inadequate
56% - 75%	Decent enough
76% - 100%	Very decent

3 Results and Discussion

At the stage of need analysis, data collection was undertaken by observation, interviews and questionnaires via google form from May 11, 2021 to May 18, 2021. Observations were carried out first before distributing questionnaires and interviews, then questions in interviews and questionnaire sheets were arranged based on observation results. Based on the results of observations, interviews and questionnaires, it is confirmed that there were not available data for basic physics teaching materials since the lectures on basic physic class was only performed conventionally without any practicum applied during the learning and teaching activity. After having further review, the obstacles found in delivering physics courses are the unavailability of laboratories and the lack of prior understanding of students due to different graduate backgrounds. So, teaching materials are needed to connect students' prior understanding with the materials being discussed. In the teaching implementation, students are asked to access PhET simulation in the beginning of the chapter, then the next step students are asked to change the independent variables. After that, students need to submit initial conclusions, from the initial conclusions it can be seen whether the basic concepts they have are correct. The next step is the explanation of the materials from the lecturer then straightens out the concepts that are not quite right. This is done because there is no physics lab and not all physics material can be visualized in words. An example of a PhETt simulation-assisted experiment is shown in Figure 2.

Lembar Praktikum Dinamika Rotasi

Keseimbangan

Langkah Percobaan

1. Buka link https://phet.colorado.edu/sims/html/balancing-act/latest/balancing-act_in.html
2. Ceklis massa, gaya berat dan tanda pada kolom di sisi kanan
3. Lakukan percobaan dengan mengubah tata letak bata pada sisi kanan, kemudian setimbangkan pada sisi kiri
4. Rubah posisi bata dan ukuran bata, kemudian catat temuan yang berhasil diamati.

Analisis

1. Berdasarkan eksperimen di atas, kapankah system menjadi setimbang?
2. Bagaimana cara kerja momen gaya pada system diatas?
3. Apakah arah mempengaruhi pergerakan system?

Buatlah kesimpulan percobaan yang anda lakukan!

Fig. 2. Rotational dynamics practice

Expert validation or expert judgment was conducted by several validators who are competent in their fields. In this study, validation was carried out by 3 validators, namely validation by material experts, validation of media experts, and validation of learning media experts. Data collection by material experts was implemented on August 16, 2021 by sending files of basic physics teaching materials assisted by PhET simulations that had been developed along with research questionnaires in the Google Form. The calculation of validation results by experts is as follows:

Materials Expert Validator

$$formula = \frac{SH}{SK} \times 100\% = \frac{54}{72} \times 100\% = 75\% \quad (2)$$

Media Expert Validator

$$formula = \frac{SH}{SK} \times 100\% = \frac{57}{72} \times 100\% = 79,9\% \quad (3)$$

Learning Expert Validator

$$formula = \frac{SH}{SK} \times 100\% = \frac{37}{48} \times 100\% = 77,08\% \quad (4)$$

The calculation of validation results by experts is shown in Figure 3

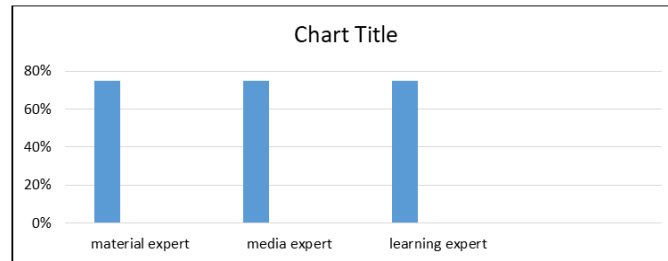


Fig. 3. The calculation of validation results by experts

The development of physics teaching materials assisted by phet simulations developed by researchers is a product that aims to assist lecturers in learning physics. In this case, there are several advantages of the product, including: (1) improving the quality of learning, (2) increasing the spirit of practice, (3) assisting lecturers in connecting the basic concepts of physics with the physics material to be studied. There are several stages in the research: needs analysis, validation, revision, limited scale trial and implementation. A needs analysis was carried out and several obstacles were found in physics learning, these obstacles are estimated to be overcome by developing PhET-assisted physics teaching materials. The validation of the study was executed by 3 experts with a validation value of 75% by material experts with decent enough teaching materials category, validation by media experts is 79.19%, and validation by learning experts is 77.08% with very decent teaching materials category.

4 Conclusion

The research that has been carried out certainly has many shortcomings, therefore to improve the quality of basic physics learning, the researcher provides suggestions for the further development of basic physics teaching materials, and for further research is expected to determine the effectiveness of the developed teaching materials, last is the utilizing teaching materials that have been developed with the support of good planning by the lecturers in order to realize what are the learning objectives in the Lesson Plan (RPS/SAP) as well as the selection of learning strategies that are in accordance with the characteristics of students. After all, here are the summary of the research:

- a) The production of basic physics teaching materials assisted by PhET is performed through several stages; including needs analysis, development of teaching materials, and implementation. The results of this study classify teaching materials into three main topics, they are teaching materials, practicum and practice questions.
- b) The validation of the study was executed by 3 experts with a validation value of 75% by material experts with decent enough teaching materials category, validation by media experts is 79.19%, and validation by learning experts is 77.08% with very decent materials category.

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