Development of electronic modules by scientific approach to train science process skills

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Abstract. The aims research is to design and implement the development of E-modules based on scientific approach and to analyse the effectiveness and feasibility using e-modules to train science process skills in SMAN 65 Kebun Jeruk West Jakarta of XI Mathematics and Natural Science grade. Research models used in this study is research and development of Borg and Gall models with stages: planning, initial product development, initial testing, major product revisions, large group trials, product operational revisions, operational trials, final product revisions, dissemination and distribution. The instruments are field test questionnaire filled out by students, teachers, and experts. The research results get a good percentage interpretation based on the effectiveness and test feasibility where is feasible category that can be concluded that the e-modules by scientific approach is effective and very feasible to train the science process skills.

1. Introduction

Technology can transform learning when used by teachers who know how to create engaging and effective learning experiences for their students [1]. For this reason, be expected that in learning there will be media that can be developed to combine the provision of material with improving student skills. Therefore, the learning process that takes place is certainly not separated from the general components of learning planning, one component of which is the use of media and learning resources.

According to Minister of Education and Culture Regulation number 69 concerning to 2013 Curriculum [2] there is a paradigm shift that brings education in Indonesia to 21st century learning system. In fulfilling demands that facilities the need for teaching materials, media is needed as a technology-based learning resource. Learning activities in this time emphasize process skills and active learning, so learning media become increasingly important [3].

Furthermore, learning media based on the distribution of needs analysis in September-December 2017 of the thirty Senior High Schools of Physics teachers in Bogor, Depok, Bekasi, and Tangerang teachers stated that learning requires teaching materials to support the process of science skills students. The results was 50% that agree; it was very supportive so that learning would be easier to implement in daily basis and 46.7% supported the skills of science processes suited with 21st century. The use of learning media is electronic modules that has varies to support to which consistent on the curriculum challenges.

The students need to train their science processes skills. The science process is derived from the steps taken by scientists when conducting scientific research, these steps are called process skills. Science process skills can also be interpreted as the ability to carry out an action in learning science so as to
produce concepts, theories, principles, evidence, laws and facts. Learning approaches must be well made to train students' skills and one of them is the scientific approach. The teaching learning process in scientific approach referred to the process of observing, asking, reasoning, experimenting, and establishing network for all subjects [4].

Theoretically, the model of electronic module can provide real problems that are packaged in multi representations in form of video, animation, or multimedia that give opportunity in providing the accessible and systematic material [5]. Modules are teaching materials that are arranged systematically with languages that are easily understood by students, according to their age and level of knowledge so that they can learn independently with minimal guidance from the teacher [6]. So that at present in learning it is necessary to develop media in the form of electronic modules according to technological progress. Learning modules are sources other than teachers that are systematically designed by experts in certain fields of study or the teaching profession according to design rules with the aim of increasing effectiveness, efficiency, and increasing students' interest in continuing to learn [7].

1.1 Electronic Modules
The electronics modules is a form of presentation of material self-learning systematically arranged into units of learning smallest to achieve specific learning presented in the electronic format in which there is animation, audio, navigation makes the user more interactive with the program [8].

The good modules have five characteristics, namely self-instruction, self-contained, stand alone, adaptive, and user friendly [9]. Some the results of the study indicate that use of moduleless in the learning process can improve learning outcomes. Characteristic of modules are self-instruction; the student is possibly to be self-study and not depend on other sides, self-contained; all the subject materials is on the modules, stand alone; developing modules are not depend on either on subjects materials nor any other subjects materials. Students don’t need other material to complete the tasks, adaptif; the modules is adaptive in developing the science and technology by any hard ware tools only in the certain time, user friendly; The modules consist of plain instruction and information which displayed in general terms, and easy to understood in simple language performance.

Teaching materials that can be used, one of which is non-printed teaching materials that use electronic media, namely electronic modules or e-moduleless. The physics electronic modules is a learning package that contains a unit of concept from physics learning material that is displayed by using electronic devices in the form of computers [10].

1.2 Scientific Approach
Scientific approach to learning is directly on the facts and the reality that exists around the student learning resulting in actually using observation and analysis in practice [11]. The scientific approach has learning models to implement the whole approach, strategy, and method components which are employed holistically and comprehensively in learning process, the approach can encourage students to be capable of observing, questioning, experimenting, associating, and communicating [12].

1.3 Science Processes Skill
Science process skills can be categorized into two levels, basic and integrated. Integrated science process skills consist of five skills: 1) identifying and controlling variables, 2) defining operationally, 3) formulating hypotheses, 4) experimenting including being able to design their own experiment to test a hypothesis using procedures to obtain reliable data, and 5) interpreting data and drawing conclusions [13].

The learning process consists of five basic learning experiences namely observing, asking, gathering information, associating, communicating. The five basic learning can be specified in various learning activities [14].

Science process skills are applied in the learning process. The formation of skills in gaining knowledge is one of the emphases in science learning so that the assessment of students' science process
skills must be carried out on science process skills both partially and intact. The classification of science process skills is divided into three levels, namely Basic, Intermediate, and Advanced [15].

2. Methods

This study aims to design and implement the development of e-modules based on scientific approach at SMAN 65 Kebun Jeruk West Jakarta to train science process skill was held in January 2019 in Mathematics and Natural Science programme as much as 36 students selected by consideration average value of assessment in e-modules of three parallel classes in 2018/2019 academic year. The research models used in this study is research and development by Borg and Gall models with stages are planning, initial product development, initial testing, major product revisions, large group trials, product operational revisions, operational trials, final product revisions, dissemination and distribution.

3. Results and Discussion

This development research produces teaching material products in the form of e-modules with a scientific approach to train science process skills. Learning with a scientific approach is learning that consists of observing (to identify problems that want to be known), formulating questions and formulating hypotheses, collecting data / information with various techniques, processing / analyzing data / information and drawing conclusions and communicating results that consist of conclusions and also other findings outside the formulation of the problem to obtain knowledge, skills, and attitudes.

Modules are divided into two learning activities. Namely Learning Activity 1: Dynamics of Rotation 2: Rigid Bodies Equilibrium. This following are the contents of the e-modules based on scientific approach:

![Image](image.jpg)

**Figure 1. Cover of Electronic Module**

The e-modules feasibility test is carried out by empirical test using the method of distributing questionnaires to material experts, learning experts, material experts, physics teachers and students. Based on data recapitulation, the results of the validation obtained with Likert scale are:

| Aspect               | Percentage | Interpretation |
|----------------------|------------|----------------|
| content eligibility component | 88%        | very good      |
| language component   | 90%        | very good      |

Based on the Table 1. The average of material expert validation is 89%.
Table 2. Media expert validation

| Aspect                        | Percentage | Interpretation |
|-------------------------------|------------|----------------|
| introduction of e-modules     | 90%        | very good      |
| e-modules component           | 88%        | very good      |
| e-modules characteristic      | 84%        | very good      |
| writing language design       | 89%        | very good      |
| Graphics                      | 86%        | very good      |
| Presentation                  | 90%        | very good      |

Based on the Table 2. The average of media expert validation is 88%.

Table 3. Learning Expert Validation

| Aspect                        | Percentage | Interpretation |
|-------------------------------|------------|----------------|
| content eligibility component| 79%        | good           |
| writing language design       | 88%        | very good      |
| presentation                  | 88%        | very good      |

Based on the Table 3. The average of learning expert validation is 84%.

Table 4. Physics teacher validation

| Aspect                        | Percentage | Interpretation |
|-------------------------------|------------|----------------|
| e-component                   | 88%        | very good      |
| Presentation                  | 88%        | very good      |
| content component             | 90%        | very good      |
| presentation                  | 88%        | very good      |

Based on the Table 4. The average of physics teacher validation is 88%.

Table 5. Small Group Trial Validation

| Aspect                        | Small Group | Large Group |
|-------------------------------|-------------|-------------|
|                               | Percentage  | Interpretation | Percentage | Interpretation |
| introduction of e-modules     | 85%         | very good    | 80%        | good          |
| e-modules component           | 82%         | very good    | 80%        | good          |
| e-modules characteristic      | 81%         | very good    | 80%        | good          |
| writing language design       | 79%         | good         | 83%        | very good     |
| Graphics                      | 77%         | good         | 79%        | good          |
Based on the Table 5. The average of small and large group trial validation is 80% and 80%.

The gain of learning outcomes is obtained from the difference between the pre-test and post-test scores. Because learning outcomes are the results obtained by students after learning, the learning outcomes in question are those experienced by students. To find out the effectiveness of using printed teaching materials in the form of e-modules with a scientific approach to the experimental class, the normalized gain calculation (N-Gain). The calculation results (N-Gain) of the experimental class can be seen in the table below:

| Class     | Posttest average | Pretest average | N-Gain | Criteria |
|-----------|------------------|-----------------|--------|----------|
| control   | 78.861           | 44.444          | 0.619  | middle   |
| experimental | 84.881         | 47.861          | 0.710  | high     |

Based on the data on the average score of the pre-test and post-test in the experimental class, the normalized N-Gain value \( \langle g \rangle \) was 0.710. The value is then interpreted that the effectiveness of the use of printed teaching materials in the form of e-modules with a scientific approach has high criteria.

The feasibility level (K) of e-modules produced to be used as learning materials, using the percentage formula as follows:

\[
K = \frac{3055.75}{3600} \times 100\% = 84\%
\]

4. Conclusion

Electronic modules with a scientific approach to the material of rotation dynamics and rigid equilibrium is very feasible in learning physics is very feasible and able to train students' science process skills with the percentage average validation of material expert is 89%, media expert is 88%, learning expert 84%, physics teacher is 88%, small group trial and large trial (implementation) is 80%. The e-modules also is very feasible to use as a learning media with the feasibility level is 84%.

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