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# The Development of Optical Module Based on Science Process Skills

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**ABSTRACT**
The optical concept is an important concept that must be mastered by pre-service teacher. The concept is not only obtained theoretically but also through scientific process skills. This requires an optical module based on process skills to assist students in mastering optical concepts. This study aims to 1) Produce an optical module based on a science process skill approach, 2) Know the quality of an optical module based on a science process skill approach according to material experts and media experts. The module was developed by using research and development (R&D) methods with ADDIE model. The research instrument was in the form of a module quality rating scale using a Likert scale created in the form of a checklist. The subjects of module quality assessment are two material experts and two media experts. The module quality data obtained are in the form of quantitative data which are converted according to the scale of the product quality percentage. The results showed that an optical module based on the science process skills approach has been developed. The quality of the modules developed is in the good category based on the material expert judgment and also in the good category based on the media expert judgment.

***Keywords:*** *Development, Module, Science process skills, Optics*

## 1. INTRODUCTION

The concept of optics is one of the most important concepts to be mastered by students as prospective physics teachers [1]. The concept of optics is given to students both at the basic level in the basic physics course to the advanced level in the optics course. After studying optics, students are expected to be able to explain the concepts of geometric optics and physical optics, verify the concepts of geometric optics and physical optics through experimental activities, and apply optical concepts in solving problems of everyday life. Without understanding the concept of the properties of light, students will not fully understand modern science [2]. Thus, students as prospective physics teachers must be able to master knowledge of optical concepts well and have scientific skills in mastering optical concepts.

However, based on data on the achievement in optics course in the previous academic year, it is known that the average value of optical courses has not been satisfactory either in terms of theoretical or practical value. Student difficulties often occur in understanding the concept of geometric optics and wave optics [3]. From the results of the analysis of the test answers it is also known that one aspect of the skill that is still difficult for students to master is the skill of describing the concept of special rays in the form of diagrams that will actually help in solving problems. Students only focus on counting questions without trying to solve the problems by making diagrams well. Likewise, the skills in reading image in optics are also not well mastered by students [4]. This shows that students' science process skills in learning optics still tend not to be maximal.

In addition, based on experience during teaching, students also seem to make more use of lecture notes without trying to add other references for learning in class. It also makes it difficult for students to study independently. In fact, the independence of student learning is one of the factors that influence student achievement [5][6][7] and student's scientific literacy [8]. Students who have good learning independence always try to learn independently and try to solve various problems in learning with their efforts and abilities.

Based on the above problems, it is necessary to provide a solution in learning so that science process skills and student learning independence can increase in optics lectures. One solution that can be done is by providing an optics lecture module that is developed based on a science process skills approach. The process skills approach is a teaching approach that provides opportunities for students to acquire a good knowledge through scientific inquiry as part of the process of cognitive and investigative [9] or to take part in the process of discovering or composing a concept as a process skill [10]. Science process skills are fundamental skills to mastering science [11] and very important in teaching ways to achieve knowledge and are an important goal in learning science [12], not only can they help students receive information but are also important in understanding learning information.

According to Ebert & Ebert [13], science process skills are divided into basic science process skills which include observation, classifying, communicating, measuring, predicting and inferencing, and integrated science process skills [14] which include defining and controlling variables, planning and testing hypotheses, defining, experimenting, interpreting data and formulating models. These skills will be developed and trained to students through a lecture module, especially in the optics subject, both theoretically and practically, discovery and proof of optical concepts in the laboratory [15]. Through a module designed with a scientific approach, one of which is the process skills approach, in addition to increasing concept mastery, it can also increase student interest in learning [16]. Besides being able to improve students 'science process skills, the optics module is also expected to increase students' independence in learning concepts in optics courses.

To develop a good learning module, it is necessary to analyze the quality of the module being developed [17], [18]. The optical module based on science process skills that is used will of course have to go through a feasibility test (validity and reliability) before being applied in learning. Likewise, with the test instrument that will be used to measure students' science process skills [19], which must go through a process of review and trial so that a good test instrument is produced. By using valid and reliable instruments in collecting data, the research results will be valid and reliable [20]. So that in the development of the optical module, the feasibility analysis is important in the research process that will be carried out.

## 2. METHOD

This research uses research and development (R&D) methods to developed an optical learning module which is based on the science process skills approach. The development model used is the ADDIE model which consists of stages, namely: the analysis stage, the design stage, the development stage, the implementation and evaluation stage [21], [22]. However, the research stage is carried out only up to the development stage to produce valid learning modules.

Data collection techniques used in this study are indirect communication techniques and measurement techniques. The data collection tools used were expert validation questionnaires and student response questionnaires. The expert validation questionnaire is used to collect expert validation data related to the draft module that has been made. The validation questionnaire consisted of a media validation questionnaire and a material validation questionnaire.

The quality of the optics learning module developed evaluates input from experts or validators. The aspects that will limit the module are (1) the accuracy of the content coverage, including the suitability of the module content with the course objectives to be achieved, and the breadth or depth of the module content (2) the digestibility of the module, including the systematic presentation of material and an orderly format and consistent (3) use of language, namely the language or editorial used in the module that is clear, precise, and communicative (4) the appearance of the interesting module and (5) the use of clear and precise illustrations. Assessment data from media experts and material experts were analyzed descriptively using the percentage feasibility technique [23]. Results obtained from validation have been followed up with revisions of validation results.

## 3. RESULTS AND DISCUSSION

The research that has been done has resulted in an optical module based on science process skills. Modules are designed and compiled based on a science process skill approach, the parts of which consist of covers, table of contents, instructions for using the module, introduction, elaboration of material, sample problems and solutions, and questions. Based on the curriculum analysis, it is known that the learning outcomes contained in the KKNI curriculum in the physics education study program are that graduates of the physics education study program have the ability and mastery of physics concepts and can apply them in everyday life. One of the concepts that physics education students need to master is the concept of optics. The optical concept is studied in an optics course with 3 credit hours. This course is the Study Program Expertise Course which is a compulsory subject for Physics Education study program students. After attending this lecture, students are expected to understand optical concepts and the application of concepts in daily life to solve science and technology problems. Lecture material includes geometric optics namely Snellius law on reflection and refraction, reflection of light on mirrors, refraction of light on spherical surfaces, thin lenses, optical equipment and physical optics namely light interference, light diffraction, light polarization and optical applications namely optical fiber and waveguides planar. The prerequisite course before attending this lecture is the wave course. So, students who will take the wave course must pass the optics course.

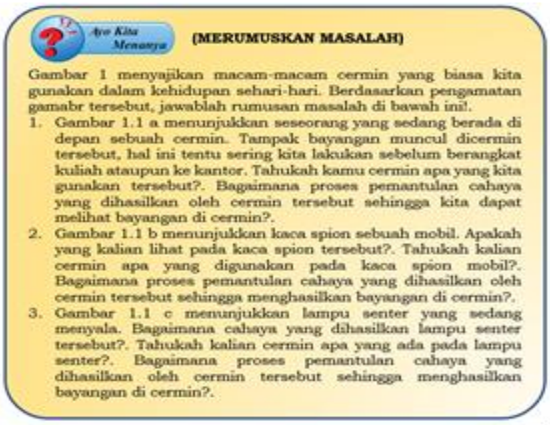
Based on the analysis of the curriculum and relevant learning theories, found basic problems in learning optics courses. Based on the results of observations and interviews, it is known that there are problems faced by students, especially in studying optics. It is known that the mean value of the optics course has not been satisfactory, both in theory and practicum scores. The theoretical value of the optics subject is dominated by the sufficient category. From the results of the analysis of the test answers it is also known that one aspect of the skill that is still difficult for students to master is the skill of describing the concept of special rays in the form of diagrams that will actually help in solving problems. Students only focus on counting questions without trying to solve the problems by making diagrams well. Likewise, the skills of interpreting the concept of the relationship between object distance and magnification on a convex lens are also not well mastered by students. This shows that the science process skills of students in learning optics are still not optimal [3-4], [24]. As a result, students are not able to apply the concepts they get in new situations, so that the understanding of material concepts in advanced physics courses is less which implies low learning outcomes achieved by students. Therefore, we need a learning material that can help students learn optical material easily and can last a long time in the minds of students.

Based on the need analysis, an appropriate module model development design is obtained, namely the science process skills approach. The process skills approach is a teaching approach that provides opportunities for students to take part in the process of discovering or composing a concept as a process skill [10]. This is as stated by Ref [25] that important science process skills are possessed by students because they become basic skills in science, thus enabling students to be active, develop a sense of responsibility, improve learning and research methods. Through a module designed based on a science process skills approach, it will train students in using thoughts, reasoning and actions effectively and efficiently to achieve certain results. The science process skills approach was chosen because it is in accordance with the curriculum and the nature of science [26]. Students will be trained to carry out a series of scientific activities such as observing / observing, grouping / classifying, interpreting / interpreting, predicting / predicting, hypothesizing, planning experiments and communicating [27].

The next stage is design. At this stage the module design is based on the subject obtained at the analysis stage. The design stage includes: (a) Determining the outline of the material to be developed. The determination of the material in the developed module is based on curriculum analysis and student needs. There are two main subjects, namely geometric optics, consisting of Snellius' law on reflection and refraction, light reflection on mirrors, light refraction on spherical surfaces, thin lenses, optical equipment, and physical optics consisting of light interference, light diffraction, light polarization and optical applications. namely fiber optics and planar waveguides. (b) Designing the module design. This stage is the initial stage of module design based on the science process skill approach used in optical recovery. The purpose of the activity at this stage is to design a prototype module (instructional material). The module design made in this study includes a cover, instructions for using the module, an introduction, materials, sample questions and their solutions and practice questions.

The module cover includes the title of the optics course module developed based on science process skills. An image of the rearview mirror in cover module is presented to enhance the appearance of the module cover and illustrate one of the optical phenomena that will be discussed in an optics course. Then, in the introductory view the module contains instructions for using the module, so that students see the parts of the module that contain steps for science process skills. In the introductory section there are also learning outcomes that will be achieved by students after studying optics through science process skills-based modules.


**1**(a)

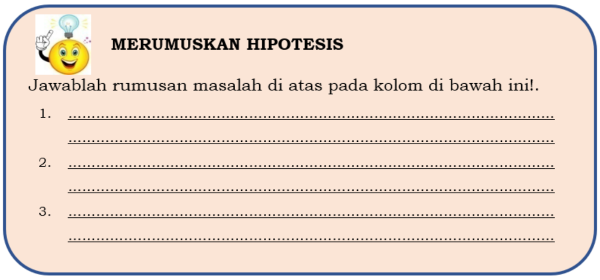

Ayo Kita Menanya

(MERUMUSKAN MASALAH)

Gambar 1 menyajikan macam-macam cermin yang biasa kita gunakan dalam kehidupan sehari-hari. Berdasarkan pengamatan gamabr tersebut, jawablah rumusan masalah di bawah ini!.

1. Gambar 1.1 a menunjukkan seseorang yang sedang berada di depan sebuah cermin. Tampak bayangan muncul dicermin tersebut, hal ini tentu sering kita lakukan sebelum berangkat kuliah ataupun ke kantor. Tahukah kamu cermin apa yang kita gunakan tersebut?. Bagaimana proses pemantulan cahaya yang dihasilkan oleh cermin tersebut sehingga kita dapat melihat bayangan di cermin?.
2. Gambar 1.1 b menunjukkan kaca spion sebuah mobil. Apakah yang kalian lihat pada kaca spion tersebut?. Tahukah kalian cermin apa yang digunakan pada kaca spion mobil?. Bagaimana proses pemantulan cahaya yang dihasilkan oleh cermin tersebut sehingga menghasilkan bayangan di cermin?.
3. Gambar 1.1 c menunjukkan lampu senter yang sedang menyala. Bagaimana cahaya yang dihasilkan lampu senter tersebut?. Tahukah kalian cermin apa yang ada pada lampu senter?. Bagaimana proses pemantulan cahaya yang dihasilkan oleh cermin tersebut sehingga menghasilkan bayangan di cermin?.

**1**(b)


MERUMUSKAN HIPOTESIS

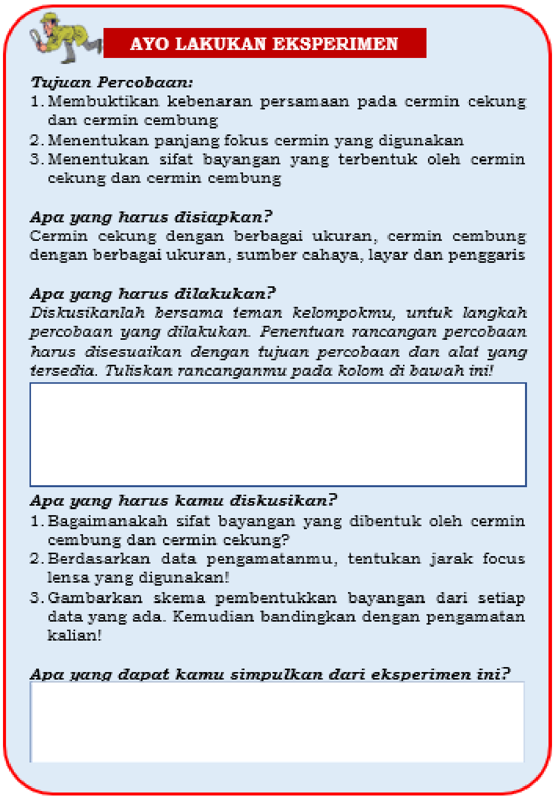
Jawablah rumusan masalah di atas pada kolom di bawah ini!.

1. ......................................................

2. ......................................................

3. ......................................................

**1**(c)


AYO LAKUKAN EKSPERIMEN

***Tujuan Percobaan:***

1. Membuktikan kebenaran persamaan pada cermin cekung dan cermin cembung
2. Menentukan panjang fokus cermin yang digunakan
3. Menentukan sifat bayangan yang terbentuk oleh cermin cekung dan cermin cembung

***Apa yang harus disiapkan?***

Cermin cekung dengan berbagai ukuran, cermin cembung dengan berbagai ukuran, sumber cahaya, layar dan penggaris

***Apa yang harus dilakukan?***

*Diskusikanlah bersama teman kelompokmu, untuk langkah percobaan yang dilakukan. Penentuan rancangan percobaan harus disesuaikan dengan tujuan percobaan dan alat yang tersedia. Tuliskan rancanganmu pada kolom di bawah ini!*

***Apa yang harus kamu diskusikan?***

1. Bagaimanakah sifat bayangan yang dibentuk oleh cermin cembung dan cermin cekung?
2. Berdasarkan data pengamatanmu, tentukan jarak focus lensa yang digunakan!
3. Gambarkan skema pembentukkan bayangan dari setiap data yang ada. Kemudian bandingkan dengan pengamatan kalian!

***Apa yang dapat kamu simpulkan dari eksperimen ini?***

**1**(d)

**Figure 1** The module display contains (a) let's observe; (b) lets'ask questions; (c) hypothesize; and (d) experimenting steps which are part of the step of science process skills.

In the introductory part, it consists of let's observe (Figure 3a), let's ask questions (Figure 3b), hypothesize (Figure 3c) and experimenting (Figure 3d). In the section let's observe, the phenomena related to everyday life are presented. It is included so that students can observe images of the phenomenon which will later lead to questions that they will investigate. In the section, let's ask questions, presented the formulation of problems that will be solved by students through investigation or experimenting. However, before the investigation, students were asked to answer the problem in the hypothesis column.

The next stage is the development stage. At this stage, content validation and testing are carried out. Modules that have been designed at the design stage are validated or assessed by experts who are considered competent so that information is obtained in the form of input, evaluation and revision both in terms of material and appearance. As for the assessment team, they are two material expert lecturers and two media expert lecturers. The data obtained consisted of quantitative data and qualitative data. Data obtained from questionnaires were analyzed quantitatively. The following shows the results of validation data analysis from material experts and media experts. The data from the material expert validation were obtained from a questionnaire given to the two lecturers. The data description can be seen in Table 1.

**Table 1.** Quantitative data analysis of material validation results

| Aspect | Data | | | |
|---|---|---|---|---|
| | *Sum* | *Aver age* | *Percentage (%)* | *Category* |
| Content eligibility | 116 | 58 | 72,14 | Good |
| Serving Feasibility | 50 | 25 | 79,17 | Very good |
| language | 76 | 38 | 78,13 | Good |
| Overall | 242 | 121 | 76,48 | Good |

Based on Table 1, it is known that the overall validation assessment by material experts is 76.48% and has a good category. From the first and second validator questionnaire, this teaching material is recommended with appropriate criteria and needs revision. Apart from quantitative data, this questionnaire also obtained qualitative data in the form of criticism and suggestions. The results of this validation are also a reference in revision of teaching materials.

Data validation results from media experts were obtained from a questionnaire given to the two lecturers. The data description can be seen in Table 2.

**Table 2.** Quantitative data analysis of media validation results

| Aspect | Data | | | |
|---|---|---|---|---|
| | *Sum* | *Aver age* | *Percent age(%)* | *Category* |
| Module Organization | 37 | 18,5 | 77,08 | Good |
| Attraction Module | 30 | 15 | 75,00 | Good |
| Module font size and shape | 27 | 13,5 | 84,38 | Very good |
| Module language | 20 | 10 | 83,33 | Very good |
| Module consistency | 11 | 5,5 | 68,75 | Good |
| Overall | 125 | 62,5 | 77,71 | Good |

Based on Table 2, it is known that the evaluation of validation by media experts as a whole is classified as good with a percentage of 77.71%. In addition to quantitative data, there is also qualitative data obtained in the form of criticism and suggestions from media experts. According to Ref [28], a valid module shows that the module is in accordance with the indicators set and can be used to train science process skills and student learning independence.

## 4. CONCLUSION

The optical module based on a science process skills approach has been developed. The quality of the modules developed is in the good category based on the material expert judgment and also in the good category based on the media expert judgment. So that this module can be implemented in optics lectures with learning outcomes according to the KKNI curriculum for the Physics Education Study Program.

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