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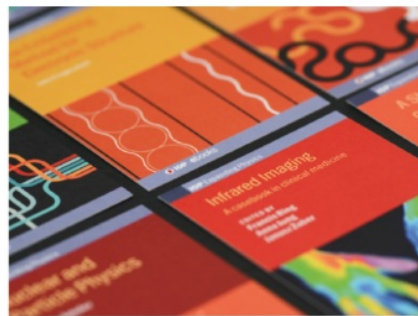
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## Learning materials of natural science of characters-based problems on light and optical concept

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**Abstract.** Problem-based learning (PBL) is one of the recommended teaching materials model in the 2013 curriculum. The purpose of this research was to develop learning materials of natural science of characters-based problems on light and optical concept in junior high School four east Praya. Research and development study referring to Dick & Carey model. Validaton by three experts (media, content, and language). The results of the first validation obtained an average of 3.6 and second validation obtained an average of 4.1, this indicates that learning materials are feasible and relevant to be used as learning resources for class VIII. The results of the reading level by Kincaid readability showed that out of 76 pages there were 40 pages of text that corresponded to the junior high school class VIII with a percentage of 52.6%, while the non-compliant text contained 36 pages with a percentage of 47%. The results of a limited trial showed that responses from students by 28% with categories quite interesting, 36% interesting, and 36% very interesting. In conclusion, learning materials of natural science of characters-based problems on light and optical concept was feasible to be applied in science learning processes.

### 1. Introduction

Problem-based learning (PBL) is one of the recommended teaching materials model in the 2013 curriculum [1] because it trains and facilitates students to formulate problems, find solutions or test the temporary answers through investigations and can also draw the conclusions as well as present them in verbal and in nonverbal (writing) teaching materials so that it affects the understanding on concepts, critical thinking skills, students' cognitive, behavioural and social dimensions, cooperation, motivation, and student teaching materials outcomes [2-7].

The implementation of PBL will be more effective if this is supported by teaching materials [8,9]. Teaching materials can be used in person or in groups, thus it can increase motivation and creativity since the students are easy to find information or materials so that the teaching materials objectives of knowledge, experience, and skills can be well achieved [10].

The results of the previous study at two schools in East Praya Subdistrict, namely SMPN 4 and SMPN 5 East Praya, revealed that (a) practical instructions on the student activity sheet had not facilitated students' critical thinking skills, and the activities were not in accordance with scientific



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procedures; (b) teaching materials used by the teachers did not present problems or phenomena that should be relevant to the teaching materials environment of the students, so students' ability to solve the problems and their critical thinking skills were still not optimal [11], (c) it only emphasized the achievement of cognitive competencies and skills, while scientific attitudes were not considered, and (d) it have not been integrated with the concept of character education which has become the government's recent priority program [7].

Another problem found during the initial observation was the presence of moral and behavioral deviations, such as students were dishonest by copying friends' answers while doing the exams, imitating data from other groups while practicing, and violating school rules or regulations (often late, not attending without permission, not submitting assignments on time). This shows that the scientific attitude of the students was still low and the implementation of characters had not got maximum attention.

Referring to these problems, the researchers developed one of the teaching materials resources, namely natural science materials of problem-based learning. The teaching curriculum was initiated according to the 2013 curriculum, consisting of light and optic chapters since both materials are much related to natural phenomena or symptoms that occur in students' daily lives. The phenomena or contextual problems were delivered with interesting and relevant images. The teaching materials were also completed by investigative activities to guide the students in carrying out inquiry activities in the hope that students' scientific attitudes can be fostered through a series of experimental activities during the teaching process [12-13].

Teaching materials are assumed to be able to help students completely and systematically think about natural sciences so that it can independently be learnt. Educators will be easier in designing or preparing and implementing teaching materials since the teaching materials are made for teaching materials objectives, materials, and activities or teaching materials experiences to achieve the goals and assessments applied in teaching materials activities.

## 2. Method

The present study is research and development (R & D), a research method used to produce certain products and test the effectiveness of these products. The procedure of development research refers to the design model for developing natural science materials. According to [14], there are ten stages of research and development, such as (a) identifying teaching materials objectives; (b) conducting teaching materials analysis; (c) analysing the characteristics of students and context; (d) formulating indicators; (e) developing assessment instruments; (f) developing teaching materials strategies; (g) designing and developing teaching materials; (h) designing and implementing formative evaluations; (i) revise teaching materials; and (j) designing and implementing summative evaluations.

Natural science materials that had previously been designed were then tested for the level of feasibility, and readability by the following stages:

### 2.1. Expert validity aimed to determine the feasibility of teaching materials

Data from expert validation was qualitatively used to improve the developed products. The feasibility value of teaching materials was determined to be at least sufficiently feasible in the interval score of  $2.6 \geq SV < 3.4$ .

### 2.2. Validation of teaching materials readability with flesch kincaid

Flesch-Kincaid was based on the index of readiness at level 7-10 which indicated that the text was easily understood by students aged 12 to 14 years (Middle School)

### 2.3. Limited field test

Data analysis of teacher and student responses to teaching materials used a Likert scale. The level of readability of teaching materials seen from the response of students was quite interesting in the interval

score of  $66.5\% \leq RS < 77\%$  at least. The limited trial was carried in class VIII at East Praya 5 Middle School with 25 students.

### 3. Result and discussion

#### 3.1. Results of need assesment

Teaching materials is one of learning components that has an impact on teaching and learning activities, so it needs to be developed. Natural science materials of character problems-based learning are one of the problem-based learning materials compiled based on the 2013 curriculum, having characteristics such as: a) focusing on problems relevant to contextual phenomena in surroundings accompanied by interesting and relevant images with contextual orientation; b) consisting of parts of the material description and investigation. The content is designed by displaying triggering questions for the readers on each first page of the chapter with the aim of exploring initial knowledge and arousing curiosity; c) character values and scientific attitudes were implicitly integrated in every investigation activity by displaying biographies of scientists and their possessions in the hope that they could be imitated and the investigative activities to guide the students in carrying out inquiry activities in the hope that their scientific attitudes could be built through a series of experimental activities during the learning process [12,13], and d) the discussed material was light and optic chapters. The developed teaching materials need to be validated to determine the level of feasibility so that it would be appropriate and relevant to use as teaching material resources.

#### 3.2. Results of expert validation

The initial design of the product before testing the field was limited and it must be validated by the experts (media, material, and language) with the aim of finding out the feasibility of natural science materials. Expert validation performed by three lecturers of master program of natural science education had been conducted twice. The recapitulation of the results of the first expert validation to the teaching materials is presented in Table 1.

**Table 1.** Recapitulation of validation I results.

No	Rated aspects	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	Average
1	Content	3.6	3.7	3.7	3.65
2	Presentation	3.6	3.6	3.7	3.6
3	Language	3.4	3.5	3.5	3.5
4	Graphics	3.7	3.7	3.8	3.8
	Average	3.6	3.6	3.7	3.6

Based on the validation I recapitulation of teaching materials in table 1 for all aspects assessed from the aspect of content, presentation, language and graphics, the scores exceeded the predetermined criteria,  $2.6 \geq SV \geq 3.4$ , so it could be used with a slight revision.

Some common things that had been corrected in teaching materials according to the validators' input are a) the image was presented with the left and right position so that the vision was not in one position, b) the image number was typed in bold and the source text was placed under the statement, c) every sub chapter was presented the questions to trigger students' critical thinking, and d) home activities material placed on the cover section was moved to the description section in the sub-chapter. The revised teaching materials were then validated for the second time. The second recapitulation of validation is presented in Table 2.

**Table 2.** Recapitulation of validation II results.

No	Rated aspects	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	Average
1	Content	4.1	4.0	4.0	4.0
2	Presentation	4.1	4.0	4.2	4.1
3	Language	3.9	4.2	4.2	4.1
4	Graphics	4.0	4.1	4.1	4.1
	Average	4.0	4.1	4.1	4.1

The results of the validation of teaching materials performed by experts in the table 2 indicate that teaching materials were feasible, and can be used with a slight revision. The score was higher than the first validation.

The parts of materials that had been corrected in teaching materials according to the validators' input are a) the fonts with type *cambrria* were changed to *arial* so that it would make it easier for students to read, b) the color of the images and the frame in the box was removed so that the vision became wider, c) the investigation sheet contained indicators of research variables to be achieved, and d) each formula was given in sequences. The results of expert validation confirmed that the teaching materials were appropriate to use in learning process and to support the process of character education.

Teaching materials are regarded as a component of learning materials that supports success in learning process so that the materials derived from books need to be developed and adapted based on the context and characteristics of students. Various studies conducted by [15, 16, 17, 18] show that PBL materials have a positive impact on student motivation, facilitating critical thinking, activities and teaching material outcomes. Meanwhile, [9] find that PBL materials can improve the ability of students to observe, ask, reason, try and communicate their findings, so that it has a positive impact on the ability of soft skills that are in line with the demands of the 2013 curriculum that emphasizes the modern pedagogical dimension in teaching materials by using a Scientific Approach [19].

Teaching materials cannot be used as a substitute for teachers or laboratories as the real practice place since teaching materials are only a facility, tool or media that can support students and teachers in learning process. Teaching materials with PBL approach can evaluate events from various perspectives, show adaptations to changing situations and can develop perspectives, think specifically and produce new information with high-level thinking. PBL is an effective teaching and learning approach, particularly when it is evaluated for long-term knowledge retention and applications [20].

### 3.3. Validation of feasibility of teaching materials using flesch readability formula

Flesch Readability Formula (FRF) aims to determine the level of readability of text in teaching materials so that the language matches the readers. This can make it easier for readers to understand the information they convey.

Based on calculations with the Flesch Readability Formula, it shows that out of 76 pages there are 40 pages of text that are in accordance with junior high school class VIII with a percentage of 52.6%, while the text that is not yet appropriate is 36 pages with a percentage of 47%, so the language in the text of teaching materials was easy and in accordance with the level of reader's understanding. The text must be then corrected either by cutting it into short sentences or avoided difficult words by using familiar languages so that the discourse would be easy to understand. The readability of a discourse was determined by three important variables, namely the number of words in the discourse, the number of sentences, and the number of difficult words.

### 3.4. Results of limited field test

The results of a limited trial show that the response of students to teaching materials is 28% with quite interesting categories, 36% interesting, and 36% very interesting. Most of them were very interested in learning materials since the examples of problems and the solutions were explained in detail and easy

to understand. Also, the display and layout of images and the harmony of colors, types and fonts were very appropriate.

The implementation of learning activities using character-based learning materials had trained the students to learn independently and actively in accordance with the steps of activities in teaching materials. The images were presented in an interesting way because they were taken from the activities of the students' surroundings so as to increase the enthusiasm for learning materials. This is in line with [21] who suggest that the more interested students use the materials during learning process, the higher their interest in the lessons they will learn.

#### 4. Conclusions

Based on the results of data analysis and discussion, it can be concluded that the results of expert validation indicate that teaching materials are feasible and very relevant to be used for junior high school students. Learning material of natural science having characteristics: a) focusing on problems that are relevant to contextual phenomena, b) consists of parts of material description and investigation, c) character values and scientific attitudes are integrated in investigation activity, and d) the material discussed is light and optics. So, learning materials was feasible to be applied in science learning processes.

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