Developing of Physics Learning Material Based on Scientific Literacy to Train Scientific Process Skills

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Abstract. Physics learning materials in junior high school have not yet contained a balanced scientific literacy component where science roles as the body of science knowledge, a way of investigating, a way of thinking, and interaction between science, technology and society. Therefore, a development is carried out to produce physics learning materials based science literacy based on validity, effectiveness, practicality of physics learning material, achievement of scientific process skills and attainment of student attitudes. The type of research is research and development using ADDIE model. The study involved five experts to validate teaching materials. The instruments used are learning materials validation sheets, lesson plan observation sheets, science process skill observation sheets and peer assessment. Data were analyzed by descriptive quantitative. The subjects of the try out are 34 seventh grade students of SMPN 27 Banjarmasin. The result of the research shows that the validity of learning materials is valid to be used, the practicality is categorized as practical, the effectiveness is categorized as effective, the achievement of the science process skills is categorized as very good and the attainment of student attitudes is categorized as good. Based on these results, it can be concluded that this physics learning materials based on science literacy is feasible to be used in learning process.

1. Introduction

Law Number 20 year 2003 regarding National Education System expects that learners can actively develop their potential to create qualified human resources (HR). One of the problems faced by the world of education today is low science literacy of learners. A research conducted by Programme for International Student Assessment (PISA) 2015 showed that the literacy ability of Indonesian students ranked 62 of 72 countries [1]. This indicates that the literacy of Indonesian students is low. Science literacy is indispensable for life to be more meaningful [2]. The term scientific literacy is used to familiarize science to the public [3]. Science literacy is the ability to read and write about science and technology [4]. Science literacy is an ability to use the concept of science and apply it in everyday life, as well as explain scientific phenomena and describe it based on scientific evidence obtained [5].

The result of interviews with science teachers of SMP Negeri 27 Banjarmasin revealed that learners rarely do practical activities that cause learners' science process skills untrained so that the science literacy is low. In addition, based on the results of learning materials analysis in the school which is analyzed with Chiapetta’s et. Al [6] theme of science literacy which are (a) science as a body knowledge, (b) science as a way of investigating, (c) science as a way of thinking, and (d) the interaction among science, technology, and society (STS), the learning materials are not in accordance with the mentioned criteria. The learning materials available in the school have not fulfilled the balanced scientific literacy component. Balanced science literacy encompasses science as the body of knowledge, a way of investigating, a way of thinking, and the interaction between science, technology and society [7].

The cause of students’ low science literacy is directly and closely related to the students, which is the learning materials [8]. Learning materials are very important in conducting the process of teaching and learning activities [9]. One type of instructional material is a module. Modul can be used by the students to learn independently so that it is compatible with learning level of each student [10]. In addition, one of the causes of low science literacy is because the lack of experiment activities or scientific inquiry. Experiment activities or scientific inquiry can train
science process skills used by scientists [11]. Process skill is something that is needed by students [12]. If students have scientific process skills, it is same with preparing students as future scientists, having science literacy, as well as preparing students to use science information in their daily life [13]. Therefore, the development of scientific literacy based learning materials is required. Learning materials based science literacy can increase the ability of students' science literacy [14].

Based on these problems, this research will develop scientific literacy based learning materials to train junior high school students’ scientific process. Learning materials that will be developed are on vibration and wave. The general purpose of this research and development is to produce appropriate physics learning materials based science literacy. Specific purposes of this research are to describe (1) the validity of the developed learning materials, (2) the practicality of the developed learning materials, (3) the effectiveness of the developed learning materials, and (4) achievement of science process skills and (5) the attainment of student attitudes. This research is expected to contribute in improving learning quality.

2. Method

2.1 Design of Research

The type of the research is research and development. The development model used is ADDIE. The first stage of the analysis is looking for problems and solutions for problem solving. The problems are the learners rarely do practicum activities and the learning materials exist in the schools have not fulfilled a balanced literacy load. The solution of these problems is to provide teaching material that contains balanced scientific literacy. The next stage is designing the learning materials based science literacy that will be used. The designs made are setting the learning goals, learning scenarios, learning materials, and tools used for evaluation of learning outcomes. After the designing activities completed, next is producing the learning materials according to the design that has been made. The next step is to implement the learning materials in the learning process. The last stage is evaluating. The subjects of this research trial are 34 students of seventh grade SMP Negeri 27 Banjarmasin. The instrument used in this study can be seen in the table 1.

| Component                  | Instrument                        |
|----------------------------|-----------------------------------|
| Validity                   | Validation sheets                 |
| Practicality               | Lesson plan observation sheets    |
| Effectiveness              | Learning outcome test             |
| Scientific process skills  | Science process skill observation sheets |
| Attitude                   | Peer assessment                   |

2.2 Data Analysis

Validation of teaching materials is done by five validators. In analyzing the validity of learning materials, Content Validity Ratio (CVR) by Lawshe [15] is used; the equation is as follow (1).

\[
CVR = \frac{n_e - \left(\frac{N}{2}\right)}{\frac{N}{2}}
\]  

Where CVR is content validity ratio, \(n_e\) is the number of panel members indicating an item essential and \(N\) is the number of panel members. The validity criteria of learning material are shown in the table 2 [15].

| Interval | Category         |
|----------|------------------|
| -1       | perfect disagreement |
| +1       | perfect agreement  |
The implementation of lesson plan is observed by two observers to measure the practicality. The practicality uses the criteria in Table 3 [16].

**TABLE 3. Criteria of practicality**

| Interval     | Category   |
|--------------|------------|
| 3.60 – 4.00  | very practical |
| 2.60 – 3.59  | practical   |
| 1.60 – 2.59  | less practical |
| 0.00 – 1.59  | not practical |

The effectiveness of learning material is measured by using learning result through pretest and posttest. The effectiveness analysis of learning material is determined using the (2) equation [17].

\[
< g > = \frac{\% s_f - \% s_i}{100 - \% s_i}
\]  

(2)

Where \( \% s_f \) = score are from post-test and \( \% s_i \) = score from pre-test. Effectiveness criteria are showed in Table 4 [17].

**TABLE 4. Effectiveness criteria**

| Value     | Category   |
|-----------|------------|
| \( <g> \geq 0.7 \) | very effective |
| \( 0.7 > <g> \geq 0.3 \) | effective |
| \( <g> < 0.3 \) | less effective |

Students’ scientific process skills are observed by using the observation sheets, while the attainment of students’ attitudes is observed by using peer assessment. The criteria of students’ scientific process skills and attitudes are shown in Table 5 [16].

**TABLE 5. The criteria of students’ scientific process skills and attitudes**

| Interval     | Category   |
|--------------|------------|
| 3.60 – 4.00  | very good  |
| 2.60 – 3.59  | good       |
| 1.60 – 2.50  | adequate   |
| 0.00 – 1.59  | less       |

3. Results and Discussion

3.1 Product

The product resulted from this research and development is physics learning material based science literacy on vibration and wave materials for seventh grade students of junior high school. The learning materials developed contain balanced scientific literacy in accordance with Wilkinson’s [7] opinion who stated that science as a body of knowledge, science as a way of investigating, science as a way of thinking, and interaction between science, technology and society. The learning materials are in the form of printed materials of modules. The developed learning material contains cover, introduction, table of contents, instructions given to use the teaching materials, concept maps, achieved competence, indicators, science literacy discourse, material summary, competency test, glossary, and bibliography. The learning materials contain three experiments, vibrations, waves, and rapid wave propagation. The advantage of this learning material is that it contains a phenomenon that can construct students’ science literacy and technology products that related to everyday life. This is in line with Chiappetta’s, et. Al [18]
opinion who stated that including a phenomenon that can construct science literacy and technology products on learning materials can make the students know the impact or effect of science to the community.

### 3.2 Validity

The results of learning materials validation are shown in table 6. The measured aspects the learning materials are content quality, organization, linguistic, glossary, consistency, format, and attractiveness. The result of analysis based on the mean score of all the aspects is 0.71 with agreement category. This indicates that teaching materials is a valid resource to be used. Toharudin [19] said that the learning materials based science literacy, in the preparation can be said as valid if they meet the eligibility criteria that include: the content of science materials, the purpose of composing science materials, clarity and correctness of the concept, in accordance with the applicable curriculum, motivate and stimulate activity, as well as the ability of learners, illustrations and examples, and the use of communicative, logical, and systematic language. This is in accordance with the criteria of learning materials that have been contained on the validation sheet used by validators to be validated. Moreover, Afrahamiryano [20] stated that a learning material can be said as valid, if it is suitable with the required learning materials, clear and accurate materials, and able to motivate students.

| Aspect of assessment | CVR | Category |
|----------------------|-----|----------|
| Content quality      | 0.60| Agreement|
| Organization         | 0.60| Agreement|
| Linguistic           | 0.60| Agreement|
| Glossary             | 0.60| Agreement|
| Consistency          | 1.00| Agreement|
| Format               | 1.00| Agreement|
| Attractiveness       | 0.60| Agreement|
| Mean                 | 0.71| Agreement|

### 3.3 Practicality

Practicality of learning materials can be measured based on the implementation of lesson plan that is observed by two observers by using lesson plan observation sheet in every meeting. According to Batoq [21] practicality of learning tools developed is measured based on the implementation of lesson plan in the classroom. The results of learning material are presented in table 7. The mean scores of the lesson plan implementation for the first, second and third meeting are 3.28, 3.20, dan 3.31. Fatmawati [16] said that a learning tool can be categorized as practical if it obtains score of 2.60-3.59. Akker, et. Al [22] stated that the product result of development is said to be practical if the product can be easily used.

| Meeting | Average | Category |
|---------|---------|----------|
| 1       | 3.28    | Practical|
| 2       | 3.20    | Practical|
| 3       | 3.31    | Practical|
| Mean    | 3.26    | Practical|

### 3.4 Effectiveness

The effectiveness of the learning materials is measured from the learners' learning outcomes from the test results that consist of pretest and posttest. The test consists of 10 pieces of essay questions. Rochmad [23] stated that the effectiveness aims to determine the level or degree of application, theory, or model. Anggela [24] said that the effectiveness of learning materials can be measured through learning outcomes before and after using the developed learning materials. Based on the result analysis, the value obtained is 0.59 which is in effective category as shown in
table 8. This indicates that the developed learning materials are effectively used in the learning process. Learning materials are effective if they influence the success of an effort or action on the learners' learning outcomes [25].

| Mean of Pre-test | Mean of Post-test | N-gain | Category |
|------------------|-------------------|--------|----------|
| 11.95            | 66.31             | 0.59   | Effective|

### 3.5 Achievement of Science Process Skills

Scientific process skills observed are formulating problems, conducting experiments, analyzing data, summarizing, and communicating. The achievement of students' science process skills is shown in Table 9. The results of the analysis for the aspect of formulating problems are very practical. Aspect of experimenting is categorized as practical, aspect of analyzing data is categorized as very practical, concluding aspect is categorized as very practical. On average, all aspects are categorized very good. This suggests that the developed materials can train students' science process skills. This is in accordance with the results of research by Muhafid, et al [26] that the development of science module is able to develop students' science process skills. In addition Dewi, et al [27] stated that the use of integrated science module can improve students' science process skills.

| Aspects               | Mean | Category |
|-----------------------|------|----------|
| Formulating problem   | 3.87 | Very Good|
| Conducting experiment | 3.17 | Good     |
| Analyzing data        | 3.53 | Very Good|
| Concluding            | 3.57 | Very Good|
| Communicating         | 3.50 | Very Good|
| Mean                  | 3.53 | Very Good|

### 3.6 Attainment of Attitudes

The observed attitudes are discipline, cooperation, and tolerance. The results of student attitudinal attainment are shown in table 10. The results of analysis for discipline aspect and cooperation aspect are categorized as good, while the aspect of tolerance is categorized as very good. On average all aspects are categorized as very good. This indicates that the developed teaching materials can train students' attitude. This is in accordance with the results of research by Puti [28] who stated that there is an increase of student's scientific attitude after the use of Junior High School science module. In addition, Gunada, et al [29] also stated that the development of physics tool is able to grow students' scientific attitude.

| Aspects     | Mean | Category |
|-------------|------|----------|
| Discipline  | 2.98 | Good     |
| Cooperation | 3.04 | Good     |
| Tolerance   | 3.39 | Very Good|
| Mean        | 3.13 | Good     |

### 4. Conclusion

The result of the research shows that the validity of learning materials is valid to be used, the practicality is categorized as practical, the effectiveness is categorized as effective, the achievement of the science process skills is categorized as very good and the attainment of student attitudes is categorized as good. Based on these results, it can
be concluded that the physics learning materials based on science literacy is feasible to use in learning process. For further physics instruction it needs to be tested in some schools.

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