Development of integrated teaching materials vibration, wave and sound with ethnoscience of bundengan for optimization of students’ scientific literation

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Abstract. The purpose of this study is to develop natural science teaching materials that integrate ethnoscience Bundengan in the Vibration, Wave and Sound material for the Central Java region. The specific purposes are to describe the characteristics of the teaching materials developed, test their validity, level of readability and effectiveness in increasing students’ scientific literacy. This development research uses the Borg & Gall development model, starting with the needs analysis, the development of teaching materials, the validity test and the readability of the teaching materials that have been developed, as well as the effectiveness of teaching materials. Validation is carried out by experts in the field of study (lecturer) and practitioners (science teacher). The subject of the reading test of textbooks and effectiveness was junior high school students in Wonosobo Regency. Test the readability of the book using the overlap test (cloze test). Data analysis techniques using percentages, normalized gain, and t test. The validity of the teaching materials for Vibration, Waves and Sounds integrated with ethnoscience Bundengan are very valid both in content, presentation and language. This teaching material is also able to increase students' scientific literacy higher than other teaching materials.

1. Introduction
From 2000 to 2018, the ability of Indonesian students in the field of science, especially scientific literacy, was still below the average from other countries. This is evidenced by the results of research conducted by the Organization for Economic Co-operation and Development (OECD) through the Program for International Student Assessment (PISA) for 15 year olds. The results reported by the OECD [1] related to the results of scientific literacy of Indonesian children always rank low. The government has made efforts to improve students' literacy skills, both in reading, science and mathematics literacy. One of the government policies is to implement a curriculum that requires integrated learning in the hope that students can understand a subject matter holistically and integratively. Based on interviews with several junior high school teachers in Central Java in the field of science, it shows that they are still having difficulty in developing learning tools, which can increase scientific literacy. The availability of science books containing scientific literacy aspects is still limited. Based on the preliminary research that has been done, it shows that several junior high school science books circulating in Central Java have not met the demands of scientific literacy. Most books only contain content aspects, while process aspects are still minimal, and the relationship between science and technology, environment and society has not been published [2]. The integration of ethnoscience
into teaching materials has also not been carried out. While there are many local wisdoms, phenomena from the surrounding environment that can be used as real examples in science learning. Based on this background, research was carried out aimed at developing Science teaching materials by integrating with ethnoscience Bundengan in the Vibration, Wave and Sound material. Bundengan is one of the unique musical instruments, which can replicate various sounds similar to several gamelan instruments such as Bendhe, Kempul, Gong, and Kendang. Gamelan is a musical instrument typical of Java, a set of tools called Bendhe, Kempul, Gong, Kendang, etc. Usually to accompany wayang performances. Bundengan is one of the local wisdom in Wonosobo district, Central Java. This Bundengan characteristic can be used to explain the concept of waves and sound in physical material. The use of musical instruments from local areas in learning is an attraction and pride for students [3]. This teaching material is expected to increase scientific literacy and introduce the richness of Indonesian culture. The specific objectives of this study were (1) to describe the characteristics of the teaching materials being developed, (2) to test the validity of the teaching materials, (3) to determine the readability of the teaching materials and (4) to test the effectiveness of the teaching materials in improving students' scientific literacy. The results of this study are expected to be used as a guide for teachers to improve students' scientific literacy skills, so that they can compete with other students globally/internationally. The availability of integrated science teaching materials of Bundengan ethnoscience which was developed is very necessary to familiarize students with thinking comprehensively. Thus, students are trained to understand science as the knowledge of science, the investigative nature of science, science as a way of thinking, and interaction of science, environment, technology, and society.

2. Methods
This Research and Development (R&D) uses a model developed]. Flowchart research procedure can be seen in Figure 1.

![Flowchart of research procedure](image)

Textbook readability and effectiveness test subjects were junior high school students in Wonosobo Regency. The book readability test used the cloze test. The word that is omitted in the cloze test is selected every 8th word from a sentence in the teaching material. If the dropping of a word falls into a conjunction, the omitted word can be shifted to the next word. The data analysis technique used percentage, normalized gain, and t test.
3. Result and Discussion

This research and development resulted in a product in the form of Vibration, Wave and Sound integrated teaching materials of Bundengan ethnoscience. The results of the study include a description of the characteristics of the teaching materials developed, the validity and effectiveness of the teaching materials in improving students' scientific literacy.

3.1 Characteristics of Teaching Materials Vibration, Waves and Sounds Integrated Bundengan Ethnoscience

The teaching materials developed in this study include Bundengan ethnoscience as a complement to sound and wave vibration materials. In addition, this teaching material contains practicum activities using Bundengan media. Types of practicum include (1) Vibration on Bundengan strings, (2) Waves on Bundengan strings, and (3) Classification and factors that affect the frequency of Bundengan strings. Experimental activities use a smartphone as a tool to observe the vibration of the experimental results with Bundengan The novelty of this teaching material lies in the loading of the local ethnoscience / wisdom of the Wonosobo area, in the form of a description and construction of the Bundengan media. The shape/construction of Bundengan can be seen in Figure 2. How to use Bundengan can be seen in Figure 3.

3.2 Validity of Bundengan Ethnoscience Integrated Teaching Materials

Validation includes three main components, namely content, language and presentation feasibility. The validation results can be seen in Table 1. Validation was also carried out on the textbook display design. The validators are media experts and practitioners (teachers). The results of the validation from media experts can be seen in Table 2. Inputs and suggestions for improvement from the validator become reference materials for improving the teaching materials developed.
Table 1 Results of the Validation of Teaching Materials by Material Expert Lecturers and Teachers

| No. | Component Assessed | Expert Lecturers | Teachers 1 | Teachers 2 | Average |
|-----|---------------------|------------------|------------|------------|---------|
| 1   | Content eligibility | 86.67            | 86.67      | 90.67      | 88.00   |
| 2   | Language            | 82.22            | 80.00      | 82.22      | 81.48   |
| 3   | Presentation        | 82.86            | 88.57      | 80.00      | 85.81   |
|     | Average             | 83.92            | 85.08      | 84.29      | 84.43   |
|     | Category            |                  |            |            | Very Valid |

Table 2 Validation Results of Teaching Materials by Media Expert Lecturers and practitioners

| No. | Component Assessed   | Expert Lecturers | Teachers 1 | Teachers 2 | Average |
|-----|----------------------|------------------|------------|------------|---------|
| 1   | Teaching materials size | 100.00          | 100.00     | 100.00     | 100.00  |
| 2   | Cover Design         | 91.11            | 97.78      | 95.56      | 94.82   |
| 3   | Content Design       | 87.27            | 91.82      | 91.82      | 90.30   |
|     | Average              | 92.79            | 96.53      | 95.79      | 95.04   |
|     | Category             |                  |            |            | Very Valid |

3.3 Readability Level of Teaching Materials

The legibility of Vibration, Waves and Sounds integrated with ethnoscience Bundengan was obtained by giving students a cloze test of teaching materials. The legibility test results obtained an average score of 80% and are in the easy to understand category.

Ethnoscience Bundengan integrated teaching materials used during the learning process are more meaningful because of the science learning process in schools. If they do not pay attention to local culture / wisdom, students will "reject" or only understand a few scientific concepts they have learned [4]. Local wisdom can be incorporated into the education system through teaching, learning and knowledge in formal, non-formal and informal education [5].

The use of ethnoscience integrated teaching materials in the learning process has the advantage of introducing students to scientific concepts and facts as well as a form of effort to train scientific literacy in observing and utilizing a natural phenomenon that occurs in life around [6]. Students who during the teaching and learning process use ethnoscience integrated teaching materials will have a greater concern for the environment [7]. The insertion of local wisdom in learning can contextualize learning so that it can make it easier for students to understand the concept of subject matter [7, 8, 9]. The results of the research of [10] show that learning using ethnoscience integrated teaching materials is more effective when compared to student books in terms of scientific literacy.

The learning process uses integrated ethnoscience teaching materials and is equipped with practical activities, facilitating students to experience learning e.g active learning, collaborative and contextual learning. The learning process of active learning, collaborative learning and contextual learning can improve scientific literacy, according to [11, 12, 13].
3.4 Effectiveness of Teaching Materials in Improving Students' Science Literacy

The effectiveness of teaching materials can be seen from the difference in the increase in students’ scientific literacy between those using ethnoscience integrated teaching materials (experimental class) and BSE (control class). The scientific literacy increase’s was calculated using N-gain, between the posttest and the pretest. The N-gain results of the two classes can be seen in Table 3.

Table 3 N-Gain Science Literacy Experiment and Control Class

| Class         | Pretest | Postest | N-Gain | Category |
|---------------|---------|---------|--------|----------|
| Experiment    | 30.22   | 81.22   | 0.74   | High     |
| Control       | 31.78   | 65.89   | 0.50   | Moderate |

In Table 3, it appears that the increase in scientific literacy (N-Gain) in the experimental class is higher than the control class. These results are reinforced by the t test conducted on the increase in scientific literacy between the two classes. The result of t count is 6.38. The value of t table for degrees of freedom (dk) = 45 and a significance level of 5% of 1.70. So t count > t table so that the hypothesis which states that the increase in literacy in the experimental group is smaller than the control group is rejected. Based on this, it can be concluded that the use of Vibration, Waves and Sounds integrated with Bundengan ethnoscience can increase students' scientific literacy higher than those using Bundengan ethnoscience unintegrated teaching materials. The value of each aspect of scientific literacy can be seen in Table 4.

Table 4 The Value of Each Indicator from the Aspect of Science Literacy

| Aspect                  | Indicator                                      | Score Average | Category |
|-------------------------|------------------------------------------------|---------------|----------|
| Knowledge               | Content Provide further explanation            | 67.70         | Moderate |
|                         | Create definition forms                        | 67.70         | Moderate |
|                         | Procedural Identify an idea /symptom formed     | 97.00         | Very Good|
|                         | Epistemic Ability to provide reasons            | 87.50         | Very Good|
| Competencies            | Interpret data Report the results of observations | 75.00         | Good     |
|                         | Draw conclusions according to facts             | 75.00         | Good     |
| Evaluating and designing investigations | Evaluating                                     | 65.40         | Moderate |
|                         | Design an Investigations                        | 65.40         | Moderate |
| Explain scientific phenomena | To explain scientific phenomena                  | 79.00         | Good     |
|                         | Average                                        | 76.65         | Good     |

Shown in Table 4 that the scientific literacy of students using teaching materials vibration, sound waves and sound integrated ethnoscience Bundengan lowest on aspects of competence Evaluating and designing investigations. In general, students' scientific literacy is in the good category. The lowest score on the competency / process indicator aspect evaluates and designs the investigation. Science is very important in everyday life. Science education builds students to think in understanding natural phenomena or events with scientific methods such as that of scientists [14]. Science education
also prepares students to become citizens who are responsible for the events around them [15]. There are at least four main elements in science education, namely (1) building students' knowledge of science concepts (cognitive), (2) developing students' ability to argue critically in science activities (psychomotor), (3) understanding students about the process, how the incident happened, not just knowing (how they know not what they know), and (4) training students to learn to work together and build scientific attitudes (social and affective aspects) [16]. This is in accordance with the domains in science education, namely the society, personal, and the nature of science domain [17].

Science literacy is defined as the ability of students to use scientific concepts to apply them in everyday life, explain and describe scientific phenomena based on scientific evidence [18] [19] [20]. Important of scientific literacy are (1) the concept of science and its application in everyday life; (2) scientific inquiry process; (3) understand the nature of science; and (4) understand the relationship between science, environment, technology and society [21]. Some science experts make scientific literacy levels on the grounds that scientific literacy is defined too much and complex for someone [22]. Science literacy in this research includes four aspects, namely science as knowledge, investigative, a way of thinking, and interaction of science, environment, technology, and society [23]. Mastery of scientific literacy, especially the aspect of interaction with the environment, is very suitable to be taught by involving ethnoscience [24]. The ethnoscience in teaching science, makes it easier for students to understand science and improves scientific literacy.

4. Conclusion
The teaching materials of Vibration, Waves and Sounds integrated with ethnoscience Bundengan contain a general description component of local wisdom of Wonosobo Regency as a medium in the learning process. Ethnoscience Bundengan integrated teaching materials were presented in experimental activities, to determine the presence of frequencies and periods, to know the waveform of the Bundengan strings when plucked, to classify sounds based on the resulting frequency, and to find out the factors that affect the frequency of the Bundengan strings plucked. The validity of the teaching materials for Vibration, Waves and Sounds integrated with ethnoscience Bundengan has been tested, and the results are very valid both in content, presentation and language. This teaching material is also able to increase students' scientific literacy higher than other teaching materials.

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