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The Effectiveness of EthnoSTEM-Based Science Learning to Improve Junior High School Students' Science Literacy Ability

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Abstract: The low scientific literacy of students needs to be improved through the teaching materials used in learning. Teaching materials can be combined with various learning models including Ethno-STEM. The research aims to develop and test the feasibility of a module on vibrations and waves material in empowering science literacy ability of class VII students. The type of research carried out is development research using the 4D method including the define, design and develop stages. In this article, the research stage is written only up to the development stage. In the define stage, an analysis of gaps occurring in the field is carried out to define what is needed in the development process. In the design stage, the researcher prepares a product design according to the needs that have been summarized in the define stage. In the development stage, researchers began to develop modules according to needs and then carried out feasibility tests. Validation was carried out on aspects of material, media, language and learning. The overall module validation results obtained were 0.91 with valid criteria. Therefore, it can be concluded that the vibrations and waves module is effective to improve students' science literacy ability.

Keywords: EthnoSTEM; Module; Science Literacy Ability; Vibrations and Waves.

Introduction

Indonesia always innovates to improve the quality of education. This is done to achieve the vision of "Golden Indonesia 2045". The government has implemented various methods as an effort to improve the quality of Indonesian education. One of them is changing the 2013 curriculum to an independent curriculum. Students' literacy and numeracy skills are one of the main focuses of independent curriculum development.

One way to evaluate the quality of Indonesian education is through *the Organization for Economic Co-operation and Development* (OECD) with *the Program for International Student Assessment* (PISA) every three years. Based on the 2018 PISA results, Indonesia is ranked 70th out of 78 participating countries in the world. Indonesia's average scientific literacy score of 371 is far below the OECD standard of 487 (OECD, 2018). The journey of Indonesia's science literacy score from 2000 to 2018 in Figure 1. Based on Figure 1, we can see that Indonesia's science literacy score has always been below the international average.

Scientific literacy in academics began to develop in 1958 when society's need for science was considered to be increasing. Scientific literacy can be interpreted as an individual's ability to understand and apply science (Li & Guo, 2021). According to the OECD, scientific literacy can be defined as students' ability to utilize scientific knowledge and scientific methods in identifying problems, reading data and drawing conclusions. There are many opinions regarding the meaning of scientific literacy, but it is recommended to maintain scientific literacy on the right track. So it can be understood that

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scientific literacy is the ability of students to utilize their scientific knowledge, identify problems around them, draw conclusions based on existing data or evidence, and make decisions about nature and its changes as human activities in real life (Permanasari, 2016 (Permanasari, 2016).

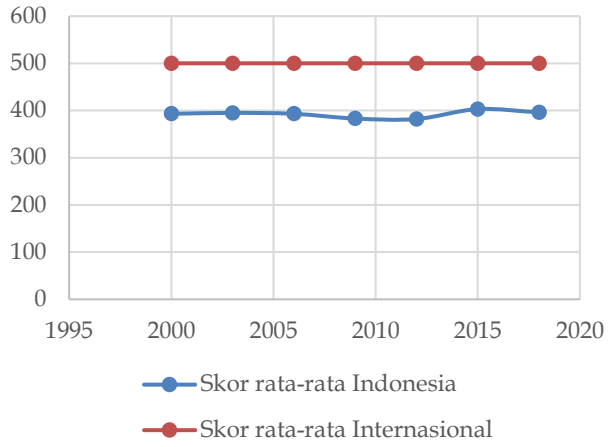

Figure 1. Obtained Indonesian scientific literacy scores for 2000-2018

Science education is considered to be able to increase students' scientific literacy. Students utilize their knowledge and skills in solving scientific problems in everyday life. Scientific literacy influences communication skills when arguing. Therefore, students who have good scientific literacy skills can put forward socioscientific arguments (Holbrook & Rannikmae, 2009).

Various efforts can be made to initiate an increase in students' scientific literacy skills, one of which is through the relevance of the teaching materials used in learning. Teaching materials can be used as a medium to empower scientific literacy by considering conceptual understanding of science, social frameworks and socioscientific situations (Utami et al., 2016). Aspects of scientific literacy according to Chiapetta (1991) include the body of knowledge, science as a way of inquiry, science as a way of thinking and interactions between science, technology and society (Chiappetta et al., 1991). The dimensions of scientific literacy must be present in the teaching materials used in learning, namely scientific concepts, scientific processes and scientific situations. Science is used by students to understand natural phenomena and the impact of human activities on them. The scientific process includes the ability to obtain, manage information and apply it in life (Ogunkola & Garner-O'Neale, 2013).

The importance of empowering scientific literacy in students has been expressed by various scientists. Thomas and Durant explained that scientific literacy is beneficial in all sectors of life. David (2022) revealed that there are five basic arguments, namely arguments related to economics, utility, democracy, social and cultural (Fortus et al., 2022). From several opinions, researchers concluded that scientific literacy is very important in maintaining a culture that is often abandoned, such as gamelan. The research seeks to insert the dimension of scientific literacy in Ethno-STEM based science teaching materials on vibration and wave material.

Ethno-STEM is a new breakthrough in the world of education by combining ethnoscience with *Science, Technology, Engineering, and Mathematics* (STEM). Ethnoscience is born from a tribe, nation or social group in the form of local wisdom (Hadi et al., 2019). Ethnoscience is knowledge in cultural form. So that the use of ethnoscience in science learning can integrate culture which is useful for students' daily lives (Widyaningrum & Prihastari, 2021). It is believed that ethnoscience can guide students to utilize knowledge in the form of local wisdom content by identifying several aspects that are in accordance with scientific knowledge. The application of STEM focuses on the problem solving process in everyday life or professional life (Septiani, 2016). The characteristics of STEM learning are the integration of at least two STEM components, centered on students, closely related to daily life, students are actively involved in collaborative and investigative activities (Mulyani, 2019). STEM learning can guide students to solve problems in everyday life through the stages of analyzing data, making assumptions and carrying out investigations. Ethno-STEM forms students' scientific literacy skills through reading, writing, observing and carrying out scientific steps (Idrus & Suma, 2022).

Ethno-STEM has several advantages that support teachers in developing students' abilities. Based on the results of literature studies, learning using the Ethno-STEM model is very effective in helping teachers develop students' communication skills (Inayah et al., 2022). Not only does it help teachers develop communication skills, learning with the Etno-STEM model is also able to develop other 4C skills such as creative thinking abilities and critical thinking abilities ((Karim et al., 2022)(Sumarni & Kadarwati, 2020).

Much of the research that has been conducted focuses on developing 4C skills by utilizing the Ethno-STEM model. However, this has not yet led to the empowerment of scientific literacy skills by utilizing the Ethno-STEM model. For this reason, research was carried out to develop Ethno-STEM based module teaching materials to empower scientific literacy in vibrations and waves material.

Method

The research aims to develop and test product feasibility. Therefore, research is included in the Research and Development (R&D) category. The research product is in the form of a Vibration and Wave module based on Ethno-STEM on vibration and wave material to improve students' scientific literacy skills. Implementation of development research uses the 4D development model proposed by Thiagarajan, Semmel, & Semmel (1974) with 4 stages, namely *defining* , *designing* , *developing* and *disseminating* . This research report only reaches 3 stages of the research and development method used in this research, namely the definition to the development stage. Research flow in figure 2. The 4D model was chosen because of its detailed and systematic nature, making it easier for researchers to develop vibration and wave modules. Research data is in quantitative form in the form of product validation questionnaire data and qualitative data in the form of suggestions from validators.

Figure 2. Research flow

Defining

In the define stage, an analysis of gaps occurring in the field is carried out to define what is needed in the development process. The define stage is a reference for researchers in developing products.

Designing

In the design stage, the researcher prepares a product design according to the needs that have been summarized in the define stage. Researchers created a module framework design with the help of the Canva application.

Developing

In the development stage, researchers begin to develop modules according to needs and then carry out feasibility tests. The validity test of the vibrations and waves module product was carried out by material, media, language and learning experts. The suggestions and input provided by the validator are qualitative data obtained during the research. Revisions are carried out with reference to suggestions and input provided by expert validators. The module validation results are quantitative data obtained during the research. Data from validation by experts were analyzed using the Aiken V coefficient with the calculation formula $V = \frac{S}{[n*(c-1)]}$. The S value is obtained through the equation S = Σ ni (r-ℓo) (Aiken, 1980).

Result and Discussion

Define stage

As many as 20% of Indonesian students who took the PISA test in 2018 had not yet reached level 2 in science ability (OECD, 2018). Level 2 in scientific abilities includes the ability to utilize scientific knowledge, interpret data, and use knowledge to draw conclusions. Based on the results of literature studies, students have low scientific literacy skills. Students only master science concepts but experience difficulties when communicating their knowledge in the process of solving problems in everyday life (Pujawan et al., 2022).

Various factors can influence students' low scientific literacy abilities. The use of teaching materials that cannot stimulate the development of scientific literacy skills is a big problem in the world of education. Scientific literacy skills are directly related to the application of science and technology in people's lives. Therefore, students' literacy abilities must be empowered in learning (Saija et al., 2022). The integration of learning materials and methods when applying teaching modules in learning needs to be considered in order to maximize scientific literacy abilities (Asrizal et al., 2018).

Low scientific literacy skills, teaching materials that do not facilitate students to develop scientific literacy skills and learning topics that are not integrated with problems in everyday life are the basis for module development. Material analysis that is most easily encountered by students in everyday life is vibrations and waves in drums. In vibration and wave material, students are only able to explain visible (macroscopic) concepts in real life, but cannot explain microscopic and symbolic concepts which are actually part of scientific literacy (Wiyantara et al., 2021). Vibration and wave material consists of physical theories, several equations, and applications in everyday life. Problems that occur in the field become a reference in developing products in the form of ethno-STEM based vibration and wave modules to empower students' scientific literacy skills.

Design stage

Product development is tailored to needs in the form of material characteristics, the aim of empowering scientific literacy skills and integration with problems commonly encountered in students' daily lives. The teaching materials developed are ethno-STEM based by presenting local regional wisdom as a learning theme. The design stage is carried out by choosing the form of teaching materials, namely in printed form to make it easier for students to access. The developed module consists of a cover section, an opening section, a contents

section and a closing section. The cover section consists of a module cover which can be seen in Figure 3.

Figure 3. Module cover

The opening section consists of general information, learning outcomes, instructions for using the module and integration of material in the module. The opening part of the module can be seen in Figure 4.

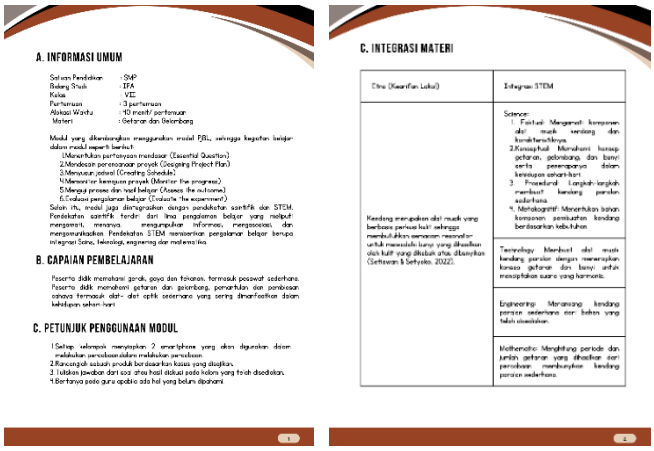

Figure 4. Opening part of the module

The content section consists of student learning sub-activities. Students' learning activities can be seen in three learning activities that adopt the Ethno-STEM syntax. Students will go through the stages of essential question, designing project, creating procedure, monitoring the progress, assessing the outcome, evaluating the experiment. The scientific approach includes the activities of observing, asking, collecting data, associating and communicating integrated at the Ethno-STEM syntax stage so as to help students construct an understanding of the concepts of vibrations and waves (Lund, B., Harald, 2016). The Ethno-STEM syntax and scientific approach in the module are given different letter colors. This aims to make it easier for teachers and students to know the stages and scientific activities that have been passed. Student learning activities can be seen in Figure 5.

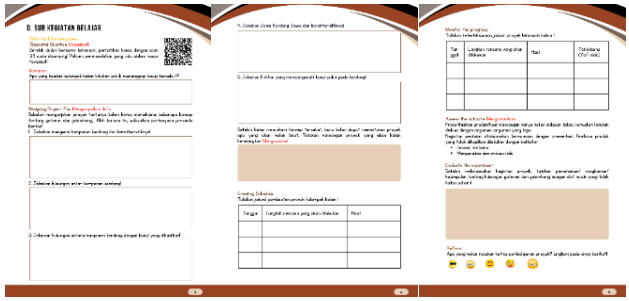

Figure 5. Learning sub-activities in the module

The module invites students to formulate solutions related to problems that have been presented through learning activities. In learning activity 1, students are invited to study Javanese drums and their relationship to sound. In learning activity 2, students are invited to study the vibrations and waves that occur in drums. In learning activity 3 students have a project to make drums that are suitable for solving the problems that have been presented. Every student's learning activity contains aspects of scientific literacy which consist of a body of knowledge, science as a way of inquiry, science as a way of thinking and interactions between science, technology and society. The integration of scientific literacy aspects in learning activities can be seen in Table 1.

In the closing section, a summary of the concepts of vibration and wave material is presented. After completing all learning activities, students can take a comprehension test. Students can use comprehension tests as an effort to develop metacognitive abilities after gaining new learning experiences (Gloria et al., 2018). The closing section is also equipped with a bibliography and comprehension test answer key. It is hoped that when taking a comprehension test, students will not look at the answer key in order to get maximum results. The module cover can be seen in Figure 6.

Table 1. The integration of scientific literacy aspects in learning activities

Learning activity stage	Scientific approach	Aspects of scientific literacy	Implementation in modules

Essential questions	Observe Ask	Science as a body of knowledge	Presented with problems regarding drums. Students can determine concepts and facts related to vibrations and waves
Designing projects	Collecting data Associate	Science as a path of inquiry	Students can provide reasons for the proposed solution After presenting the problem. Students are greeted
Creating procedures Monitor the progress Assess the outcome	Communicate	Interaction between science technology and society	Students can provide appropriate solutions in the context of problems related to local wisdom
Evaluate the experiment		Science as a way of thinking	Students can conclude based on valid information

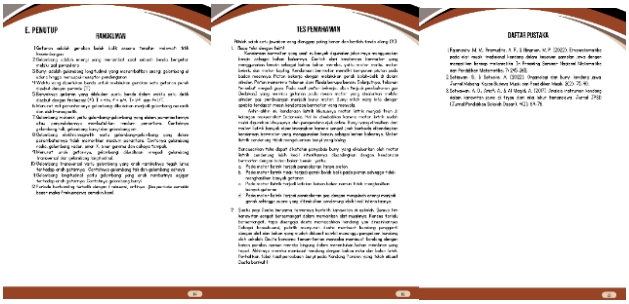

Figure 6. Part of the module cover

Develop stage

The product development results are tested for validity against material, media, language and learning experts. Validators are expert lecturers in their fields. Quantitative data in the form of module validation questionnaire results from experts. The module validation instrument uses 5 ratings with 4 raters. So we get a V index of 0.88. The overall module validation analysis results were 0.91. The validation results obtained a value of 0.91 > V index of 0.88. So the Ethno-STEM based vibration and wave module was declared feasible in empowering students' scientific literacy. When conducting validation tests with experts, suggestions and input were obtained to improve the PjBL-STEM module. Suggestions from media experts include improving writing typos so as not to cause misconceptions among students. Suggestions from validators are qualitative data obtained from development research.

The module has an attractive appearance with the use of soft colors. The proportional number of pages does not cause user boredom. The sentences in the module have been adjusted to the level of development of students. The module guides students' learning activities using clear and concise command sentences. In addition, the material content presented in the module can help students understand the meaning of the concepts obtained in the investigation. It is hoped that each student can achieve the determined learning objectives. So the module is worthy of empowering students' scientific literacy.

Conclusion

The results of the development research are a vibrations and waves module based on Ethno-STEM to empower students' scientific literacy abilities. The module is adapted to the level of development of grade 7 secondary school students. The overall module validation analysis results were 0.91. The validation results obtained a value of 0.91 > V index of 0.88. So the Ethno-STEM based vibration and wave module was effective to improve students' scientific literacy.

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Conflicts of Interest

The authors declare no conflict of interest

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