Development of E-Module STEM integrated Ethnoscience to Increase 21st Century Skills

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Article Info	Abstract
_____ Keywords: E-module, STEM, Ethnoscience, Ethno- STEM, 21st Century Skills _____	_____ Education is the most important thing in preparing quality young people in the 21st century. The results of the analysis of learning in several secondary schools show that there are still several obstacles in the learning process, including the limited learning resources of students who only use the 2013 curriculum BSE books and have not approached the Ethno-STEM . This study aims to develop an E-Module with an Ethno-STEM Approach on Traditional Musical Instruments with Vibration, Waves, and Sound Materials to develop students' 21st century skills. This study uses a development research method (R&D) with the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation). The research data were taken using a questionnaire and test method. This development research resulted in an e-module with the characteristics of integrating the STEM approach with ethnoscience and the development of 21st century skills of students which include critical thinking skills, creative thinking skills, collaboration skills, and communication skills and equipped with evaluation questions containing ethnoscience. The results of the e-module validation assessment showed that it was very feasible with an average percentage of 87.75% and received a very good response from students with a percentage of 82.9%. The developed e-module is very effectively used as an additional learning resource for students with an effectiveness score of 83.72.

INTRODUCTION

21st century education requires students to have complex money knowledge accompanied by supporting skills. These skills that have been announced by the Partnership for 21st Century Learning include higher order thinking skills, skills in the world of work, skills to use technology and information in accordance with the 21st century innovative learning framework. These skills are as expressed byTrilling & Fadel (2009) include: (1) life and career skills, (2) learning and innovation skills, and (3) information media and technology skills. The National Education Association (nd) identifies 21st century skills as "The 4Cs" skills which include critical thinking, creativity, communication and collaboration. One of the government's efforts to develop education in Indonesia is to present the 2013 curriculum to prepare competent human resources in science, technology, engineering design and mathematics considering the increasingly fierce competition in the 21st century (Milaturrahmah, 2017; Utami & Jatmiko, 2018)). In practice, the implementation of the 2013 curriculum does not seem to be maximal enough to prepare students who are able to face 21st century competition. This is because based on the results of the 2018 PISA (Program for International Student Assessment) report released by OCED (Organization for Economic Co-operation and Divelopment) shows that the ability of students in Indonesia is still below the average, especially in the field of science with a score of 396, which is far below the OECD average score of 489 (OECD, 2018).

STEM is an integrated discipline of science, technology, engineering, and mathematics learning that is considered to be able to help meet the demands of the 21st century needs (Beers 2011; Ni'mah et al., 2018). The application of the STEM approach to science learning can be applied by integrating between STEM subjects. The application of this learning can be done by studying the manufacturing process of a product with scientific concepts. (Anggraini & Huzaifah, 2017). The use of real-world contexts is a key component of 21st century learning. Learning activities that focus on resources, strategies and contexts that are appropriate to students' daily lives will result in more developed collaboration and communication, as well as increased critical thinking skills and academic achievement (Zubaidah, 2017).

Ethnoscience learning can improve students' cognitive and critical thinking abilities because in this model it is carried out by linking classroom learning with students' daily lives and also encouraging students to play an active role in the learning process (Arfianawati, 2016). Ethnoscience is an activity of transforming between original science and scientific science. Genuine scientific knowledge consists of all knowledge pertaining to the facts of society. (Battiste, 2005). One of the local wisdoms found in the community is the art of traditional music such as Gamelan and Angklung. Traditional musical instruments in Gamelan and Angklung are one of the applications of the concept of vibration and waves in everyday life because they can produce sound when played. Research by Sudarmin (2018) has developed a learning on essential oils with an integrated STEM approach to ethnoscience with a project-based learning model and got a positive response and was able to improve student learning outcomes and experiences when applied. The results of the study also found that the learning model by linking natural culture can develop creativity and innovation in national culture.

The results of the learning analysis at SMP N 1 Kersana and SMP N 40 Semarang show that the limitations of teaching materials used by students are only the 2013 curriculum BSE book. Conditions like this require students to be able to access learning resources from anywhere and anytime. Based on these problems, it takes a learning resource in the form of e-modules to be able to help students in the implementation of learning. E-Module development can be applied by integrating STEM and ethnoscience approaches, namely a learning that emphasizes science, technology, engineering and mathematics as well as its integration with ethnoscience which will be discussed with an ethno-STEM approach. Thus, research was carried out on the

development of teaching materials in the form of e-modules with an ethno-STEM approach on traditional musical instruments on the concept of waves.

METHODS

This research was conducted using the Research and Development (R&D) method with the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) development model. The implementation of this research consists of three stages, namely; analysis stage, design and development stage, and implementation and evaluation stage. The analysis stage is carried out by analyzing learning problems, students' learning needs, as well as material and curriculum analysis. In the design and development stage, the e-module design was drafted, adjusted the e-module content using the ethno-STEM approach, made the e-module in the form of an online Flipbook, validated the product by media and material experts, and revised the product based on the validation results.

The small-scale trial phase of the e-module was carried out at SMP Negeri 1 Kersana. With the subject of 12 students of class VIII. Data collection methods include interviews, documentation, questionnaires, and tests. The data analysis in this study consisted of an analysis of the evaluation instrument to be used, an analysis of the feasibility of the e-module, an analysis of the readability of the e-module, an analysis of student responses, and an analysis of students' cognitive learning outcomes.

RESULTS AND DISCUSSION

The product developed in this study is an e-module with an integrated STEM approach to ethnoscience on traditional musical instruments for science subjects on vibration, waves, and sound materials for class VIII SMP in even semesters. The development model used in this research is ADDIE, with the stages of Analysis, Design and Development, and Implementation and Evaluation.

Analysis

This stage begins with conducting an analysis to find out and determine the basic problems in learning that are obtained by conducting unstructured observations and interviews on initial observations, which aim to find out the facts that occur in the field based on the opinion of the teacher. Next is to analyze the learning needs of students based on existing problems by reviewing some literature and research results that are in accordance with these problems.

The results of the analysis obtained indicate that the learning resources used by students are only limited, namely the 2013 curriculum BSE book where the book does not contain Ethno-STEM. In addition to BSE books, several published books that are used as teacher references also only focus on delivering the concept of learning materials that have not been able to develop students' thinking skills. Based on the existing problems, a more innovative student teaching material is needed and can support students to develop 21st century thinking skills by developing e-modules with an ethno-STEM approach. Analysis of the curriculum used in schools uses the 2013 curriculum for science material for class VIII.

Design and Development

The next stage is design and development (planning and development). The design stage is carried out by designing the e-module product design which will be developed in accordance with the problem analysis that has been done previously. At this stage, what is done is the preparation of the e-module design, the drafting of the e-module, the preparation of evaluation questions, and the preparation of the instrument

validation sheet and questionnaire sheet that will be used at the development stage. The draft e-module that has been compiled is then validated by media experts and material experts at the development stage. The e-module draft was validated by 4 media expert validators and 4 material experts until it was declared valid and ready to be tested on students. The validation results are explained as follows.

Validation of E-Module Ethno-STEM Feasibility

The e-module feasibility test uses eligibility criteria sourced from BSNP with four eligibility criteria, namely this feasibility, presentation feasibility, linguistic feasibility, and graphic feasibility. The results of the e-module feasibility test can be seen in Table 1.

**Table 1** E-Module Feasibility Test Results

Aspect	Percentage	Criteria
Content Eligibility	90.24%	Very Worthy
Serving Eligibility	89%	Very Worthy
Language Eligibility	87.50%	Very Worthy
Graphic Eligibility	84.25%	Worthy
Average	87.75 %	Very Worthy

Based on the validation results, the ethno-STEM e-module developed was declared very feasible. The ethno-STEM e-module has characteristics in the form of a small file size, easy to carry, and a link that helps students to browse the material linearly and non-linearly so that it directs students towards certain materials (Puspitasari, 2019). Vibration, wave and sound material delivered in the e-module uses an ethno-science approach that is integrated with the four STEM aspects, namely science, technology, engineering, and mathematics. The ethnoscience content contained in the e-module is traditional musical instruments, especially gamelan and calung which are often found in Brebes Regency. Integrating STEM subjects can contribute to various competencies and learning outcomes, including; problem solving, critical thinking, and make real-world connections (DeCoito, 2014). The characteristics of the ethno-STEM e-module are described in detail in Table 2.

Table 2 Ethno-STEM E-Module Characteristics

| No	E-Module Section	Picture
1	**Introductory Part** The introductory part of the e-module consists of an introduction, a table of contents, instructions for using the e-module, a general explanation of the ethno-stem approach, content standards, and a concept map. The cover design is made as attractive as possible with red dominated so that students are interested in reading the e-module.	Cover e-module Instructions for Use, General Description and Concept Map
2	**Contents Section** The e-module contains material for vibration, waves and sound. The developed e-module is structured using the integration of STEM and ethnoscience approaches, in other words the e-module contains the integration of ethno with the four STEM aspects, namely science, technology, engineering, and mathematics. The material in the developed e-module is divided into 3 sub-chapters, namely vibration, waves, and sound. The description of the material contains an explanation of the learning material in detail and systematically. Each learning unit consists of	Apperception and Material Description Section Let's Add Knowledge

apperception, terms you need to know, material description, let's find out, let's solve it, sample questions, practice questions, and group project activities.		
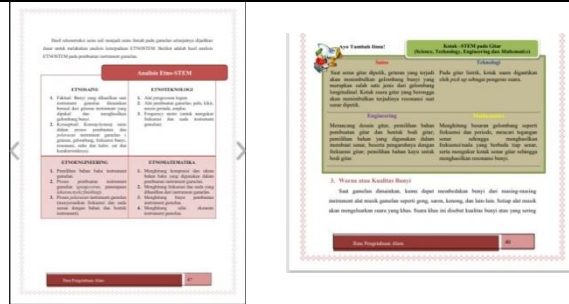
"Let's Find Out" and "Let's Work It Out" Sections
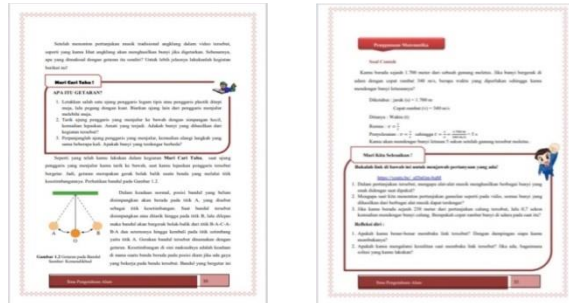
Use of Mathematics and Project Assignments

Summary and Evaluation Questions
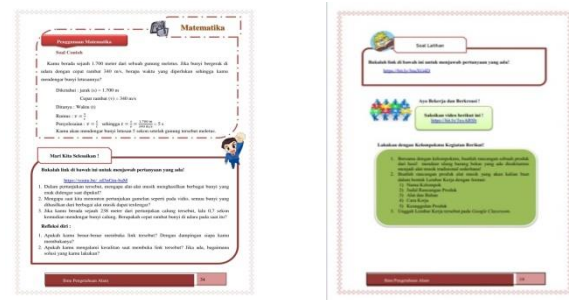
3	Cover Part	
	The last section is the closing section which contains a summary, evaluation questions based on the material and activities that have been carried out by students, bibliography, and author profile.	

Bibliography and Author Profile

The evaluation presented in the etno-STEM module were developd to determine student learning outcomes referring to the competencies achieved and the basic competencies achieved. the characteristics of knowledge are those that refer to the disciplines of science, technology, engineering, and mathematics that are charged to ethnoscience. The ethno-science content presented is about public knowledge related to traditional musical instruments, especially gamelan and calung as well as several phenomena that often occur around the community. The form of questions used in the e-module is multiple choice which is reasonable for understanding the material. The open-ended multiple choice form can be used to identify misconceptions and measure the level of understanding (Gurel, 2015).

Implementation and Evaluation Stage

E-The module that has been developed and has been declared valid is then carried out on a small-scale trial on 12 eighth grade students of SMP Negeri 1 Kersana online using Google Classroom. At this stage, data on the readability and effectiveness of the e-module are obtained when carrying out activities in the e-module.

E-Module Ethno-STEM Readability Results

The data from the e-module readability test results were obtained through the analysis of the e-module readability questionnaire by 1 teacher and 12 students of class VIII of SMP Negeri 1 Kersana. Based on the analysis of the readability test that has been carried out, it was found that the average score by teachers was 77 and by students was 61.25 with a maximum average score of 80, so that the percentage of readability by teachers was 96.25% with very good criteria. , and the percentage of readability by students is 76.6% with good criteria. So the percentage of readability of the developed e-module is 86.43% with very good criteria for use in learning.

The readability of the material in the e-module also affects students' understanding. The results of research conducted by (Aryawan et al, 2018; Suryani et al, 2020) also stated that the readability of the material in the e-module made it easier for students to understand the material presented by around 79%. The e-module with the ethno-STEM approach that has been developed has fulfilled the components of the assessment of teaching materials, namely the title, relevance, material achievements, materials, exercises/stimulation, preparation, and references so that they are suitable for use in the learning process (Suryani et al, 2020).

E-Module Ethno-STEM Effectiveness Results

The data on the results of the e-module effectiveness test were obtained through a small-scale trial of the e-module with a population of class VIII students at SMP Negeri 1 Kersana and took a sample of 12 students from the scores of practice questions and accumulated evaluation scores. Based on the results of the accumulation of effectiveness values obtained a value of 83.72 with very effective criteria. This shows that the ethno-STEM e-module product developed is effectively used as a learning resource on vibration, waves, and sound materials for class VIII SMP/MTs students. These results indicate that the e-module with the ethno-

STEM approach that was developed is very effectively used as an additional learning resource for students as evidenced by 11 students getting a final score above 75 and only 1 student getting a final score below 75.

The thinking ability of different students results in students who are complete and incomplete, so that not all students can meet the targets that have been set. As explained by Kurniahtunnisa et al., (2016) thinking is an ability that must be trained and cannot be obtained instantly. In addition, in studying the ethno-STEM e-module developed, students have different speed of understanding.

Good learning outcomes show good mastery of the material. These results are in accordance with the results of research by Esmiyati et al., (2013) that the module used for independent learning can help facilitate the understanding of concepts and the use of the module has a positive impact on student learning outcomes. Ethnoscience-based learning materials will make it easier for students to understand the material presented, because the material is closely related to the environment around students and local wisdom so that the developed ethno-STEM e-module can affect students' cognitive learning outcomes. The material presented in the e-module is closely related to the environment around students so that it is contextual. Contextual teaching materials can help students learn (Lisdiana et al., 2016).Ethnoscience-based learning can improve students' cognitive and critical thinking abilities because in this model it is carried out by linking classroom learning with students' daily lives and also encouraging students to play an active role in the learning process (Arfianawati, 2016).

The ethno-STEM e-module helps students learn the material of vibration, waves, and sound more effectively because in the module the focus is on discussing these materials. The use of the module allows students to learn independently without having to meet face-to-face with the teacher. The use of modules in the learning process frees students to learn according to their level of understanding, time, and speed of learning (Ali, 2010; Susilawati et al., 2016).

E-Module Ethno-STEM in Developing 21st Century Thinking Skills of Students

Students' critical thinking skills are measured by using an evaluation test in the form of multiple choice reasoned which refers to critical thinking indicators consisting of 12 questions. The results of students' critical thinking skills based on the answers to the evaluation questions given can be seen in Picture 1 below.
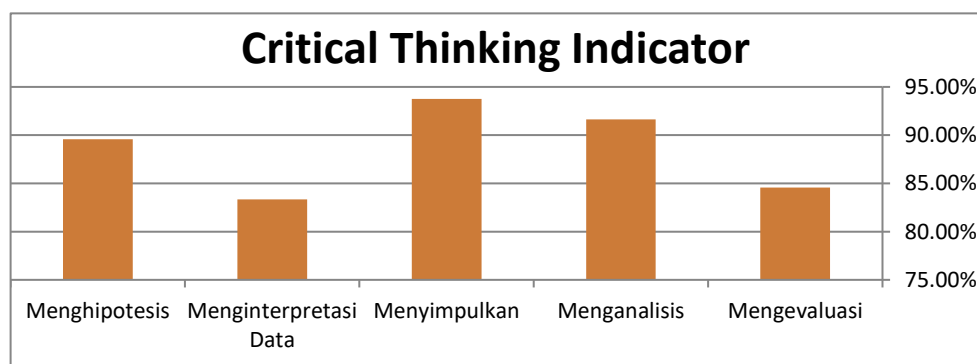
Picture 1 Critical Thinking Indicator

Critical thinking skills are developed through the activities contained in the e-module. In the developed ethno-STEM e-module, students will be presented with questions containing problems to encourage students to observe a phenomenon in the form of video links, information, or simple experiments which are then asked to make hypotheses or tentative assumptions related to the phenomenon. served. These activities can help students improve their ability to hypothesize which is one aspect of critical thinking. In accordance with the

research of Darus & Saat (2014) the factors that can affect the ability to hypothesize are understanding the concepts and relationships between variables in practical or experimental activities.

Creative thinking skills are developed through assignments in the e-module. The e-module also uses a learning model that can support the ethno-STEM approach used, one of which is PjBl (Project Based Learning). The use of the STEM approach in the PjBL learning model can help students integrate the four components of the material by focusing on solving problems in real life so that they can train students' creativity (Sunyoung, et al, 2016). The application of the STEM PjBL model will be very helpful because it involves students to think on a complex problem that sharpens their thinking and reasoning power (Ulfa et al, 2019).

The collaboration and communication skills of students are developed through project assignment activities contained in the e-module. In working on projects, students need to be taught to appreciate each person's strengths and talents and to take on roles and adapt appropriately (Saenab et al, 2019). Collaboration skills that involve students in the dealing process or agreement to make a decision will determine the success of the project (Huang, 2002). This is reinforced by the results of Chan Lin's research in Notari (2013), that project-based learning shows advantages in developing students' collaboration skills, because through the complex activities of the model, students are able to mutually agree and respect different opinions to find solutions and achieve the main objectives of project implementation. The improvement of students' collaboration skills is directly proportional to the improvement of their communication because through the involvement of students in teamwork, students have the opportunity to express their ideas, share ideas and knowledge, and help each other among team members (Huang, 2002). This can be influenced because the Project Based Learning (PjBL) stage is very strict involving the cooperation of each group member starting from the project preparation stage to the presentation stage.

CONCLUSION

Based on the results of the analysis and discussion that has been carried out, it can be concluded that:
1. The development of e-modules with an ethno-STEM approach uses the ADDIE development model.
2. The characteristics of the e-module with the ethno-STEM approach apply an integrated STEM approach to ethnoscience on traditional music, especially gamelan and calung on vibration, waves, and sound materials.
3. The results of the e-module feasibility test analysis with the ethno-STEM approach in terms of content feasibility, presentation feasibility, linguistic feasibility, and graphic feasibility are included in the very suitable category for use with a presentation of 87.75% and the results of the readability test analysis are included in the very good category with the percentage of 86.43% with very good criteria for use in learning.

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