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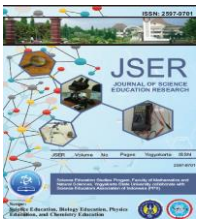

Development of Ethno-STEM Learning Module based on Javanese Gamelan

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Keywords
Ethno-STEM, Module, Grade

Abstract

Ethno-STEM can help students to learn the right learning concepts. The purpose of the study was to design, develop, and test the feasibility of the Ethno-STEM-based science learning module for class VIII students that was feasible to use. The module was printed teaching materials. The module aimed to make students learn independently and study anywhere and anytime without the need for supporting tools. The research development module refers to the Thiagarajan 4-D (Four-D) device development model with the stages of define, design, develop, and disseminate. The samples were 12 students of class VIII in SMP Institut Indonesia in the academic year 2021- 2022. The research instruments used validation sheets of learning material experts, learning media experts, practitioners, and student questionnaires. The feasibility of the module is reviewed based on the results of analyzed data. First, the validation of the Ethno-STEM-based learning module from the science learning validator, consisting of two learning material expert lecturers, obtained an overall score of 3.0 with good criteria. Second, the expert validation of learning media, consisting of 2 media expert lecturers, obtained an overall score of 3.60 with very good criteria. Third, the practitioner validation, consisting of two junior high school science teachers, obtained an overall score of 3.88 with very good criteria. And, student responses showed a percentage score of 94.8% with a very good category. Thus, the learning module of Ethno-STEM was feasible for science learning in class VIII of junior high school.

INTRODUCTION

Learning science in junior high school should be integrated following Permendiknas No. 22 in 2006. In learning science, it is needed to give experiences that are related to students' lives (Nurwahidah et al., 2020). Teachers are supposed not only to develop students' cognitive ability but also problem-solving ability.

This particular skill is referred to as 21st century skill (Widana, 2018). The 21st-century skills consist of some abilities, supporting the individuals to face challenges in this century that has been examined by Usbased partnership for the 21st (P21), is well known as "The 4Cs" (Critical Thinking, Creative, Collaboration, and Communication) (Haryanti 2018). There are four aspects of 21st-century-based learning. They are student-centered, contextual, collaborative, and integrated with the needs of society (Zulirfan et al., 2020).

One of the learning systems to promote the development of 4C or 21st-century skills is STEM (Science, Technology, Engineering, and Mathematics) multidisciplinary education (Zulirfan et al., 2020). STEM education focuses on approaching multiple disciplines, among science, technology, or engineering based on contextual problems (Khoriyah & Husamah, 2018, Nuryadi & Kholifa, 2020). Also, STEM education concerns with reasoning, critical, logical, and systematic thinking abilities so that it can become supporting media to face many kinds of global challenges (Izzaty & Fatikhah, 2015). STEM is an interdisciplinary integration that influences students' future careers (Widiyawati et al., 2020). The purpose of STEM learning is similar to 21st-century education demands, that is, students have science and technology literacy which can be seen from reading, writing, observing, and doing scientific works, as well as developing competence that they have to implement in solving daily life problems, especially that relate to STEM (Jauhariyyah et al, 2017).

STEM education is a well-known approach for teachers because it may improve the 21st-century global technology perspective (Fishbane, 2017). Mastering STEM can be done by teachers by

combining scientific concepts taught in class and real-life problems. Students are expected to be able to apply their knowledge in their environment. Also, through STEM, they are expected to solve problems, become logical thinkers, and associate culture and local wisdom.

STEM education integrated with ethnoscience or local wisdom-based science learning is also referred to as ethno-STEM (Sudarmin et al., 2020). Ethno learning involves local excellence around and connected with learning materials (Utami et al., 2018). Henceforth, ethno-STEM is culture and local wisdom-based STEM, which means it is utilizing more local culture in the learning process. The study of the surrounding culture can be included in the learning process (Ismaya & Santoso, 2019). Integration of an ethnic-STEM approach with a synergistic learning-like learning process that involves local wisdom culture can give solutions for existing problems. Ethno-STEM is capable of being a model for science learning in enhancing 21st-century skills.

Teachers can use local wisdom and integrate it into the science learning process. This integration can be realized by developing an ethno-STEM-based science learning module by combining science, technology, engineering, mathematics disciplines, and local culture. That integration will be used by students as a guide to perform in the learning process. The module is printed learning materials that are packaged systematically and interestingly and include material contents, methods, and evaluations that can be used independently (Anugrahana, 2019). A module should contain learning materials that are appropriate to students' characteristics and capable of making students feel they are involved in a meaningful learning process (Hidayat, 2017).

One of the greatest local wisdom in Javanese culture was *Gamelan*. *Gamelan* is a wealth of art that is owned by Indonesia because this traditional musical instrument is originally from Indonesia and has existed since the Majapahit era until today (Rahayu & Sutarno, 2021). *Gamelan* is usually used to accompany *wayang* (puppet) shows or traditional events in Java (Widiyawati et al., 2022). In 2014, *gamelan* was inaugurated as a culture from Indonesia by The United Nations Educational, Scientific, and Cultural Organization (UNESCO). *Slendro* and *pelog titilaras* as a tone system in *gamelan* instruments (Risnandar, 2018) can provide STEM integration from an ethnic point of view. In the science learning process, *gamelan* can be presented through vibration, sound, and wave materials. Students will try to calculate the vibration, sound, and wavelength through some formulas e.g. when the *gong* was beaten.

Based on observation and initial interviews with science teachers in Junior High Schools of the Institute of Indonesia, textbooks and students' worksheets are used as teaching material in the science learning process. However, there were no teaching materials in the form of interesting, characterful, or ethno-STEM-based modules. Furthermore, the teachers have not understood yet the meaning of ethno-STEM.

Some previous relevant studies relate to ethno-STEM. Sartika et al. (2022) have conducted the research regarding ethno-STEM-based science learning process with Sidoarjo local wisdom to practice students' analytical thinking ability. Another research conducted by Sumarni & Kadarwati (2020) showed that ethno-STEM PBL can improve the average of students' critical and creative thinking ability on every indicator in various categories, from low to moderate criteria. Idrus & Suma (2022) also analyzed problems in ethno-STEM-based chemistry learning from a curriculum aspect. Saputra et al. (2022) also have developed Ethno-STEM-based elementary school thematic teaching materials in Papua. Muhammad & Marsigit (2019) also use the Borobudur temple as an art ethnic symbol to describe the geometry literacy of lower-grade students in elementary school. However, no research has developed an ethno-STEM-based learning module oriented to Javanese culture, especially *gamelan*. Module with an ethnic-STEM approach, specifically *gamelan*, is expected to help students develop skills that are needed in the 21st century (Hermansyah, 2020).

Therefore, the study aimed to develop an Ethno-STEM-based learning module in vibration, sound, and wave materials for grade VIII students that is feasible to use.

RESEARCH METHOD

The research was research and development, adapted the Thiagarajan model which consists of 4 stages named 4D model. The four stages are define, design, develop, and disseminate (Thiagarajan, 1974: 6). Because of the time limitation, this particular research only adopted three stages, define, design, and development. The developed product was an ethno- STEM based science learning module on vibration, sound, and waves materials for students of class VIII that is feasible to use. The research was conducted in April-July 2022. The steps of this development are presented in Figure 1. The subjects were students of grade VIII in SMP Institut Indonesia Semarang.

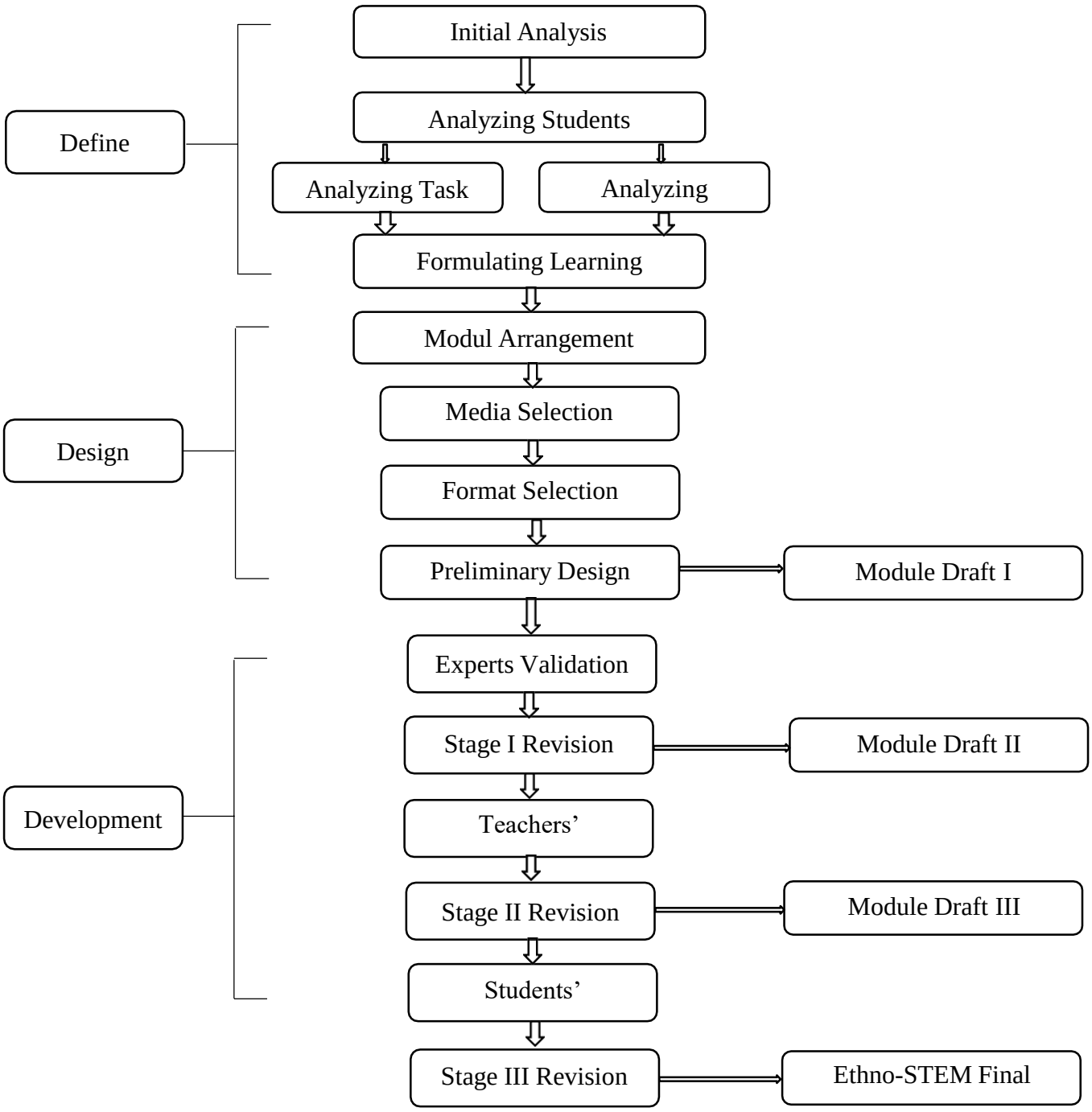


Figure 1. The Stages of Product Development of Ethno-STEM Based Science Module for Grade VIII students

The data collection techniques were interviews, validation tests with learning material experts and learning media experts, validation tests with science teachers, and readability tests on students. A preliminary study was conducted by interviewing science teachers for several purposes, such as: (1) analyzing science materials and extracurricular in the school; and (2) identifying problems experienced during product trials and field trials. Furthermore, the validation test was conducted to examine the feasibility of the developed product. Validators consisted of 4 lecturers who are experts in their fields and 2 science teachers. 12 students were also asked to give responses on the developed module.

The obtained data were analyzed using quantitative description which was used to revise the developed module to obtain a feasible and valid module. After that, the obtained validation is tabulated in every assessment aspect. Then, this data was converted into interval data on a scale of 4. The quantitative data were interpreted using qualitative sentences. The reference of the scores conversion on a scale of four based on learning media experts, learning material experts, and practitioners' instructions is presented in Table 1.

Table 1. Conversion Criteria for Module Assessment Scores Obtained from Learning Media Experts, Learning Material Experts, and Practitioners.

No	Score	Category
1.	$X \geq \bar{X} + 1.SBx$	Very Good
2.	$\bar{X} + 1.SBx > X \geq \bar{X}$	Good
3.	$\bar{X} > X \geq \bar{X} - 1.SBx$	Poor
4.	$X > \bar{X} - 1.SBx$	Very Poor

(Mardapi, 2008: 123)

Description:

X = Achieved score

$\bar{X}$ = Average ideal score

= ½ (max ideal score + min ideal score)

SBx = Ideal standard deviation

= 1/6 (max ideal score – min ideal score)

Max ideal score =

∑ each item of criteria x highest score

Min ideal score =

∑ each item of criteria x lowest score

RESULT AND DISCUSSION

This research aimed to develop a science learning module with vibration, sound, and wave materials for grade VIII that is feasible to use. This material explains more about Javanese local culture, specifically gamelan, in science learning reviewed from STEM disciplines. There were 4 stages in the 4D Model. And, the model was adapted in developing the module in this research, namely: Define, Design, Development, and Disseminate (Thiagarajan et al, 1974). However, the dissemination stage was not performed because of the time limitation of the research.

The first stage is Define (defining), which consists of analyzing initial observations in SMP Institut Indonesia by interviewing science teachers. From the interview, obtained the information that learning methods were lecturing and question-answer. Additionally, science teachers conducted lab work and used either students' worksheets or textbooks as the learning sources. The teachers stated that the developed learning module with a local culture approach in the form of gamelan has never existed in the school. Ethno learning model or local culture-based was still considered new for teachers, meanwhile the term STEM was familiar to them. Idrus & Suma (2022) stated that one of the reasons caused the lack of dissemination of learning models in correspond with K-13 is that Ethno-STEM is difficult for teachers to implement. Idrus & Suma (2022) also stated that the learning process is only carried out by lectures, discussions, and exercises using students' worksheets books, or textbooks. Henceforth, this research is needed to develop an Ethno-STEM-based model as learning media support. Ethno-STEM-based learning module is expected to help students learn STEM discipline integrated with local culture that is connected with learning materials (Priyani & Nawawi, 2020).

The next stage is Design (planning) which consists of making the module, selecting media, selecting the format, and designing the initial module. The steps in this designing stage are explained as follows:

1. Making Module

This step was done by collecting references that would be used as the source for making learning modules.

2. Selecting Media

This stage was done by choosing some examples of Ethno-STEM-based media that were presented in the developed science learning module. It used some reference books about learning media and internet sources of Ethno-STEM-based media.

3. Selecting Format

In this step, it was choosing the language text format. The text should refer to the Great Dictionary of the Indonesian Language (KBBI). Meanwhile, the sentence arrangement used non-standard sentences so that the module would be easier to read, but still paid attention to the rules of the language in order not to reduce the educational values in it.

4. Designing Initial Module

At this stage, it designs the initial plan for module arrangement, media selection, and format selection to result in a draft of Module I.

The third stage is development (developing) which consists of validating and revising the draft. This stage was the last in developing a science learning module. The next step was validating the science learning module by material learning experts, practitioners, and students' responses. Learning module validation is the process in which the product or media is assessed to find out the feasibility of the learning module before using it in the learning process. This statement is supported by Sawitri (2014) who stated that qualified and feasible learning modules can be used after fulfilling the validity standard assessed by experts. Validation is one of the ways to evaluate and complete the result of the developed learning module. In assessing validation, there were some validators, validation of learning material experts (2 validators), learning media experts (2 validators), and practitioners (2 validators). The

aspects validated by learning material experts are materials based on KI and KD, aspect of material accuracy, aspect of material recency, aspect of material depth, aspect of material context, aspect of curiosity-driven, aspect of material presentation, aspect of writing, aspect of picture, and aspect of Ethno-STEM. This stage aimed to result learning module that would be tested academically, could be read, and easier to understand by students. The assessment obtained from learning material experts and practitioners became the basis for making revisions so that the developed product was feasible to be tested. The score of the Ethno-STEM-based learning module validation results obtained from learning material experts are presented in Table 2.

Table 2. Validation Results of Learning Material Experts

Aspect	N	Score		Total Score	Mean	Criteria
		Expert 1	Expert 2			
Material Accordancy	3	8	10	18	3	Good
Material Accuracy	3	9	10	19	3.17	Very Good
Material Recency	3	7	9	16	2.7	Good
Material Depth	1	3	4	7	3.5	Very Good
Material Context	3	9	11	20	3.3	Very Good
Curiosity Driven	3	8	10	18	3	Good
Material Presentation	2	5	7	12	3	Good
Writing	3	9	10	19	3.17	Very Good
Picture	4	12	15	27	3.38	Very Good
Ethno-STEM	2	4	7	11	2.75	Good
Total	27	74	93	167	3.09	Good

Based on Table 2, the aspect of material depth has the highest mean score of 3.5 on the very good criteria as it gives deep, detailed, and specified explanations in every chapter, and also gives examples of questions that can enhance students' cognitive ability. Material recency obtained the lowest mean score of 2.7 on the good criteria. One of the reasons is that it only focused on the Ethno aspect in the form of local culture-based learning observation so that it gives analogies and examples of the cultural learning process. Some suggestions were obtained from learning material experts regarding writing errors and practice.

The existence of a local culture that has developed since a long time ago is very needed in science learning. This thing is in agreement with the prior research which has examined learning that optimizes local culture adopted by local communities will be more appropriate and beneficial for students in terms of cognitive, affective, and psychomotor dimensions (Hikmawati et al., 2021). The effort to preserve local culture has been carried out by emerging it in educational institutions like schools to improve the quality of learning. There are questions in the module that have not been met yet with Ethno-STEM. Those suggestions were used to revise the developed module. In developing a science learning module, it is needed to be concerned with several factors, such as the form of the module, the size of the module, and the design of the module. A module should contain efficient, practical, interesting, explicit, and specific elements. Therefore, a module should be validated by learning material experts. 3 aspects of validation are divided into 12 indicators. Results of learning media experts' assessment scores regarding the development of Ethno-STEM based science learning module are presented in Table 3.

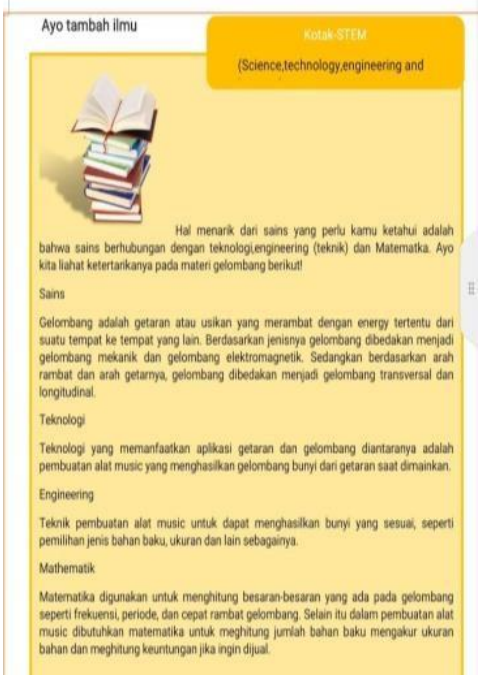
Table 3. Results of Learning Media Experts' Validation

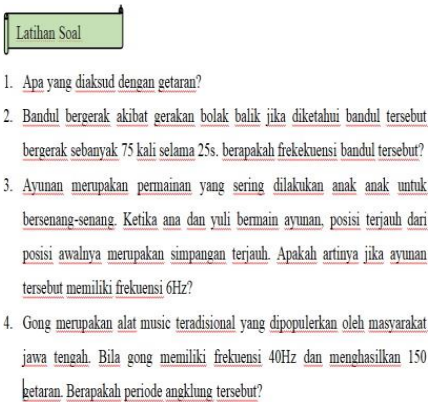
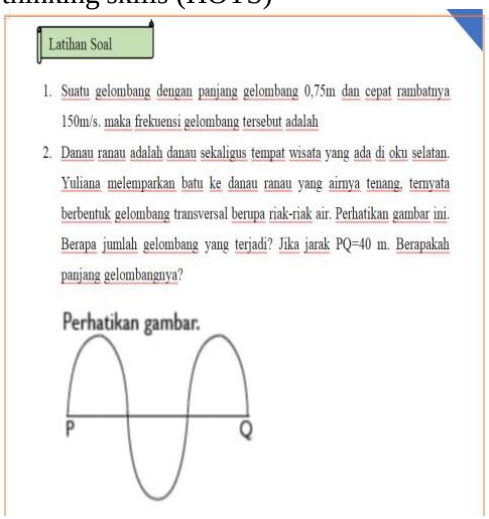
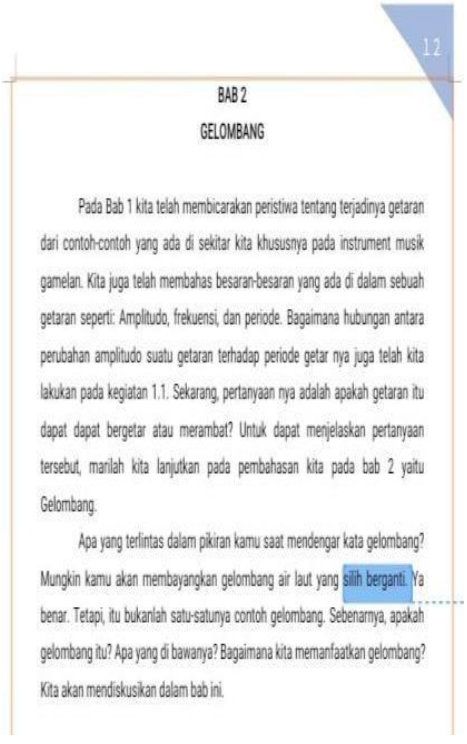
No	Aspects	N	Score		Total	Mean	Criteria
			Expert 1	Expert 2			
1	Module's Size	2	7	8	15	3.75	Very Good
2	Module's Cover Design	3	11	10	21	3.5	Very Good
3	Module's ContentDesign	7	25	25	50	3.57	Very Good
	Total	12	43	43	86	3.60	Very Good

In Table 3, the aspect of the module's size obtained the highest mean score of 3.75 on very good criteria. Meanwhile, for the module's cover design, learning media experts gave 3.5 with very good criteria. The basic green was chosen for the color of the cover combined with white and yellow for the module's title to look contrast. Pictures of gamelan and science are also attached to represent the content of the module. Furthermore, the aspect of the module's content design obtained 3.57 with very good criteria. Every chapter is always completed with illustration pictures to give an interesting impression and make students understand the materials learned easily. It concluded that based on the results of learning material experts' validation, the highest score is 3.5. In learning material experts' validation, this is categorized as a very good criteria because it gave deep, detailed, and specified explanations in every chapter. Meanwhile, the lowest score in learning material experts' validation, one of the reasons is because it only focused on the Ethno aspect in the form of local culture-based learning. In addition, there are only a few references about Ethno-STEM because it is categorized as a new model. In learning media experts' validation, the highest score is 3.75 because the developed module is following ISO standards, either based on the margin size or the paper in the module. The suggestion given by learning material and learning media experts is, that it should collect more references about the Ethno aspect and revise based on what they have suggested.

Therefore, the development of the module has passed phase I of validation with revisions based on the suggestions, because the score has the minimum limitation of 3.00. The experts gave some notes on the module to make the first phase of revision. The revision based on learning material and learning media experts' notes are summarized in Table 4.

Table 4. Examples of Science Learning Product's Revisions

No.	Before	After Revision
1.	In page 21, there is writing that can not be seen in "Kotak STEM"because it is covered with picture. 	Revising the picture in "Kotak STEM". 

No.	Before	After Revision
2.	Development in practice questions items can not develop students' high orderthinking skills (HOTS)  Latihan Soal 1. Apa yang diaksud dengan getaran? 2. Bandul bergerak akibat gerakan bolak balik jika diketahui bandul tersebut bergerak sebanyak 75 kali selama 25s. berapakah frekekuensi bandul tersebut? 3. Ayunan merupakan permainan yang sering dilakukan anak anak untuk bersenang-senang. Ketika ana dan yuli bermain ayunan, posisi terjauh dari posisi awalnya merupakan simpangan terjauh. Apakah artinya jika ayunan tersebut memiliki frekuensi 6Hz? 4. Gong merupakan alat music teradisional yang dipopulerkan oleh masyarakat jawa tengah. Bila gong memiliki frekuensi 40Hz dan menghasilkan 150 getaran. Berapakah periode angklung tersebut?	The practice questions are revised so that they can improve students' high order thinking skills (HOTS)  Latihan Soal 1. Suatu gelombang dengan panjang gelombang 0,75m dan cepat rambatnya 150m/s. maka frekuensi gelombang tersebut adalah 2. Danau ranau adalah danau sekaligus tempat wisata yang ada di oku selatan. Yuliana melemparkan batu ke danau ranau yang airnya tenang, ternyata berbentuk gelombang transversal berupa riak-riak air. Perhatikan gambar ini. Berapa jumlah gelombang yang terjadi? Jika jarak PQ=40 m. Berapakah panjang gelombangnya? Perhatikan gambar. P Q
3.	Module format consistency. In chapter 1 and chapter 3, there's a section called "istilah yang perlu kamu ketahui" (terms that you need to know), but there is no such section in Chapter 2.  12 BAB 2 GELOMBANG Pada Bab 1 kita telah membicarakan peristiwa tentang terjadinya getaran dari contoh-contoh yang ada di sekitar kita khususnya pada instrument musik gamelan. Kita juga telah membahas besaran-besaran yang ada di dalam sebuah getaran seperti: Amplitudo, frekuensi, dan periode. Bagaimana hubungan antara perubahan amplitudo suatu getaran terhadap periode getar nya juga telah kita lakukan pada kegiatan 1.1. Sekarang, pertanyaan nya adalah apakah getaran itu dapat dapat bergetar atau merambat? Untuk dapat menjelaskan pertanyaan tersebut, marilah kita lanjutkan pada pembahasan kita pada bab 2 yaitu Gelombang. Apa yang terlintas dalam pikiran kamu saat mendengar kata gelombang? Mungkin kamu akan membayangkan gelombang air laut yang silih berganti. Ya benar. Tetapi, itu bukanlah satu-satunya contoh gelombang. Sebenarnya, apakah gelombang itu? Apa yang di bawanya? Bagaimana kita memanfaatkan gelombang? Kita akan mendiskusikan dalam bab ini.	Fixing module format by adding the section "istilah yang perlu kamu ketahui" (terms thatyou need to know) in Chapter 2.  12 BAB 2 GELOMBANG Istilah yang perlu kamu ketahui: 1. Gelombang mekanik 2. Gelombang elektromagnetik 3. Gelombang transfersal 4. Gelombang logitudinal Pada Bab 1 kita telah membicarakan peristiwa tentang terjadinya getaran dari contoh-contoh yang ada di sekitar kita khususnya pada instrument musik gamelan. Kita juga telah membahas besaran-besaran yang ada di dalam sebuah getaran seperti: Amplitudo, frekuensi, dan periode. Bagaimana hubungan antara perubahan amplitudo suatu getaran terhadap periode getar nya juga telah kita lakukan pada kegiatan 1.1. Sekarang, pertanyaan nya adalah apakah getaran itu dapat dapat bergetar atau merambat? Untuk dapat menjelaskan pertanyaan tersebut, marilah kita lanjutkan pada pembahasan kita pada bab 2 yaitu Gelombang
4.	There found some misspelled words	Correcting the misspelled words.

After the learning module has been validated in the first stage, the next step is the second stage of validation to 2 practitioners. The practitioner is the science teacher in junior high school who will practice the Ethno-STEM-based module. Practitioners' validation assessment consists of 3 aspects, such as material depth, material accordancy, and linguistic feasibility. The practitioners' second stage of validation relates to material accuracy, depth, and presentation. The results of module validation by practitioners

obtained a mean score of 3.88 with very good criteria. The results of experts' and practitioners' validation assessment are presented in Table 5.

Table 5. Results of the Second Stage Validation of Ethno-STEM Based Science Learning Module by Practitioners

No	Aspects	Total score	Mean	Total Average	Criteria
1.	Material Depth	16	4.00		
2.	Material Accordancy	47	3.91	3,88	Very Good
3.	Linguistic Feasibility	15	3.75		

The practitioners gave 16 for the score and 4.00 on the mean score in the aspect of material depth, and the material accordance obtained 47 for a score with a mean score of 3.91 with very good criteria. In the second stage of validation which was supported by practitioners, the developed module obtained a total average score of 3.88 with very good criteria. The score shows that the developed Ethno- STEM-based science learning module is feasible to use because aspects such as material accordance, accuracy, depth, context, curiosity-driven, presentation, writing, and pictures have very good criteria. This shows that the module is feasible to use as a good learning source due to it can give an understanding of Science, Technology, Engineering, and Mathematics (STEM) and also give experiences the experiment directly that makes the learning itself more qualified. In addition, this module also needs to be revised in writing, lack of materials in the aspect of Ethno-STEM, and practice questions that have not been met in improving concept mastery.

In phase III of validation, a readability test was conducted on the students. The aspects are the clear instructions to use the module, the easy-to-understand materials, the use of clear learning media, and the easy-to-understand language use. The results of the readability test that has been conducted on the students are summarized in Table 6.

Table 6. Results of Phase II Validation of Ethno-STEM Based Science Learning Module

Validation	Percentages (%)	Criteria
Students' Responses	94.8	Very Good

Based on Table 6, the developed science learning module obtained positive responses from students around 94.8% with very good criteria. Students' positive responses are caused by clear instructions in using the learning module so that the students can do the learning process independently. They can easily comprehend the steps and materials in the module because it is supported with language and instructions to guide them in doing the activity. The pictures that can be observed and the examples of practice questions are also the reasons that make it easier to understand the learning materials. The positive responses from students to the local culture-based science learning module mean that they are interested, understand, and easily comprehend the materials, As the output, it is expected to help students to improve their scientific thinking ability (Nailiyah et al., 2016). Henceforth, the Ethno-STEM-based science learning module that discussed Javanese gamelan is expected to be used in vibration, sound, and wave materials. Supported by Nihwan & Widodo (2020), the application of local culture-based science learning on soil and life sustainability materials can enhance the students' scientific literacy. Another research also stated that the implementation of ethno-STEM-based science learning with a digital microscope can improve elementary school students' science process skills (Priyani & Nawawi, 2020).

CONCLUSION

Based on the findings and discussion, the developed learning module has been validated by learning media experts and learning material experts. The experts in both fields have given positive responses to the developed module's content and the module. The results of the module's validation on practitioners and readability test on students showed very good with a mean score of 3.88. Also, the developed Ethno-STEM-based science learning module can result valid and feasible learning product in science learning for junior high school students.

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