

Ethnoscience-based E-worksheet to Stimulate Science Process Skills

Eko Suyanto^{1*}, Agus Suyatna², Annisya Destryati³, Afis Pratama⁴

^{1,2,3}Physics Education Department, University of Lampung, Indonesia

⁴Informatics Education Department, Universitas Ivet, Indonesia

*Corresponding Address: eko.suyanto@fkip.unila.ac.id

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ABSTRACT

This study aims to develop an ethnoscience-based E-worksheet on sound waves topics that are valid and practical. The E-worksheet developed to stimulate students' science process skills was developed using the Flip PDF Professional application. This study employed Design and Development Research (DDR), which consisted of four stages: analysis, design, development, and evaluation. This ethnoscience-based E-worksheet contains material and practical guidance using Gamolan to investigate the sound waves topic with science process skills indicators, namely observing, formulating problems, formulating hypotheses, determining variables, collecting, processing, and concluding data. The E-worksheet was declared highly valid, with an average score of 3.6. Based on the analysis, the ethnoscience-based E-worksheet can be used to teach sound waves for the second semester of eleventh-grade high school students. The E-worksheet obtained a percentage of 93% in the very practical category based on the practical test by students and teachers. The students commented that the E-worksheet is appropriate for classroom learning, is interesting to read, and is equipped with videos that helped them in the learning process.

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INTRODUCTION

Education and culture are closely related and influence each other (Nambiar et al., 2020). The success of learning science, especially physics in schools is strongly influenced by the cultural background possessed by students or the community where the school is located. When brought into the classroom during the learning process, the cultural background possessed by students (students' prior beliefs and knowledge) will play a very important role in the concept mastery process and determine the creation or conditioning of the learning and teaching atmosphere (Olimov, 2021).

Education that integrates culture is essential because culture plays an important role in shaping individual and group

identity. Cultural integration in education can help students understand the history and traditions of their own culture and those of others (Lubis, 2022). Culture-based science learning as a national identity is something that needs to be highlighted in curriculum development in Indonesia (Lia et al., 2016).

Integrating culture or local wisdom in science learning allows students to better understand scientific concepts. By incorporating local knowledge and culture, students can relate scientific concepts to their own experiences and ways of knowing, which can help them better understand and remember the information. It can be done through direct observations, and students can be trained to find various concepts comprehensively and meaningfully for themselves and encourage participants to

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explore scientific knowledge contained in the values of local wisdom (Damayanti et al., 2017).

Gamolan is a traditional musical instrument for the culture of the Lampung community (Trihasnanto, 2016). So far, Gamolan at school is only used for art subjects. However, with ethnosience, teachers can use Gamolan as a learning tool to better understand the topic of sound waves. This allows Gamolan to be studied through physics.

Physics relates to systematic natural phenomena, so learning contains mastery of knowledge and discovery processes in the form of concepts (Fadhilah et al., 2017), facts, and principles (Azizah et al., 2021). Physics learning involves students studying nature (Astiti et al., 2023) and its phenomena through a series of scientific processes built on a scientific attitude (Yulianci et al., 2021). A scientific attitude can be built through science learning, which trains students' science process skills (Nugraha and Susilaningsih, 2017).

Science process skills play an important role in discovering scientific concepts such as acting logically (Sukma et al., 2022), researching, reasoning (Angelia et al., 2022), thinking skills, and building scientific concepts to solve problems (Dewi & Muhiri, 2020). Cognitive, psychomotor, and social skills are involved in science process skills (Yildiz et al., 2021). This will make science learning more meaningful (Nugraha and Susilaningsih, 2017). Investigations or experiments can train students to acquire science process skills. Science process skills can be developed through hands-on experience by conducting scientific investigations or experiments (Kızılaslan, 2019).

Through scientific activities, several skills can be trained and learned by students. The forms of scientific activities carried out are stages and indicators of science process skills (Maison et al., 2022). Scientific activities in the form of scientific experiments in the laboratory require

devices that can be operationalized in learning (Ejiri, 2015), one of the tools in question is a student worksheet. The activities in the worksheet contain a list of scientific activities (Herman and Aslim, 2015).

Student worksheets, commonly called E-student worksheets, can combine student activities with technology (Ito et al., 2018) such as computers, laptops, and even smartphones (Dewi & Sadjiarto, 2021), compared to traditional printed worksheets (Haryanto et al., 2019). E-student worksheets can encourage interesting interactions between students and teachers, improving the learning experience (Ernawati et al., 2018). The E-student worksheet can facilitate student activities in conducting investigations and solving problems (Nur et al., 2024).

Ethnosience connects culture and science, enriching learning with local values and traditional wisdom (Sani et al., 2023). Students learn scientific concepts associated with local culture (Rahmawati & Atmojo, 2021) to make learning more relevant and contextual. Ethnosience can increase students' appreciation of their own and other cultures (Lestari & Nabila, 2024).

According to preliminary research results through interviews and questionnaires to physics teachers in 3 schools in Lampung, information was obtained that teachers had difficulties in conducting sound wave practicums due to the absence of a Sound KIT. Students confirmed this through a questionnaire, which stated that there were no practical learning activities in the sound wave topic. During the analysis, it was discovered that the school possesses a sufficient number of traditional Gamolan instruments, ideal for sound wave practicums. However, a practical guide was lacking, such as a worksheet designed to utilize Gamolan in these activities.

The integration of E-student worksheets with ethnosience can train science literacy skills on membrane

transport material (Junita & Yuliani, 2022; Mahyuny et al., 2022), increase students' motivation and science literacy in chemistry (Januarti & Muliyadi, 2024), improve students' thinking skills in chemistry (Sudarmin et al., 2019), and improve students' scientific argumentation skills and enrich learning with cultural context (Nur et al., 2024). However, there is no specific research and development of ethnoscience-based E-worksheets to stimulate science process skills.

Therefore, a practical guide was lacking, such as a worksheet designed to utilize Gamolan in these activities.

METHOD

This study employed the ADDE model with four stages: analysis, design, development, and evaluation (Richey and Client, 2007). The ethnoscience applied in this study was limited to a regional musical instrument of Gamolan to study the sound wave topic. The E-worksheet was made using the Flip PDF Professional application and was tested for validity and practicality. Three validators carried out the product validity test: two Physics Education Study Program lecturers at the University of Lampung and one SMA Negeri 1 Kotagajah teacher. The practicality test was tested on 30 twelfth-grade high school students at SMA Negeri 9 Bandar Lampung. A teacher practicality test was conducted on one physics teacher at SMA Negeri 9 Bandar Lampung.



Figure 1. ADDE Model

At the analysis stage, the researchers administered the preliminary research through interviews and questionnaires. This preliminary research was conducted on students and physics teachers of class XI. A needs analysis was conducted to collect information about the potential and problems of the school. Interviews with Gamolan experts were conducted with Musical Arts Education students and Gamolan trainers to verify information about Gamolan.

At the design stage, the researchers designed an ethnoscience-based E-worksheet framework. The product was designed based on a needs analysis with the following science process skills indicators (observing, formulating problems, formulating hypotheses, determining variables, collecting, processing, and concluding data).

At the development stage, the researchers developed the product according to the designs determined at the design stage. After that, the researchers conducted a validity test. Product validation was carried out through material testing and product design testing through questionnaires. The scoring system used a Likert scale (Pimentel, 2019) using four choices presented in Table 1.

Table 1. The Likert Scale of the Questionnaire

Category	Score
Excellent	4
High	3
Low	2
Poor	1

The practicality test was carried out using a questionnaire with a Likert scale via Google Forms. The results of the validity test and practicality test questionnaire were analyzed using the following equation:

$$p = \frac{\text{Average score obtained}}{\sum \text{Total score}}$$

The results of the score (p) of the validity test data obtained were then converted to

criteria adapted from (Riyani, et al.,2017) as seen in Table 2.

Table 2. Conversion Score for Validity

Scoring Result Interval	Criteria
$3 \leq \text{score} < 4$	Highly valid
$2 \leq \text{score} < 3$	Valid
$1 \leq \text{score} < 2$	Quite valid
$0 \leq \text{score} < 1$	Not valid

The results of the score (p) of the practicality test data obtained were then converted to criteria adapted from (Arikunto, 2011), as seen in Table 3.

Table 3. Conversion Score for Validity

Scoring Result Interval	Criteria
0,00%-20%	Not practical
20,1%-40%	Less practical
40,1%-60%	Quite practical
60,1%-80%	Practical
80,1%-100%	Very practical

After the product was declared valid, it was tested for practicality. Two practicality test instruments were used: the practicality test instruments according to teachers and the practicality test instruments according to students.

The evaluation stage was carried out at each stage of the development to improve the product by revising it based on suggestions from experts, teachers, and students. The evaluation was performed to identify the product's success so that it was valid and practical.

RESULTS AND DISCUSSION

The product developed in this research is an ethnosience-based E-student worksheet created with the help of the Flip PDF Professional application. The worksheet was created to guide students and assist teachers in practical activities. This benefit will be effective if the teacher develops and adapts the E-student worksheet to the student's learning objectives, needs, and conditions. Interesting teaching materials can help students understand physics concepts and

directions in carrying out practicums to stimulate students' science process skills.

Using an ethnosience-based E-student worksheet can help students understand sound wave material through ethnosience in Gamolan based on the practicum that will be carried out. Students' science process skills can also be stimulated through practical activities.

In activity 1, students observe a video showing the sound differences from each bamboo blade on Gamolan. When observing the show, the students are asked to focus their observations on the vibrations in the bamboo blades and the differences in sound for each note on the Gamolan blades (related to frequency). After observing, they will be asked questions to encourage finding problems with this phenomenon. Next, they will formulate problems and hypotheses regarding sound differences in each bamboo blade in Gamolan.

In Activity 2, the students will be asked to experiment to prove the hypothesis prepared in Activity 1. They will start activity two by preparing tools and materials for conducting experiments. Next, they will conduct experiments according to the guidelines on the E-student worksheet and write down the data obtained in the table provided.

In activity 3, the students will answer guiding questions to describe the results of the data obtained from the experimental results. There are four questions that students must answer in this experiment. They must make graphs and compare practical results according to the references provided.

In activity 4, the students are asked to conclude from the results of hypothesis testing in activity 2. They will summarize the concepts and understanding they have obtained from the previous activity. This activity is useful for knowing the knowledge, skills, and information that students get.

This development research produces ethnosience-based E-worksheet products to

stimulate science process skills (observing, formulating problems, formulating hypotheses, determining variables, collecting, processing, and concluding data) that have gone through product validation tests and practicality tests. The product has been integrated with Google Forms in every answer upload. The product has images, videos, audio, and animations to add to its advantages. The product was developed to stimulate science process skills in the sound wave material for the eleventh-grade second-semester students.



Figure 2. E-worksheet Cover

This ethnoscience-based E-worksheet was developed based on indicators of science process skills with four core activities students will carry out.

This E-worksheet was validated through a design test and material test. Based on the design validation results, the average score obtained was 3.6 in the highly valid category. Based on the results of the material validation, the obtained score was 3.61 in the highly valid category. The average result of the two aspects was 3.6 in the highly valid category. This finding shows that the quality of the design and material of the E-worksheet was highly valid. Some suggestions for improvement given by the validators also served as improvement guidelines.

The science process skill indicators used in this ethnoscience-based E-worksheet consisted of observing, formulating problems, formulating hypotheses, determining variables, collecting, processing, and concluding data (A'la et al, 2019).

In the observing indicator, the students carry out activities in the form of watching a video of Gamolan and listening carefully to the difference in sound between the two blades so that students can practice

observing skills with the senses of hearing and sight, collecting relevant facts, and looking for similarities and differences. This idea is in line with (Safaruddin et al, 2020) that observing in science process skills is the most basic skill when students conduct experiments. They use their senses to gather information about objects or events in their environment.

In formulating a problem, the students are asked to express questions based on the problems they find after observing activities (Guangul et al, 2020). They are given questions about the findings regarding the difference in sound on the Gamolan to formulate the problem correctly. In the indicators of formulating hypotheses, the aspect achieved by the students is by making temporary answers or possibilities. Students use past observations and discoveries to create hypotheses for predicting future events (McComas, 2014). The available information influences the strength of students' predictions in preparing hypotheses. The E-worksheet is equipped with books and scientific articles to assist students in formulating hypotheses.



Figure 3. Improvements: (a) E-worksheet before Revision; (b) E-worksheet after Revision

There are also indicators for determining variables to identify the quantity used as a variable. The students are asked to write down what variables they will use in the experiment and the relationship between them. The indicators collect data by conducting experiments using tools and materials following the guidelines. Activities carried out by students on these indicators are conducting experiments using several tools and materials, one of which is Gamolan. Students will collaborate in groups to collect data from Gamolan and the articles provided in Activity 1. This data collection activity trains students to measure

sizes to describe the dimensions of objects or events. In this case, students measure the frequency, blade area, and density of bamboo in Gamolan. Monhardt (Falloon, 2019) believes this measuring activity is important in science process skills because it can add accuracy to students' observations, classification, and communication.

The indicator of processing data requires students to process the data obtained into tables and graphs. They will process the data into a unified table and graph. This idea is to the research of (Pratiwi et al., 2020) that through data processing activities, students can practice scientific communication skills in the form of activities using words, actions, or graphic symbols to describe an action or event. This activity requires students to put the information they have gathered from observations so that it can be shared with others.

In the indicator of concluding data with aspects of describing the conclusions from the results of testing hypotheses or experiments, students will conclude the results with the help of several questions and graphs to guide them to conclusions. This concluding activity on the ethnosience-based E-worksheet is by (Wise and Jung, 2019) opinion that making conclusions involves evidence in the form of data to explain observed events or things. It is important to help students distinguish between what they observe and their conclusions.

This ethnosience-based E-worksheet was developed using indicators of science process skills using Gamolan. This E-worksheet shows that applying Gamolan ethnosience can be applied in physics learning, especially sound wave material. In addition, ethnosience using Gamolan can stimulate science process skills because the content students learn is relevant to everyday life. In this case, Gamolan is a Lampung regional musical instrument that is relevant to the culture around students. Learning science with an ethnosience approach can improve students' science

process skills (Atmojo, 2012). Another study that supports this statement was carried out by (Andriani and Widodo, 2018) that there was an increase in students' science process skills after using a scientific approach-based ethnosience worksheet.

Based on the students' experience after working on the ethnosience-based E-worksheet, the students stated that the practicum using the Gamolan musical instrument was a fun experience when studying sound wave material. Students are more interested and enthusiastic about learning science using an ethnosience approach because it feels more fun (Ardianti, 2022). Based on the results of the practicality test, the students obtained a percentage of 91.4 % in the very practical criteria. Thus, the E-worksheet can be used easily by students.

The next component of the practicality test is the teacher's practicality test. The teacher's practicality test assessed the suitability of the E-worksheet with the basic competencies of the chosen learning topic. Based on the practicality test, the teacher obtained a percentage of 93.7 % in the very practical criteria. Thus, the E-worksheet can be used easily in learning sound wave material. The E-worksheet was in the very practical category because it was created based on the sequence of material and suggestions given by the teachers.

Practical products are one of the goals of this research. Based on the calculations, the average percentage of the practicality test was 92.5 % in the very practical criteria.

Based on the students' practicality test results, the developed E-worksheet was suggested to be developed so that iOS users can use it since the current E-worksheet can only be run on Android. Furthermore, the students commented that the E-worksheet was good for classroom learning, interesting to read, and equipped with videos that helped them in the science process skills (analysis, design, development, and evaluation).

CONCLUSIONS AND SUGGESTION

Based on the analysis, an ethnoscience-based E-worksheet product was produced to stimulate students' science process skills on sound wave material. This E-worksheet contains material and practical guidelines using Gamolan with indicators of observing, formulating problems, formulating hypotheses, determining variables, collecting, processing, and concluding data. This E-worksheet was declared very valid with an average score of 3.6. The E-worksheet can be used as teaching material on sound waves for the second semester eleventh-grade senior high school students based on the assessment obtained from the readability test and teacher response test with a percentage of 92.5 % in the very practical category.

Several suggestions can be formulated for further research, specifically on Gamolan musical instruments. Further research is suggested on Young's Modulus on Gamolan blades, especially when the Gamolan blade is hit. In addition, ethnoscience-based E-worksheets can be further developed on sound wave material with other traditional musical instruments. The ethnoscience-based E-worksheet can be developed on other materials by linking it to other regional cultures in Indonesia.

AUTHOR'S CONTRIBUTION

ES and AS conceived the original research idea and designed the overall study. AD conducted the majority of the laboratory experiments and data collection. ES, AS, and AD performed the statistical analysis and interpretation of the results. AP drafted the initial manuscript with critical revisions and edits from ES, AS, and AD. All authors approved the final version of the manuscript for submission.

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