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Integrating Pentatonic Angklung into Physics Experiment to Identify Multiple Representation Skills in Junior High School

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ABSTRACT

Angklung is a traditional musical instrument from West Java that can be used as a learning medium for sound concepts. The study focuses on pentatonic Angklung as a musical instrument commonly used in Ngaseuk ceremonies as rice planting rituals in the Baduy tribe. This study aims to report the integration of pentatonic Angklung into physics experiments and investigate multiple representation skills. Technology-based mobile used as an experimental tool is Phypox. The designed activity aims to identify multiple representation skills using guided-inquiry models in four stages: Open, Explore, Create, and Share. The study participants are 31 8th-grade students at one of the junior high schools in West Java Province, Indonesia. Experiment activities investigate variables that affect the frequency of the pentatonic Angklung. A worksheet guides experiment activities following the syntax of the guided-inquiry model. The study results show that students use different representations at each stage in the worksheet. Students use four representations in this experimental activity: verbal, mathematical, pictorial, and graphical. It can be concluded that integrating pentatonic Angklung into physics experiments can identify students' multiple representation skills in junior high school.

INTRODUCTION

Students consider Physics as a complex subject. Some literature found that students view physics as conceptually complicated and abstract (Morales, 2017). However, teachers are convinced that with a suitable teaching strategy, students can find that physics learning is understandable (Rahmat et al., 2023; Noor et al., 2021; Surya et al., 2022).

Previous studies found that students' experiences relating to concrete, real-life examples in physics concepts may create meaningful learning (Baran et al., 2018). Meaningful learning can involve students connecting phenomena they have encountered with scientific knowledge and also affects performance learning achievement in physics learning (Handayani et al., 2019). Creating fun learning activities that allow students to experience physics concepts with examples related to the environment surrounding them is feasible for attracting their interest in learning physics.

Local culture can be brought into the physics classroom to build a learning environment that relates to students' daily lives, making the learning process meaningful. Existing indigenous knowledge integrated into science education creates effective learning (Anthony, 2017). Students can learn from what they see, feel, and do by observing, measuring, collecting, and classifying. Besides, integrating local culture

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into school curricula has an advantage in perceiving national identity (Liliarti & Kuswanto, 2018).

In Indonesia, various local cultures have potencies to be integrated into physics learning. In a previous study, the making process of a traditional textile called Batik was brought to physics class to show the application of the thermal physics concept (Shabrina & Kuswanto, 2018). Traditional toys and games also have been used to engage Indonesian students in analytical and critical thinking during the discussion about mechanics (Maghfiroh & Kuswanto, 2022; Sari et al., 2020). Some studies also show the feasibility of using traditional dance and performance to show the mechanics concept to students (Handayani et al., 2016; Wulansari & Admoko, 2021).

In the western part of Java Island in Indonesia, the influence of Sundanese culture is dominant. The Sundanese culture can be seen through traditional musical instruments called Angklung, which most middle school students are familiar with. As a Representative List of the Intangible Cultural Heritage of Humanity, UNESCO recognized Angklung in 2010 (Hani et al., 2012). Besides, Angklung has given its identity to traditional agrarian societies, such as the Baduy tribe (Zidny & Eilks, 2022). The community usually performs a ritual with Angklung performance in the Ngaseuk ceremony to invite Dewi Sri to come to earth and give her blessings for the fertility of rice plants (Iskandar & Iskandar, 2017). The type of tone used in the ritual is pentatonic Angklung, which has five tones: *da*(1), *mi*(2), *na*(3), *ti*(4), and *la*(5) (Sudarsono & Merthayasa, 2013). Traditional musical instruments can engage students in learning sound wave concepts (Anwar et al., 2018; Haroky et al., 2020). The application of the sound concept can be seen directly on a musical instrument like Angklung.

The tremendous development of technology has influenced all aspects of life, including education. Students are more engaged in learning when recent technology is involved (Rahmat et al., 2023; Lestari et al., 2021). A striking example of this is the use of smartphones as a learning tool. No longer just a communication device, with its embedded sensors, the smartphone has evolved into a supportive instrument for physics learning. The Phyphox application, available on both Android and iOS, facilitates its use as a data acquisition tool in physics experiments (Staacks et al., 2018). Phyphox features a timer, light sensor, magnetometer, audio scope, audio spectrum, tone generator, etc. It can be used as a data acquisition tool in physics experiments (Pusch et al., 2021). It increases access to laboratory activity since not every school has complete experimental equipment, but most students have a smartphone.

However, even with technology paving the way for enhanced physics learning, many students still grapple with designing experiments and formulating hypotheses. This often stems from not understanding the demonstrations presented by the teacher because the presentations are not multi-representative. In physics learning, the representation skill is essential. Visual representations like pictures, graphs, and tables can communicate ideas in physics learning (Suyatna et al., 2017). The representation type is generally divided into verbal, graphic, picture, and mathematical (Nuha et al., 2021), and a combination of several representations is called multiple representations. Explanation teachers using multi-representative can help students develop multiple representation skills (Hwang et al., 2007). Multiple representations can encourage students to build an in-depth understanding (Riechmann et al., 2022). Besides, representations in physics learning are the structure of physics itself (Airey et al., 2017).

Using learning models in the classroom positively impacts and greatly influences student learning achievements (Huda, 2021; Priadi et al., 2021). The learning model that can teach students the basics of scientific knowledge so that students learn more independently and develop creativity in solving problems is the guided-inquiry model (Sanjaya, 2008). In physics experiments, students need guidance to solve problems. The physics experiment is more effective when using the guided-inquiry model to improve multiple representations skills (Prahani et al., 2016).

Using a guided-inquiry model, this study designed and implemented a physics experiment activity based on a local-culture context in the physics classroom. Students collaborate to analyze the frequency of pentatonic Angklung as part of local culture using Phyphox on their smartphones. This study aims to investigate frequency measurement experiments using Angklung and Phypox and their multiple representation skills.

METHOD

This study explores using pentatonic Angklung and Phypox for frequency measurement experiment activities in junior high school and students' multiple representation skills. The descriptive analysis method was used in this study. The participant of this study was 31 8th-grade junior high school in one class on science subjects studying sound materials in the second semester of the academic year 2022-2023. They consisted of 14 male and 17 female students.

In this study, students are asked to fill out a worksheet when conducting experiment activities. Then the results will be analyzed to find information related to students' multi-representation skills based on syntax or sequence of learning activities in the guided-inquiry model, as shown in Figure 1. The syntax of this study was adapted from Kuhlthau (2021) and then adapted to the design of experimental activities and the multi-representational skills to be observed.

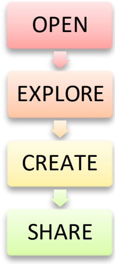


Figure 1. The Syntax of Guided-Inquiry

The guided-inquiry model used in this study consists of 4 stages. The first stage is "Open" where the teacher opens the lesson by providing orientation with an Angklung performance video and then conceptualizes the physics concepts, especially the concepts of frequency and tone. The second stage is "Explore" where students explore the pentatonic Angklung frequencies in each note. Students make experimental designs by including the observation tables. Students explore the measurements and determine what factors affect the frequency of the pentatonic Angklung. The third stage is "Create" where students process the data from the exploration results and make conclusions. The final stage is "Share" where students present their findings by presenting them in front of the class. The layout of the worksheet in this study and the mobile apps used in this study are shown in Figure 2. The worksheet also contains a procedure for using Phypox for frequency measurement experiments.

Figure 2. Worksheet Layout (Left) and Phypox Apps (Right)

RESULTS AND DISCUSSION

Integrating local culture can enrich the learning environment and relevant information between culture and physics concepts (Handayani et al., 2019). This study focuses on Angklung as a local culture from West Java. Experimental activities in this study integrate pentatonic Angklung in physics learning activities and measure the frequency using Phypox apps. Learning activities follow the syntax of the guided-inquiry model as shown in Figure 1. At each stage, there are several representations of skills that students can assess. The following is an explanation of each stage of the experimental activity according to the stage of the guided inquiry model.

First Stage: Open

At the Open stage, the teacher shows photos and videos of the Angklung performance as shown in Figure 3. The teacher explains a few of the history of Angklung which is commonly used in rice planting rituals.

Figure 3. The Teacher Shows a Video of the Angklung Performance

Then, the teacher explains the sound concept in the Angklung as shown in Figure 4. Several physics concepts can be taught to students in traditional musical instruments such as frequency and music scale instruments (Arifin & Pribadi, 2019; Sudarsono & Merthayasa, 2013).

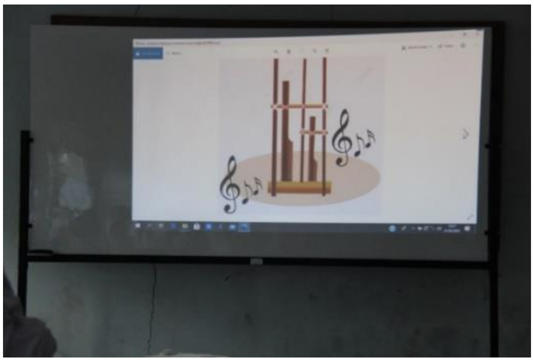


Figure 4. The Teacher Explains the Physics Concepts Contained in Angklung

After understanding the sound concept of Angklung, the teacher introduces pentatonic Angklung, which is less familiar to students because they usually use diatonic Angklung types when learning art and culture subjects. Students are asked to demonstrate how to play Angklung, as shown in Figure 5.

Figure 5. Demonstration of How to Play Pentatonic (Left) and Diatonic (right) Angklung.

Students stated that it was the first time they used the pentatonic Angklung. There are differences between diatonic and pentatonic Angklung forms as shown in Figure 5. Students are asked to discover the differences and similarities between diatonic and pentatonic angklung. The results of student representation at this stage are shown in Figure 6.

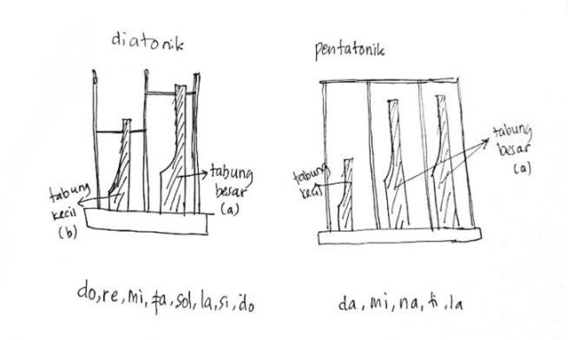


Figure 6. Pictorial and Verbal Representation

Figure 6 shows that students use picture and verbal representations at the "Open" stage. Students show the differences in diatonic and pentatonic forms of angklung using pictorial representations and the differences and similarities using verbal representations. From the representations shown, students could show that the diatonic and pentatonic Angklung have different shapes, the number of sound tubes, and the type of tone produced. They have similarities in that they both have large and small tubes. The combination of visual representation (pictorial) and verbal shows that students can understand situations and information related to human memory (Rossiter, 1976). The use of visuals and verbal is the delivery of persuasive communication, demonstrating sensory processes in understanding concepts and the need to facilitate the delivery of judgment and other cognitive processes (Bagozzi, 2008). In physics experiments, visual representations can help conceptual understanding and knowledge generation to see how science works (Evagorou et al., 2015).

Second Stage: Explore

From the results obtained at the "Open" stage, students can create experimental designs and determine what variables need to be measured to determine what factors affect the frequency of the pentatonic Angklung. The Angklung has a sound tube that can produce sound. Students identify the tube and indicate the measured variables, as shown in Figure 7.

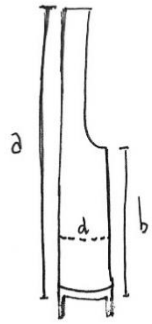


Figure 7. Design of Sound Tube Measurement

Students determine the rules for measuring the sound tube on the Angklung. Figure 7 shows that three variables are measured which are the length of a and b and the diameter of the tube. Students measure the length of the large and small tubes as shown in Figure 8.

Figure 8. The Length Measurement of the Sound Tube

One of the physics concepts related to the tone produced by the Angklung is frequency. Students follow the instructions for measuring frequency using Phypox on the worksheet. Students shake the tube near the smartphone to get accurate results (Figure 9a). The frequency measurements are carried out on big and small sound tubes. When calculating the frequency of the big sound tube, the other tube is held while the big sound tube is shaken so that the sound is heard and can be recorded by the Phypox app to determine the frequency, as shown in Figure 9b.

(a)

(b)

Figure 9. Experiment Activities (a) Shaking the Angklung; (b) Frequency measurement on Phypox

After exploring and doing frequency measurements, students make an observation table. The observation table aims to make it easier to understand the experimental results, as shown in Figure 10.

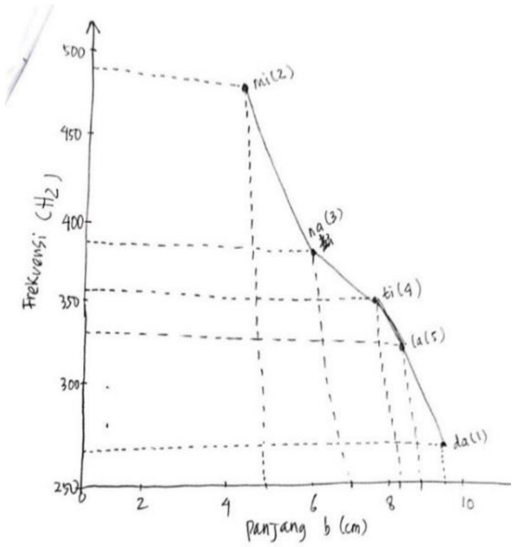
Nada	Tabung besar				Tabung kecil			
	a(cm)	b(cm)	d(cm)	f(Hz)	a(cm)	b(cm)	d(cm)	f(Hz)
da(1)	34,0	9,7	3,7	263	22,0	5,0	3,0	135
mi(2)	24,5	5,8	3,1	492	13,2	3,0	2,0	242
na(3)	26,7	7,0	3,3	396	16,0	3,4	2,4	187
ti(4)	29,7	8,2	3,5	353	18,0	4,5	2,7	168
la(5)	32,0	9,0	3,6	330	20,5	4,4	3,0	151

Figure 10. Table of Observation

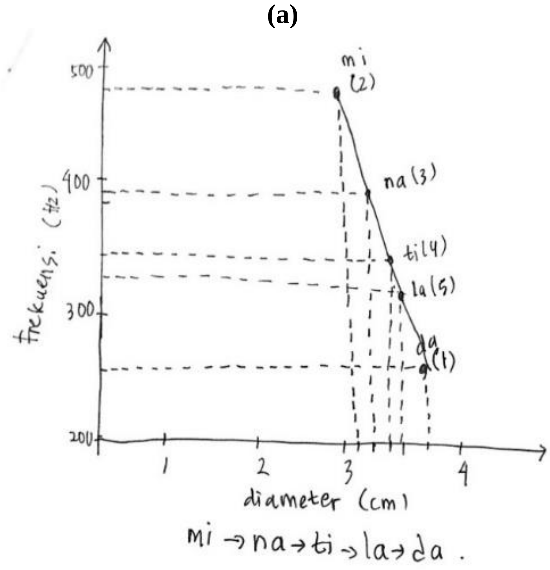
At the "Explore" stage, students use verbal, mathematical, and pictorial representations. Verbal representations explain what variables must be measured according to the experimental design. The mathematical representation is used when measuring the frequency, and the picture representation is used when determining the measurement rules for the sound tube. These three representations are important in understanding the concept of physics (Airey et al., 2017).

Three Stage: Create

After students have successfully collected data, students are asked to make conclusions on the experiments that have been carried out. Students are asked to make it in another representation to make it easier to understand. Students change the table in Figure 10 into the graph as shown in Figure 11.



(a)



(b)

Figure 11. Graphical representation (a) length and (b) diameter to the frequency of the sound tube

In this stage, students showed that they could represent tables in graphs. It can be interpreted that students have multiple representation skills. The graph depicted by the students in Figure 11 shows that the length and diameter of the sound tube have the same pattern sequence: mi(2)→na(3)→ti(4)→la(5)→da(1).

The graph can be interpreted that the frequency decreases when the length and diameter of the sound tube increase. When the sound tube length is shorter and the frequency is higher. The high or low sound produced by the bamboo tube is influenced by the length of the bamboo used for the resonance chamber in the angklung (Siswanto et al., 2012). The longer the sound tube, the higher the pitch interval or frequency range (Zainal et al., 2009). From these two graphs, it can be interpreted that the diameter and length of the sound tube affect the frequency. The results of this study are also in line with previous studies, which found that the diameter and length of bamboo affect the frequency (Nurhidayati et al., 2022).

Using a graphical representation in a physics experiment means translating a phenomenon from a graph to physical reality (McDermott et al., 1987). Graphical representations can increase students' understanding of measurement and uncertainty so that they are useful in physics experiments (Susac et al., 2017). Representing data as a graph can teach students to simulate physics which has complex concepts (Sanchez-Gonzalez et al., 2020). It can be concluded that graphical representation is very important in physics experiments to be able to determine the effect of experimental variables.

Four Stage: Share

In the last stage, students are asked to present the results of their findings based on the experiments in front of the class, as shown in Figure 12. Presenting experimental results in front of the class evaluates students' verbal representation skills.

Figure 12. Students Presenting the Result of Experiments

Verbal representation in physics learning can be written or spoken text (Opfermann et al., 2017). Learning physics in verbal and written expression has a positive impact (Meltzer, 2002). Training students to verbally convey the results of investigations can help increase self-confidence (Nadiah, 2019).

Based on the syntax of the guided-inquiry model in this study, it was found that integrating pentatonic Angklung into physics experiments can identify students' multiple representation skills. Each stage in the guided-inquiry model shows the use of different representations. During the experiment activities, it was found to have used the four representations commonly used in physics learning: verbal, mathematical, pictorial, and graphical.

CONCLUSION AND SUGGESTION

Integrating pentatonic Angklung and Phypox in the physic experiment and worksheet guides experimental activities following the syntax guided-inquiry model. The study results show that students use different representations at each stage in the worksheet. Students use four representations in this experimental activity: verbal, mathematical, pictorial, and graphical. It can be concluded that experimental activity using a guided-inquiry model can identify students' multi-representational skills in junior high school.

The limitation of the study is a small sample size and only identifies multiple representation skills from the worksheets that students work on. Future research can create instrument tests to evaluate multiple representation skills and use a pre-post-test control group design to see the effectiveness of integrating Angklung into physics experiment activities. Suggestions for further research can use another traditional musical instrument or implement Angklung with different tones like diatonic-chromatic, commonly used to play western music, and also identify students' critical and creative thinking skills using the physics experiment activity.

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AUTHOR CONTRIBUTIONS

ADR conducted a study on designing and implementing frequency measurement experiments of pentatonic Angklung in the classroom and drafted an article. HK participated in providing experimental designs and revising draft articles. IW participated in helping analyze data from frequency analysis and editing draft articles. All authors read and approved the final draft article.

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