

# Innovation in Ethno-STEM Teaching Materials: An Ethnoscience Study in Cengklungan Music

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**Abstract.** Local wisdom needs to be maintained, protected and preserved, so it does not become extinct. Therefore, scientific studies on extracting local wisdom from the community in schools are increasingly needed. There have been many previous ethnoscience studies, but there have yet to be any ethnoscience studies in the Temanggung district, Central Java, Indonesia. The purpose of this study was to identify and reconstruct the original science of the community contained in the presentation of the art of cengklungan music into scientific science in Ethno-STEM teaching materials. Data collection was carried out in Geblog Village, Kaloran District, Temanggung Regency, Indonesia. The research method used is descriptive qualitative with data collection techniques through observation and interviews. The obtained data is then analyzed, verified, reduced, and reconstructed into scientific science. The results showed that there were several studies of ethnoscience in the presentation of the art of cengklungan music on the material of vibration, waves, and sound. Three main elements in the presentation of the art of cengklungan music are vocals, instruments, and dance. The ethnoscience study is integrated into Ethno-STEM-based teaching material.

**Key words:** Ethnoscience; Cengklungan; Waves and sound; STEM

**How to Cite:** Trisnowati, E., Wiyanto, W., Subali, B., Sulhadi, S., Arifah, T. (2022). Innovation in Ethno-STEM Teaching Materials: An Ethnoscience Study in Cengklungan Music. *ISSET: International Conference on Science, Education and Technology* (2022), 286-291.

## INTRODUCTION

Students spend more time in their neighbourhood than in the school environment, so they know the rules, behaviours, and traditions in their community (Sudarmin, 2014). Culture is a heritage passed down between generations in a group, develops through habit, and has a characteristic in the form of indigenous knowledge of the community (Siregar, 2002), which will become the basic knowledge of students to develop scientific knowledge (Nureflia et al., 2018). It shows that local wisdom is one of the supporters of declining environmental efforts. Local wisdom needs to be maintained, protected and preserved, so it does not become extinct (Kasa, 2011). It is increasingly necessary to conduct scientific studies about extracting indigenous knowledge from the community in schools, known as ethnoscience.

Ethnoscience is obtained by specific methods, which are traditions/cultures and can be empirically justified (Sudarmin, 2014). There are 3 (three) fields of study in ethnoscience research, namely: (1) ethnoscience, which emphasizes research on culture in society in the form of norms and values both prohibited and not prohibited, (2) ethnoscience on cultural situations/social phenomena faced by society and how to organize

it using the knowledge possessed by the community, (3) ethnoscience in a culture that is influencing daily behaviour and can gather people (Sudarmin, 2014). Local wisdom can be used in learning or education (Arfianawati et al., 2016). The purpose of ethnoscience-based learning is to make students more familiar with facts in society that are associated with scientific science material (Septiaahmad et al., 2020). There have been many previous ethnoscience studies (Ariningtyas et al., 2017; Hadi & Ahied, 2017; Ilhami et al., 2020; Najib, 2018). However, there has been no ethnoscience study in the Temanggung district, Central Java, Indonesia.

The cengklungan music is the typical musical art of the Temanggung Regency, precisely from Krajan Hamlet, Geblog Village, Kaloran District. This art is the only cengklungan music art that a group of Paguyuban Podho Rukun still preserves. The art of cengklungan is less popular among the public, so the younger generation does not know and know about cengklungan music, which is the original art of Temanggung Regency, Central Java, Indonesia. Vibration, waves, and sound are included in the subject matter of Junior High School Natural Sciences. In the presentation of the art of cengklungan music, there is actual community knowledge that is reconstructed into scientific knowledge. This research aims to identify and rebuild the original science of society

in presenting the art of cengklungan music into scientific science on vibration, waves, and sound. The results of the analysis of the distribution of articles in the 2015-2020 period related to ethnoscience in learning provide recommendations for future research trends in the Scopus database, namely chemistry learning and Ethno-STEM, and in the Google Scholar database, namely booklet development and worksheets (Erma, 2021). Based on the problems mentioned above, an ethnoscience study of cengklungan music was conducted as study material for ethno-STEM-based teaching materials.

## METHODS

This research was in Geblog Village, Kaloran District, Temanggung Regency. This type of research is descriptive qualitative research. The study focused on presenting the art of cengklungan music associated with science—sources of data used in the form of primary data and secondary data.

Primary data collection is done through observation and interviews, which aim to make direct observations of the object. The results of the observations were informational data about the art of cengklungan music, both from musical

instruments and dance movements. At the same time, in-depth interviews were conducted directly with the head of the Podho Rukun Paguyuban, Geblog Village, Kaloran District, Temanggung Regency. Secondary data were obtained from literature studies of cengklungan music art articles and sources related to vibrations, waves, and sounds.

In this study, the researcher is the main instrument for collecting data based on the knowledge of the community as much as possible to verify, reconstruct, formulate and conceptualize it into scientific knowledge. After the primary and secondary data verification process is complete, the next step is to link the scientific studies in Cengklungan art with efforts to foster the value of local wisdom and student character. The next step is to analyze the study material in STEM elements.

## RESULTS AND DISCUSSION

The presentation of the art of cengklungan music contains ethnoscience studies related to science subject matter, namely vibrations, waves, and sounds. The explanation of science in the presentation of the art of cengklungan music is shown in Table 1.

**Table 1.** Explanation Science of Cengklungan Music

No	Community original knowledge	Scientific Science
1	The dance movements of female dancers in the art of cengklungan music describe agricultural and rhythmic activities to make them look beautiful.	There is a regular back-and-forth movement through the equilibrium point in the hand movements of female dancers in the art of cengklungan music, which reflects the concept of vibration in everyday life.
2	The male dancer whips a whip to the ground as a sign that the baritan ceremony will soon begin, followed by the presentation of the art of cengklungan music.	When the whip is whipped to the ground, it will produce vibrations that propagate and carry energy called waves. The types of waves that occur are mechanical waves (rope waves and sound waves) which in their propagation require a medium, and transverse waves (on ropes), whose propagation direction is perpendicular to the direction of vibration.
3	There are four types of cengklung as a cengklungan musical instrument: cengklung 1, cengklung 2, cengklung bass, and cengklung drum, with their respective constituents to produce a beautiful sound.	Four types of cengklung as instruments of cengklungan music have their respective constituent components. Cengklung 1, 2, and bass have almost the same constituent components, namely the kenthongan and the strings stretching above it, while the difference is the type of string and the length. It causes a difference in the pitch of the sound produced. The tone is influenced by the size of the frequency of the strings. In contrast, the frequency of the strings is controlled by the strings' length, tension, and surface area, compared to the case with cengklung kendang, where the components of the kenthongan and guitar strings are replaced with three bamboo blades that produce a drum-like sound.

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| <p>4 Sinden and Wiraswara sing poems using microphones so that people go to the location of the cengklungan music performance.</p> | <p>When Sinden and Wiraswara sing the poems, a sound-hearing mechanism occurs. Sound is a mechanical wave which requires a medium for its propagation. The requirements for sound to be heard are the presence of a sound source, medium, and sound receiver. At the time of the incident, the source of the sound was the voices of Sinden and wiraswara, who were assisted by a microphone to make it sound more transparent and louder, the medium was air, and the receivers were the ears of listeners and spectators of cengklungan music.</p> |
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There are three main elements in the presentation of the art of cengklungan music: vocals, instruments, and dance. The vocal elements are played by three Sinden (female singers) and three wiraswara (male singers) in unison. Each song performed by Sinden and wiraswara has its meaning, including thanksgiving, agricultural activities, harmony, and the identity of the origin of cengklungan music.

The instrument element consists of 4 types of cengklung and a flute played by the niyaga (music players). The use of the krudhuk umbrella on the cengklung instrument makes this musical art unique. There are four krudhuk umbrellas used, each played by one niyaga. Along with the times, the use of grinting grass or palm fibre was replaced by guitar strings stretched on the kenthongan in the middle of the krudhuk umbrella. Four types of cengklung instruments in cengklungan music consist of cengklung 1, cengklung 2, cengklung bass, which has a function similar to a gong, and cengklung drum, which has a role similar to a drum. The components that make up the three types of cengklung instruments are almost identical. The difference is the size of the kenthongan and the kind of guitar strings used.

The dance element consists of 2 female

dancers and one male dancer. The dancers describe agricultural activities by imitating farmers' movements in the fields. The movements in the dance as the identity of the cengklungan music. The costumes used by the female dancers are a green kebaya which symbolizes Javanese cultural identity and agriculture. In contrast, the costumes used by the male dancers are Black clothes, Batik striations on the waist, Caping on the head and accessories in the form of whips.

There are several ethnoscience studies on the presentation of the art of cengklungan music, namely as follows.

#### 1. Movement of female dancers in cengklungan music

The dance movements of female dancers and male dancers are different. The male dancers imitate the actions of farmers hoeing, herding buffalo, and returning buffalo. In contrast, the dance movements of female dancers imitate the movements of farmers who are planting rice, weeding rice, and driving away birds. The actions of the hands, body and feet in the dance must be in harmony and balance to produce beautiful and rhythmic movements. This dance has a back-and-forth movement through a fulcrum/equilibrium point. The dance movements are shown in Figure 1.



**Figure 1.** Hand movements to the left (A), middle (O), and right (B)

In Figure 1, it can be seen that there are three kinds of movements performed by female dancers, namely, moving their hands from the middle (O) to the right (B) and the left (A). An object can be said to vibrate if it moves back and forth regularly through the equilibrium point. The picture above illustrates the vibration concept that we find in everyday life.

2. The male dancer whipping a whip to the ground

One of the functions of cengklungan music is communication in society, namely through song



**Figure 2.** Boy dancer



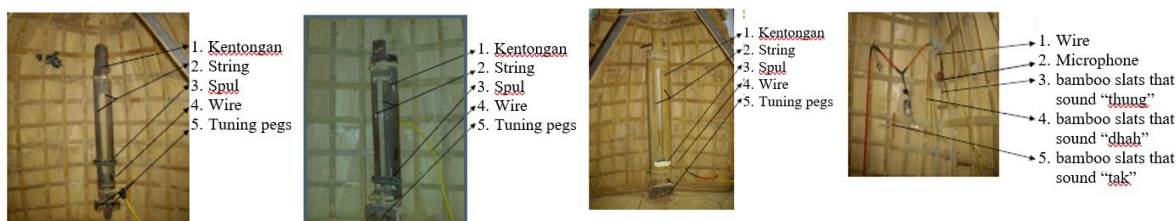
**Figure 3.** Illustration of a male dancer whipping a whip to the ground

In the illustration in Figure 3 it can be seen that if a whip is whipped to the ground, it will produce vibrations that propagate and carry energy called waves.

3. The components of the cengklung musical instrument

By the name cengklungan, the main musical instrument used in this musical art is the cengklung in the form of a krudhuk umbrella as a

protective tool for shepherds in ancient times from rain or heat during the day. There are four types of cengklung used as musical instruments, namely cengklung 1, cengklung 2, cengklung bass, which has a function similar to a gong, and cengklung drum, which has a role similar to a drum. The pictures of the four types of cengklung are shown in Figure 4.



**Figure 4.** Four types of cengklung instruments

Based on Figure 4 show that each type of cengklung has its constituent components. The components of cengklung 1, 2, and bass are almost the same. The difference is the size of the kenthongan and the type of guitar strings used. Kenthongan was used as a means of communication between residents in ancient times. There are differences in the components of the cengklung drum from the three previous types of cengklung, namely the absence of kenthongan and guitar strings but replaced with three bamboo blades. The four types of cengklung instruments

produce different sounds because there are differences in a tone which are regular vibration frequencies. The tone in the strings is affected by the size of the frequency of the strings. The frequency of the strings is affected by the strings' length, the strings' tension, and the surface area of the strings, as mathematically formulated as follows. 
$$f = \frac{1}{2L} \sqrt{\frac{F}{\rho A}}$$

Where  $f$  is the frequency of the string,  $L$  is the length of the string,  $F$  is the tension of the string,  $\rho$  is the density of the string, and  $A$  is the surface

area of the string.

- The length of the string is inversely proportional to the frequency of the sound. The longer the string, the lower the sound frequency, so the pitch of the sound will also be lower. In the cengklung instrument, the strings stretch over the kenthongan so that the length of the string is equal to the size of the kenthongan. Respectively, the length of kenthongan on cengklung 1, 2, and bass is 45 cm (small diameter), 35 cm (large diameter), and 45 cm (large diameter). Cengklung 2 has the shortest string length than the other cengklung, so the sound frequency is the highest, which causes the highest pitch of the sound to be produced.
- String tension is proportional to the frequency of the sound. The greater the string tension, the higher the sound frequency, so the sound produced will also be higher. In cengklung 2, which has a shorter string length, will make a higher sound frequency so that the string tension is also greater.
- The type and surface area of the strings are inversely proportional to the frequency of the sound. The greater the density and surface area of the strings, the lower the sound frequency so that the resulting tone will be lower. In cengklung bass uses a type of bass guitar string with a larger surface area than other cengklung so that the frequency is low, which causes the tone of the sound produced is also low.

#### 4. The Sinden and wiraswara singing poems

The vocal elements in cengklungan music are played by three Sinden (female singers) and three wiraswara (male singers). The Sinden wear kebaya costumes that characterize Javanese culture, while the wiraswara wear costumes in the form of a black shirt, black trousers, and a batik-patterned headband as a symbol of the identity of the buffalo herders and farmers in the fields. They sing using microphones so that their voices can be heard more clearly by the public because the art of cengklungan music is usually displayed outside the room and in the field so that people can immediately go to the location of the performance. In this event, there is a sound-hearing mechanism so that the audience can hear the songs sung by Sinden. Sound is a mechanical wave which requires a medium for its propagation. There are three requirements for sound to be heard by humans, namely the sound source, the medium, and the sound receiver (Giancoli, 2001).

Ethnoscience can be integrated into teaching materials. The ethnoscience aspect of teaching materials for vibration material is explained by the hand movements of female dancers in rhythmic cengklungan music. If studied in scientific science reflects the concept of vibration, which is a regular back-and-forth movement through an equilibrium point. It is supported by the opinion of Nureflia et al. (2018), who states that the development of students' scientific knowledge comes from the actual knowledge of the community. In addition, Arfianawati et al. (2016) revealed that local culture can be used in learning or education. In the lesson, a video is also shown about the movement of female dancers in the art of cengklungan music so that students can understand the vibration material even if they do not watch the cengklungan music art performance directly. It follows Putri & Kusairi (2021) statement, which states that with the help of science learning videos, students can more easily understand the concepts being studied.

The scientific aspect is integrated into the activities in the teaching materials through simple experiments. One of them is a simple experiment of vibration on a ruler and pendulum that can stimulate students to scientifically explain the phenomenon of vibration. It is supported by the research of Sudarno et al. (2015), which states that students' understanding can reach if the material is associated with their environment.

Technological aspects are integrated into evaluation questions, one of which is about the seismograph, an instrument for measuring the strength of an earthquake. Students are asked to explain how a seismograph works. It requires students to be able to explain the phenomenon of how a seismograph works scientifically related to vibration. Students look for information from textbooks or the internet so that they can find out the answers. It is supported by the opinion of Puspaningtyas & Suparno (2017), which states that in guided inquiry, there is a process of questioning existing phenomena and seeking answers.

Engineering aspects are integrated into teaching materials by asking students to design simple experiments on vibrations on a ruler and pendulum. The teacher guides the form of questions that direct students to conduct their investigations. It is in line with the results of research by Tati et al. (2017), which states that engineering aspects are integrated by designing how to give students practice in integrating

STEM fields in solving problems.

## CONCLUSION

The study of ethnoscience in presenting the art of cengklungan music can be used as a source of learning for students. Teachers are expected to be able to connect the community's original science with scientific science concepts, so that science learning is expected to be more meaningful. Further research suggests exploring the actual science of the community in other cultures in Temanggung Regency to be constructed into scientific science to be used as a learning resource for students in Natural Science subjects.

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