Journal of Turkish Science Education, 2024, *21*(3), 410-429.
DOI no: 10.36681/tused.2024.022

Exploration of science concepts in Indonesian indigenous culture: actualization of the Indonesian curriculum

Nadi Suprapto[1], Iqbal Ainur Rizki[2], Hanandita Veda Saphira[3], Yusril Alfarizy[4], Shafna Nor Jannah[5]

[1]*Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia, Corresponding author, nadisuprapto@unesa.ac.id, ORCID ID: 0000-0002-8990-7412*
[2]*Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia, ORCID ID: 0000-0001-8618-5592*
[3]*Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia, ORCID ID: 0000-0002-3609-952X*
[4]*Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia, ORCID ID: 0000-0001-5530-5096*
[5]*Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia, ORCID ID: 0000-0002-5704-1490*

ABSTRACT
Ojhung is one of the indigenous Indonesian cultures from Sumenep Regency which contains relevant science concepts to be applied in science learning. Therefore, this research aimed to identify and explore the concepts of science contained in the Ojhung tradition while evaluating their relevance to the *Merdeka* or national curriculum. This research uses a qualitative design with a grounded theory based on scientific concepts in the Ojhung tradition and can be applied in science learning. The concepts of science that have been successfully explored and identified are Newton's Third Law, Sound Waves, Sense of Hearing, Pressure, Flexibility, Body Muscles, Moments of Inertia, and Skin Wounds. All concepts that have been explored can actualise learning outcomes in the Merdeka Curriculum. This research implies applying science concepts to Ojhung to improve public scientific literacy and science learning in schools.

RESEARCH ARTICLE

ARTICLE INFORMATION
Received: 17.04.2023
Accepted: 25.03.2024

KEYWORDS:
Ojhung, science concepts, merdeka curriculum.

To cite this article: Suprapto, N., Rizki, I. A., Saphira, H. V., Alfarizy, Y., & Jannah, S. N. (2024). Exploration of science concepts in Indonesian indigenous culture: actualization of the Indonesian curriculum. *Journal of Turkish Science Education, 21*(3), 410-429. DOI no: 10.36681/tused.2024.022

Introduction

Culture and tradition are familiar words to hear because they have many meanings for people who still maintain and preserve the culture and traditions found in each region (Mackie, 2018; Smith et al., 2020; Suarta et al., 2022). Indonesia is a country that has quite a variety of ethnic groups, each of which has its own characteristics that we can find in each region, especially the culture characteristic of each region in Indonesia (Fatmawati, 2021). One area in Indonesia with many indigenous cultures is the Sumenep Regency (Humaidy & Ariwidodo, 2020; Ridwan, 2018) located at the eastern end of Madura Island and which has a variety of indigenous cultures that vary within the region (Qodariyah & Wahed, 2019). The people of Sumenep generally tend to uphold cultural values, making this area

rich in art and culture that is still maintained and preserved by the local community. One aspect of the indigenous cultures still being preserved is *Ojhung* (Raditya, 2022).

Ojhung is the art of fighting by hitting and fending off opponents using rattan (*Lapalo*) and led by a referee (Pradana et al., 2019). Initially, the *Ojhung* tradition was carried out as a ritual or traditional ceremony to conjure up rain. However, over the course of time, the *Ojhung* tradition is staged in entertainment events and community games, for example, at village celebrations, earth almsgiving, and *nadzar* [a solem promise] events. In its development, this tradition underwent several changes in roles, *bhabhutoh* [referee], staging arenas, and staging equipment (Abbas, 2017). *Ojhung* is a rain-summoning tradition with a spell called *Bato' Peter*. The phrase *bato' peter* consists of the word *bato',* which means 'cough' and the word *peter,* which means 'lightning' (Maknuna et al., 2013).

However, believing in a myth sometimes negatively impacts mental health (Nie & Olson, 2016) and can form a negative mindset (Kishore et al., 2011). The *Ojhung* tradition has the potential to act as a source of scientific concepts that can be explored to explain societal myths and superstitions. This can certainly improve the science literacy skills of the community and school learners if applied in learning because it integrates knowledge with daily life. In previous research by Said-Ador (2017), the learning process which refers to the context of pupil life including cultural heritage (local wisdom) can act as a conduit for understanding chemistry or physics topics, developing aspects of attitudes and skills, and conducting scientific investigations based on natural laboratories that can improve cognitive, affective and psychomotor learning outcomes. Exploring science concepts in *Ojhung's* local wisdom has the potential to change the mindset of society and pupils through science learning.

In Indonesia, science is included as one of the subjects in the '*Merdeka*' (=Independent for all levels) Curriculum, especially at the secondary levels (Phases D, E, and F). Science learning in this curriculum emphasises the aspects of meaningful and everyday life and their learning outcomes (Wiyarsi et al., 2023). The science concepts contained in *Ojhung* certainly have the potential to actualise the *Merdeka* Curriculum in science learning because they are related to pupils' daily lives. Combining indigenous science with scientific knowledge in learning can improve student learning outcomes (Khusniati et al., 2023; Sumarni et al., 2016). This integrated approach enriches the curriculum by providing diverse perspectives and real-world applications. Consequently, students gain a deeper understanding and appreciation of scientific concepts, leading to enhanced academic performance (Abah et al., 2015; Chinn, 2015; Zidny et al., 2020).

This research identified and explored the concepts of science contained in the *Ojhung* tradition while analysing their relevance to the *Merdeka* Curriculum. The following research questions guided this study:

1) How is the *Ojhung* tradition described practically?
2) How are science concepts reconstructed from the *Ojhung* tradition?
3) What is the relevance of these concepts in *Ojhung* to the *Merdeka* Curriculum in science learning?

The concepts of science contained in the tradition will increase the science literacy of the community and reduce belief in myths and superstitions. This research can also help actualise the *Merdeka* Curriculum because it has relevant content and context. It provides rich contexts for science learning and links it with more comprehensive worldviews required for advancing sustainability (E.-J. A. Kim et al., 2017; E.-J. A. Kim & Dionne, 2014).

Literature Review

Exploration Study of Science Concepts in Local Wisdom

Exploratory research on science concepts has been widely researched, for example, the exploration of science concepts and science process skills on Balinese local wisdom (Suarmika et al., 2020), exploration of physics concepts in traditional *Kolecer* (Sholahuddin & Admoko, 2021), exploration of chemical concepts in Sasak and Javanese local wisdom (Sutrisno et al., 2020;

Wahyudiati & Qurniati, 2023), and the concept of utilising forest resources in *Ngata Toro* local wisdom (Yuliana et al., 2017). The traditional concepts are categorised under the headings of Ethnoscience, Ethnophysics, Ethnochemistry, or Ethnobiology, which can be applied to learning (Silvini et al., 2020; Suprapto et al., 2021).

Exploratory research tests the reliability of research instruments and their suitability for subsequent research (Lee & Shim, 2007). The main objective of exploratory research is to generate inductively derived generalisations regarding the group, process, activity or situation under study (Stebbins, 2001). Subsequently, the researcher weaves these generalisations into the basic theory explaining the study's object. The ultimate goal of exploratory research is to formulate new hypotheses for follow-up research, or at least to provide a basis for determining and formulating more specific research problems (Kothari & Garg, 2019). The end result of exploratory research is a hypothesis or the beginning of a new theory (Casula et al., 2021). Since a problem has not been formulated and a hypothesis does not yet exist, the number of samples taken in exploratory research is not very important (Kusewitt Jr., 1985); however, it is important that they are representative.

Ojhung Tradition

The *Ojhung* tradition is the art of fighting, hitting and fending off opponents using rattan and guided by a referee (Pradana et al., 2019). This tradition was born and developed in Sumenep Regency, especially in Bunbarat Village. This tradition contains a magical element because it is a traditional ceremony or ritual to conjure up rain (Abbas, 2017). The *Ojhung* tradition is carried out in a series of earth alms traditions and is believed by the community to protect them from all forms of calamities that can threaten the village.

Currently, there is very little research on the *Ojhung* tradition. This is evidenced by the search for the keyword "*Ojhung*" on the Scopus web which yields 0 document results. Nonetheless, some local references, as examples of research by Pradana et al. (2019), reveal that this tradition can be used as sports tourism because it is attractive and contains sportsmanship. Other research by Supiani (2016) describes the actualisation of the values implicit in the *Ojhung* tradition in primary school pupils. Therefore, this exploratory research becomes a necessary creativity and has still not been carried out by previous studies.

Merdeka Curriculum

In responding to the changes that continue to occur and increasing the quality of Indonesian human resources in a better direction than the education sector, the Indonesian government has enacted a new policy known as independent learning in the *Merdeka* Curriculum (De Vega & Nur, 2022; Maipita et al., 2021; Purwanti, 2021). The concept of a *Merdeka* learning curriculum emphasises the provision of freedom in the field of education. In this case, the teacher is a facilitator for pupils in providing learning because the learning process is supposedly student-centred (Abdigapbarova & Zhiyenbayeva, 2022). The essence of independent learning in the *Merdeka* Curriculum is the freedom to think individually and in groups to produce critical, creative, collaborative, innovative and participatory among learners (Jainah et al., 2022). The learning outcomes emphasised in this curriculum are related to everyday life (Solikhah, 2022), so the science concepts contained in the *Ojhung* tradition can have a role in actualising learning in the *Merdeka* Curriculum. Previous research also recommended adopting indigenous knowledge in science education (Zidny et al., 2020).

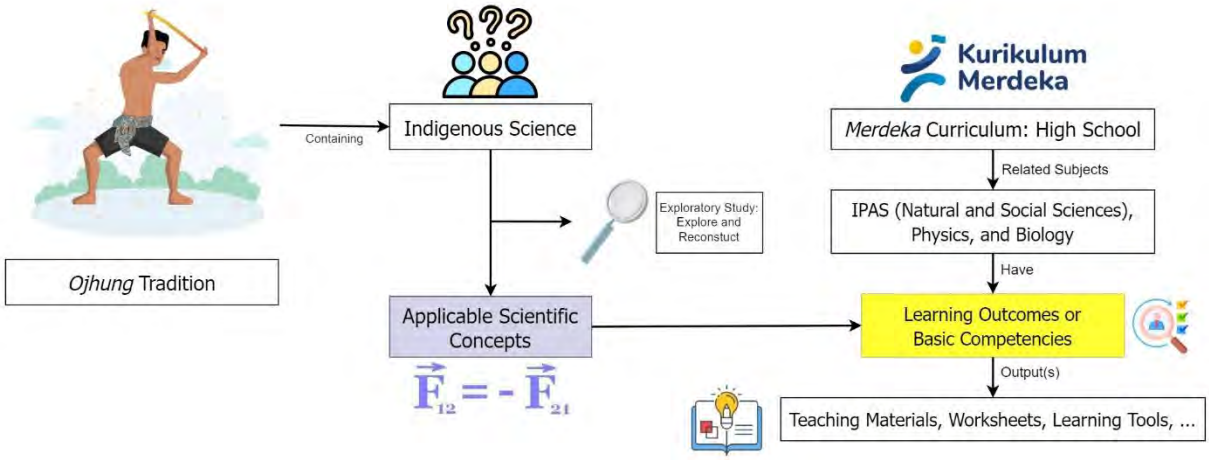
Research Framework

Definitely, the *Ojhung* tradition harbours numerous scientific concepts that often remain unrecognised, leading to their categorisation as indigenous science. This concept elucidates the intertwining of scientific knowledge with cultural norms and values, which serve as the bedrock for

societal structures and progress. Typically conveyed orally and steeped in experiential wisdom and symbolism, indigenous science encounters limitations in dissemination through contemporary models due to the fundamental differences in epistemology, communication methods, and the reliance on context-specific knowledge that is often difficult to translate into the written or digital formats favored by modern scientific discourse (Sumarni et al., 2016). This socially constructed reservoir of living knowledge can serve as an alternative educational resource if it undergoes codification, reinterpretation and elevation to the status of scientific knowledge (Sumarni et al., 2022). Exploratory research offers a pathway to unravel and reconstruct indigenous science into formalised knowledge applicable to educational curricula. Through this investigative process, researchers can uncover science concepts ripe for integration into educational frameworks.

All education units in Indonesia are currently transitioning from the 2013 Curriculum (K-13) to the *Merdeka* Curriculum based on the ministry decree number 008/H/KR/2022. One of the differences between these two curriculum types is the intended competencies. In K-13, basic competencies are expressed as points and sorted to achieve core competencies evaluated annually. Meanwhile, in the *Merdeka* Curriculum, learning outcomes are compiled in each phase and expressed in paragraph form, providing a more holistic and narrative-driven approach to student progress. This method allows for a more comprehensive understanding of student development, capturing the nuances of learning that go beyond standardised metrics and offering educators a richer, more detailed framework to assess and support student growth over time (Munandar et al., 2021). In relation to the *Ojhung* tradition, the most relevant subjects are IPAS (natural and social sciences), Physics and Biology. The real actualisation of the concepts of science contained in the *Ojhung* tradition can be applied as teaching materials or worksheets for learners. So far, traditions in Indonesia that have been reconstructed from the original science and implemented in teaching materials, such as *Karapan Sapi* tradition-based worksheets (Fauzi et al., 2022), *Hombo Batu*-themed with mobile learning (Saputra & Kuswanto, 2018), augmented reality of the *Ketapel* local wisdom (Rahmasari & Kuswanto, 2023). In addition, some of the learning outcomes in the *Merdeka* Curriculum are more directed to material related to everyday life so that the concepts of science in *Ojhung* will make it easier for teachers and pupils in learning. The research framework is witnessed in Figure 1.

Figure 1
Research framework



Method

General Background

This research uses qualitative design (Safdar et al., 2021), with data analysis techniques in the form of descriptive qualitative without testing a hypothesis. Qualitative research focuses on data collection, analysis and writing (Yin, 2011). The type of qualitative research is grounded theory (Kandasamy et al., 2017; Redman-MacLaren & Mills, 2015), which is a qualitative research method that uses a systematic set of procedures to develop an inductive theory for a phenomenon. This method starts from a statement that is still vague and eventually produces a theory collected from various data. The resulting theory is based on scientific concepts in the *Ojhung* tradition and can be applied in science learning.

Data Collection

Data collection techniques in this study involved indirect observation (Anguera et al., 2018) and document studies (Sommerhoff et al., 2018). Indirect observations come from observations of documentation and videos of the implementation of *Ojhung*'s local wisdom obtained from Youtube and other digital platforms. The indicators of scientific concepts to be explored such as the concept of physics (mechanics, dynamics and thermodynamics), the concept of biology (touch systems, the concept of enzymes and anatomy of the human body), and the concept of biochemistry (chemical compounds residing in the body). Literature studies of this study use journal sources, empirical research that has been carried out, and books. The documentation study was carried out to synthesise relevant indicators of science learning in accordance with the *Merdeka* Curriculum. Focus Group Discussions (FGDs) involving two science education experts and one professional science teacher aimed to discuss, validate, confirm and reconstruct science concepts on the *Ojhung* tradition and its linkages to the *Merdeka* curriculum. The FGD was conducted for about 60 minutes using the Indonesian language.

Data Analysis

The data analysis technique used in this study is a qualitative descriptive analysis. Activities in qualitative data analysis are referred to the Miles and Huberman model (Miles et al., 2014), which includes four stages (Suliyanah et al., 2021), namely: collection of data from various reliable sources to obtain the necessary information that supports the ability of research objectives; data reduction is carried out to sort out important things that focus on the needs of the author in order to facilitate the collection of the desired data in accordance with the objectives of the study; data presentation generally in the form of short descriptions, charts, relationships between subjects, and so on; and conclusion and verification.

Trustworthiness

In qualitative research, the term trustworthiness is used in place of terms including internal and external validity, dependability and objectivity (Kosasih et al., 2022; Suprapto & Ku, 2022). Trustworthiness consists of credibility, dependability, confirmability and transferability (Peterson, 2019). The credibility and dependability of the data were reflected in the data collection instruments referring to the relevant literature. The credibility of the data is achieved by triangulating the data to reduce research bias through documentation, literature studies, and FGD. Documentation studies are carried out through relevant documents as well as the results of documentation of researchers who have seen the *Ojhung* tradition before. Meanwhile, the FGD also helped the researcher confirm and develop the exploratory results based on suggestions with experts and practitioners. In terms of

dependability, researchers have recorded the entire process of data and research results. Confirmability in this study was carried out by collecting data by all team members, then a critical discussion with experts and practitioners was carried out with various perceptions so that the data could be more trusted. Finally, the transferability of this research has been set up by researchers in a complete, in-depth, detailed manner involving experts as well as analysing the relationship in aspects of science learning in the *Merdeka* Curriculum so that users can apply the results of exploring science concepts in learning.

Result and Discussion

Practical Overview of the Ojhung Tradition

It was observed that the *Ojhung* game generally started at 3:00 p.m. after *ashar* prayers. In this game, people aged 17 to 50 are allowed to compete in the *Ojhung* tradition. Usually, the players choose their dueling opponents behind the arena. If an agreement occurs, they must register with the organizers of the *Ojhung* event.

Ojhung game arenas are generally found in rinks measuring 10 x 10 m. The equipment used in the *Ojhung* game tradition, as well as functioning as a weapon, is a rattan stick used as a punching tool called *a lapalo* or *kol-pokol*. Rattan wood is flexible and sturdy The rattan has a length of 1 metre, which is the characteristic of. In addition, players use head protection (*bhungkus* or *bhuko*) and left arm pads (*bulen* or *tangkes*). The game is arranged by a referee who, by the local people, is called *bhubhuto*. In its implementation, the performance was accompanied by the *Okol* orchestra, whose musical equipment consisted of traditional East Javanese musical instruments in the form of *ghambang* and *dhuk-dhuk*.

Ojhung's performance art is the same as other fighting arts involving two fighters with a referee. The main goal of the *Ojhung* players is to try to hit the opponent's back. The referee will declare one of the winners after successfully injuring the opponent's back or knocking down the opponent's *lapalo.* If the attack hits the head, the area of the outer arm and the lower part of the body, then the attack is not considered successful. In specific matches, the referee has the right to stop matches that he thinks are one-sided.

The player who gets the most points during the three rounds becomes the winner. Players can also be disqualified directly during the game if they attack by going more than three steps, or if the rattan slips from the grip and hits more than once in a round. There are five referees: four people are player supervisors, and one person is the determinant of the game (main judges). Family, sportsmanship, and togetherness are the main values that have always been upheld in the *Ojhung* game.

Results of Exploration of Science Concepts in Ojhung

After exploration and FGD, several scientific concepts in the *Ojhung* tradition have been identified: Newton's Third Law, sound waves, sense of hearing, pressure, flexibility and body muscles, and kinetic energy. The results of the exploration can be comprised in Table 1.

Table 1

Results of Exploration of Science Concepts in Ojhung

Science Concepts	Explanation	References in the Literature	Figure
Newton's Third Law	One player gives the whip a boost to attack another player, and then the player gives the force to resist the attack from the first player, as seen in Figure 2.	The force of two bodies on each other is always equal in magnitude and in the opposite direction (Göbel et al., 2021)	Figure 2 *A player attacks an opponent in Ojhung*  *Source: Youtube Wirawiri Promotion*
Sound Waves and Sense of Hearing	The accompaniment sound of traditional musical instruments, such as the *okol* orchestra, as seen in Figure 3, whose musical equipment consists of *ghambang* and *dhuk-dhuk* made from a wooden plate that vibrates from being hit. If those instrumentals are played, it causes sound interference that is pleasant to hear.	Previously, the concept of sound waves in gamelan has been studied for sound waves, fast propagation of sounds, resonance and vibration and the sense of hearing (Wardani, 2021).	Figure 3 *Okol orchestra*  *Source: Youtube Aural Archipelagio*
Pressure	Pressure will be applied when the first player hits the second player using a *lapalo* (Figure 4). If the force of the blow given to the rattan by the first player is greater, then the pressure generated also increases.	The concept of pressure is the same as the distribution of force over the area of a surface. Thus, if the force exerted on an object is greater, the pressure generated will be even greater (Serway & Jewett, 2014).	Figure 4 *A player presses his opponent*  *Source: Direktorat Warisan dan Diplomasi Budaya*
Flexibility	*Ojhung*'s tradition of using *lapalo* as a weapon to whip opponents because of its flexibility and strength. The *lapalo* flexibility and strength in hitting the opponent are affected by the cross-sectional area of the *lapalo* itself. Additionally, this flexibility also has a relationship with the elasticity properties of the materials used (Figure 5).	The content of cellulose and lignin is closely related to the strength of rattan. Therefore, the high concentration of cellulose content increases the rattan Modulus of Rupture (Gu & Zhang, 2020).	Figure 5 *The rattan flexibility used by players*  *Source: Youtube Wirawiri Promotion*

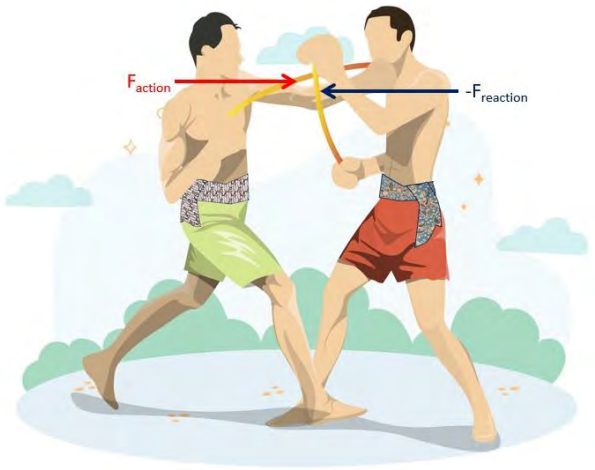
Science Concepts	Explanation	References in the Literature	Figure
Body Muscles and Inertia Moment	In the game, players must prepare their stances before attacking and dismissing the opponent's attack (Figure 6). Stances strengthen mass in a standing position, and due to their greater mass, the torso and pelvis have stronger moments of inertia during rotation.	When the pelvis and torso have more mass, these body parts, while the rotation has a greater moment of inertia (Choppin et al., 2021).	Figure 6 *Ojhung players do the stance*  *Source: Youtube Wirawiri Promotion*
Kinetic Energy	In *Ojhung*, players must whip the opponent using *lapalo,* which requires energy because it is affected by the speed of the player's lash (Figure 7), causing injury if it hits the skin.	When work is done on an object by applying a net force, the object speeds up and gains kinetic energy (Halliday et al., 2014).	Figure 7 *Ojhung players get whipped*  *Source: Youtube Wirawiri Promotion*

Newton's Third Law, Pressure, Flexibility and Elasticity in Lapalo

Newton's third Law states that for every action, there is always an equal and opposite reaction. The forces of two bodies on each other are always equal in magnitude and the opposite direction (Göbel et al., 2021; Landell-mills, 2021; Zuza et al., 2018). For example, during the match, the first player gave *Lapalo* a boost to attack the second player. While the second player provides a force to withstand the attack of the first player. This is one example of the application of Newton's Third Law to the game *Ojhung*. If the force vector is depicted in the *Ojhung* activity, as shown in Figure 8.

Figure 8

Vector illustration of Newton's 3rd Law



The vector direction from the first player towards the left is a given action force, in the form of a push against the second player's whip. Then, the second player generates a reaction force that an arrow toward the opposite action force by the first player depicts. To indicate that the reaction force is always opposite to the action force, the reaction force is always written using a negative or minus sign. The equations applicable to Newton's third law in general and as an integration of reaction action forces in the *Ojhung* game are written in Eq. 1 (Aquino et al., 2018).

$$F_{action} = -F_{reaction} \quad \ldots (1)$$

The equipment used in the game that simultaneously serves as a weapon and a punching tool is a rattan stick. The tool by the local people is called *lapalo* or *kol-pokol*. The concept of applied pressure is the spread of force on the area of an object's surface (Elandt et al., 2019; Halliday et al., 2014). If the force exerted on the rattan by the first player is greater, the pressure also generated increases. The force and the pressure are directly proportional. So, when the first player hits the second with a high force, he will feel pain. It is also influenced by the cross-sectional area of the object used to exert pressure, in this case, it is rattan. The size of the rattan affects the pressure generated. The greater the cross-sectional area, the smaller the pressure. Conversely, if the cross-sectional area is smaller, the pressure is greater. The equation of this concept is written in Eq. 2.

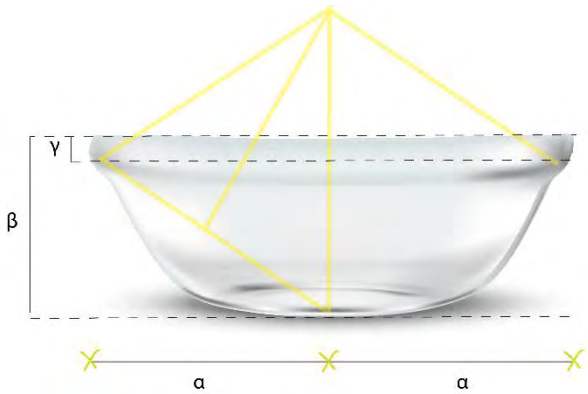
$$P = \frac{F}{A} \quad \ldots (2)$$

P is pressure, F is the force, and A is the cross-sectional area. Thus, from this equation, it can be seen that the relationship between pressure and cross-sectional area is inversely proportional, while the relationship between force and pressure is directly proportional (Serway & Jewett, 2014).

In general, rattan rods are composed of cellulose (39–58%), lignin (18–27%), and starch (8–15%) (Zuraida et al., 2017). Rattan's strength is closely correlated with its cellulose and lignin levels. The high proportion of cellulose increases rattan's Modulus of Rupture (MOR). The high lignin content makes the strong connection between rattan strands possible. Rattan is flexible anatomically because it contains protoxylem. Rattan and bamboo bend more easily if they have more parenchymal cells and larger cavities of the metaxylem and phloem (Dwianto et al., 2020).

Figure 9

Rattan cross-sectional geometry



The rattan's flexibility and strength in hitting the opponent are influenced by the rattan's cross-sectional area, as seen in Figure 9. The cross-sectional area is equal to the sum of the cross-

sectional areas of the rectangle and the area of the circle's segments. The sector area of a circle less the area of a triangle, can also be used to represent the segment area of a circle. As a result, Eq. 3 may be used to compute the cross-sectional area (S) in mm², where α is half the rattan's width (mm); β is the rattan's overall thickness (mm); and γ is the thickness of the rattan piece's rectangular cross-section (mm) (Gu & Zhang, 2020).

$$S = \alpha(\beta + \gamma) + \frac{\pi\left(90 - arc\frac{\alpha}{\beta - \gamma}\right)[\alpha^2 + (\beta - \gamma)^2]}{360\cos^2 arc\frac{\alpha}{\beta - \gamma}} - \frac{\alpha\sqrt{\alpha^2 + (\beta - \gamma)^2}}{2\cos arc\frac{\alpha}{\beta - \gamma}} \quad \ldots (3)$$

Meanwhile, elasticity is a material property that enables changes in both size and shape when subjected to an external force, but the material returns to its original size and shape once the external force is removed, provided that the applied force is smaller than the elastic limit (Halliday et al., 2014). *Lapalo* players exert an external force by whipping it at other players. Research indicates that rattan used as *lapalo* has a good modulus of elasticity, with a range of 130.2 to 2830.7 N/mm² (Olorunnisola et al., 2005). This concept of elasticity can be further explained by teachers, for example, by demonstrating the use of rattan to teach elasticity in materials. This will help pupils understand the practical applications of elasticity and flexibility in everyday life.

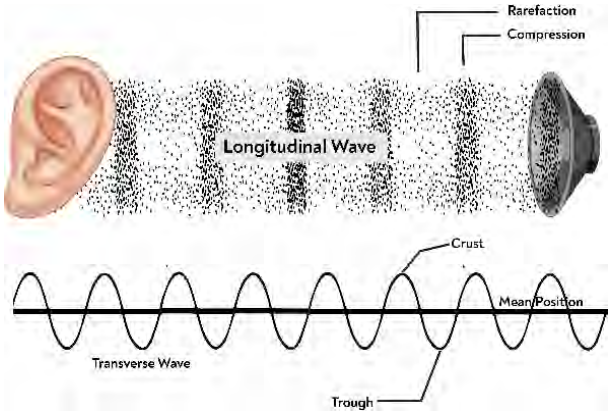
Sound Waves and Sense of Hearing in Okol

During *Ojhung* activities, the host enlivens the show as a game commentator. East Javanese accompaniment music also adorns the *Ojhung* playing arena, including the *gamelan*. *Gamelan* is a traditional Javanese musical instrument made of metal or bronze, with a set of instruments played together (Astuti & Wulandari, 2023). The sound waves produced by the gamelan come from vibrating strings (*siter, rebab*), vibrating air columns (*gender*), and vibrating wooden plates (*ghambang*) (Prasetya, 2012). If those instrumentals are played, it causes sound interference that is pleasant to hear. Previously, the concept of sound waves in *gamelan* has been studied for sound waves, fast propagation of sounds, resonance as well as vibration and sense of hearing (Wardani, 2021).

To become a sound itself, it must meet three aspects: vibrating source (sound generator), conducting media, and receiving media (eardrum). These three aspects must be fulfilled so that sounds/sounds can be created. A sound can be produced from vibrations of objects that can produce sounds, ranging from falling objects and musical instruments to vibrations from human vocal cords (Sterling et al., 2018). The vibration will change the pressure on the medium (compression and rarefaction), as illustrated in Figure 10.

Figure 10

Illustration of vibrations from the sound system to the receiving media



In this cycle of pressure changes, it will create a pattern called a sound wave. So, a sound wave is a series (cycle) of pressure changes moving through the medium. The medium can be in the form of a liquid, a solid substance, or in the form of a gas. Sound waves can propagate in water or air (Nassi et al., 2020).

Sound waves consist of air molecules that vibrate and then propagate in all directions. The molecules will be crowded in some places, so they can produce regions that can produce high pressure, but in other places, stretch, they can produce regions with low pressure. High-pressure and low-pressure waves alternately pass through the air and disperse from the source of the sound. This wave conducts sound to the human ear, the sound wave is a longitudinal wave (Karaoglu, 2020; Vincze & Vincze-Tiszay, 2021; Volfson et al., 2022; Zohuri, 2019). In general, the formulation of the theory of the rapid propagation of sound waves is written in Eq. 4.

$$v = \frac{s}{t} \quad \dots (4)$$

In Eq. 4, v is the velocity of the sound wave, s is the distance, and t is time. Then, the resonance of the sound will also appear due to vibration from the sound systems. Sound resonance is the event of vibrating an object due to vibrations produced by the sound source. Sound resonance can only occur if an object has a natural frequency equal to the natural frequency of the vibrating sound source (Caicedo-Lopez et al., 2020; Nunes et al., 2021). In addition to objects, the medium around the sound source can also resonate as long as it has the same natural frequency as the natural frequency of the sound source.

Gamelan can produce sound because it obtains mechanical energy from the outside. The tweeter can direct the energy outward. After getting energy from the outside, there is a process of displacement and change of energy in gamelan. The mechanical energy from the blow given by the whistleblower will be stored for a moment in the gamelan and immediately converted into vibration energy that produces sound. There are many types of gamelans. The difference between *gamelan pelog* and *sendro* is in the fundamental frequency of each note and interval. *Gamelan slendro* has a tone range high enough to give the impression of a happy, carefree, light, and crowded atmosphere (Purnomo et al., 2022). In addition, the *gamelan pelog* has a high tone range to give a gallant, grandiose, sacred and sacral effect (Cahyadi & Mutiarasari, 2021). In *ojhung*, the gamelan instruments used include a *gamelan pelog* that aims to give the impression of a fierce fight. Pitch intervals are measured using cent measures based on logarithmic calculations since the perception of the human auditory system to tonal frequencies is logarithmic (Klapuri, 2003). Cent measures are a logarithmic unit of measure used for musical intervals, specifically to compare the size of pitches or the difference between two frequencies. In the context of tuning and music theory, one cent is 1/100th of a semitone, making it a useful standard for precise tuning adjustments and the analysis of musical intervals. The measuring value of cent units is formulated through the following comparative calculation in Eq. 5.

$$int = \log\frac{f_{n+1}}{f_n} x \frac{1200}{log2} \quad \dots (5)$$

Note:

f_{n+1} = fundamental frequency of (n + 1) tones

f_n = fundamental frequency of n-th tone of comparison

The Number $\frac{1200}{log2}$ is the multiplier factor for converting measurement results into cents. The number 1200 cents is equivalent to *log 2*, that is, the logarithm of the frequency comparison of one octave (Prasetya, 2012).

Sound waves enter the outer ear and pass through the ear canal, a small opening that connects to the eardrum. Incoming sound waves cause the eardrum to vibrate, and these vibrations are then sent to the three tiny bones (*maleus*, *inkus* and *stapes)* in the middle ear (Singh et al., 2022; Thresa et al., 2019). The cochlea, a fluid-filled snail-shaped structure in the inner ear, receives sound waves amplified or enhanced by the bone in the middle ear. Between the cochlea's beginning and end, an

elastic barrier divides it into upper and lower portions. The main auditory structure is located on the ground floor, which is why this partition is known as the basilar membrane.

A running wave develops along the basilar membrane as soon as the vibration causes the fluid inside the cochlea to tremble. On the basilar membrane, the sensory cells, known as hair cells, ride the waves. The wide end of the cochlea, which resembles a snail, has hair cells that can pick up high-pitched noises like a baby crying. Near the centre, people heard low-pitched noises, such as a big dog barking. As the hair cells move up and down, microscopic hair-like projections (known as stereocilia) perched above the hair cells crash into the structures above them and bend. Bending causes the pore-like channel, which is at the end of the stereocilia, to open. When that happens, chemicals enter the cell, creating an electrical signal. The auditory nerve carries these electrical signals to the brain, converting them into sounds we recognize and understand (T. Kim & Park, 2020; Sonmez & Varol, 2020; Warwick, 2020).

Muscles and Moment of Inertia in Stance Movements

In the *Ojhung* game, the players must prepare their stances before attacking and dismissing the opponent's attack, as seen in Figure 11. Stances can strengthen standing positions when attacking or punching opponents (Triaiditya et al., 2018). The attacker lowers his centre of gravity while extending his stance, lunging toward his opponent and sticking his punch arm forward, executing a punch in the opponent's exposed and unattended abdomen. Participants must relax to maintain their stance and balance (Venkatraman & Nasiriavanaki, 2019).

Figure 11

Players who use stance on Ojhung

A double increase in punch speed will takes twice as much energy to make it happen in the first place. Punching is studied as a kinetic link principle in which the movement of the joint occurs sequentially. The kinetic link principle is the idea that body parts work together in a chain during movement. It means starting with movement in the center of the body and then moving outward to create smooth and efficient motion, helping to perform better and avoid injuries. The next distal joint's peak speed exceeds the previous proximal joint. Due to their greater mass, the torso and pelvis have stronger moments of inertia during rotation (Hellström, 2009). The larger muscles linked to this joint contract during movement and peak in angular velocity before the following segment. After attaining their maximum contraction, these muscles relax and transmit it to the following distal section. The muscles involved in a fist punch to understand the role of the main individual muscles in a blow. It

was found that the gastrocnemius is the first muscle activated during a blow due to moving the body forward with *plantarflexion* [the movement of pointing our toes downward, away from our shin]. Rectus femoris and biceps femoris are activated subsequently to extend the knee and hip. This is followed by the trapezius, deltoid, and biceps brachii muscles to flex the elbow immediately, followed by an elbow extension performed by the brachial triceps and a radial *carpi flexor* in the forearm to execute the blow (Leung et al., 2015). Like *Ojhung*, players must provide high speed to provide a powerful lash so that the kinetic energy is also high.

Kinetic Energy Causing Skin Wound

Simply, kinetic energy is the energy of an object that is affected by its motion, meaning that objects that move must have and be able to impart energy. When a player whips a *lapalo* at an opponent, it means that the moving *lapalo* has kinetic energy because it has two components: mass and acceleration, which are the basis of the kinetic energy equation (Serway & Jewett, 2014).

$$K = \frac{1}{2} \times m \times v^2 \quad \ldots (6)$$

The greater the kinetic energy delivered to the opponent, the greater the frictional force between the lapalo and the skin. Friction can occur when a player hits the *Lapalo* with a rough surface against the skin with a smooth surface. The more uneven the surface of the object, the greater the friction force and vice versa (Taylor, 2022). The size of the friction force is what causes the skin to become inflamed or bruised when hit by a *Lapalo*. In other words, players lashed out from the opponent's *Lapalo* will certainly get deformations on their skin in the form of injuries. The skin is our body's first line of defence against the external environment and acts as the primary and essential physical interface. After the *Ojhung* player's body is injured, the wound will undergo a healing process that goes through four processes: haemostatic, inflammatory, proliferative, and remodelling (Yang et al., 2022).

The Relevance of Science Concepts in *Ojhung* with the *Merdeka* Curriculum

The relevance of the concept of science in *Ojhung* to a *Merdeka* curriculum can be seen in Table 2 as quoted from the Decree of the Board of Education Standards, Curriculum, and Assessment, Ministry of Education, Culture, Research, and Technology Number 008/H/KR/2022 concerning Learning Outcomes in Early Childhood Education, Primary and Secondary Education Levels in the *Merdeka* Curriculum (Kementerian Pendidikan Kebudayaan Riset dan Teknologi, 2022). This relevance was also formulated based on the results of FGDs with experts and practitioners.

Table 2

The relevance of the science concepts in Ojhung to the Merdeka curriculum

Subject	Learning Outcomes According to the *Merdeka* Curriculum	Science Concept in *Ojhung*
IPAS (Natural and Social Sciences)	Learners can identify the organisational system of living beings and outline the relationship between organ systems and their functions and abnormalities or disorders that appear in certain organ systems (digestive, circulatory, respiratory, and reproductive systems).	Sense of Hearing in *Okol*, Muscles in Stance Movements, Skin Wound after Being Lashed by Lapalo
	Learners can describe and measure a variety of motions and forces, understand the relationship between the concepts of effort and energy, measure the amount of temperature caused by the heat energy given, as well as can distinguish between insulators and heat conductors.	Newton's Third Law and Pressure in *Lapalo*, Kinetic Energy, Heat

Subject	Learning Outcomes According to the *Merdeka* Curriculum	Science Concept in *Ojhung*
	Learners understand motion, force and pressure, including simple machines. They understand vibrations and waves, reflection and refraction of light, and simple optical tools often used in everyday life.	Newton's Third Law and Pressure in *Lapalo,* Sound waves in *Okol,* light
Physics	Learnerss can apply the concepts and principles of vectors, kinematics and dynamics of motion, fluids, symptoms of sound waves and light waves in solving problems, as well as applying the principles and concepts of heat and thermodynamics with their various changes in heat machines.	Newton's Third Law, Pressure, and Flexibility and Elasticity in *Lapalo*; Moment of Inertia in Stance Movements, Sound Waves in *Okol,* and Kinetic Energy
Biology	Learners can describe the relationship between organ structures in organ systems and their functions and abnormalities or disorders that arise in those organ systems; understand the function of enzymes.	Sense of Hearing

Conclusion and Implications

The *Ojhung* tradition presents scientific concepts including Newton's Third Law, sound waves, sense of hearing, pressure, flexibility, body muscles, moments of inertia, and skin wounds. Newton's Third Law on *Ojhung* is when the player gives the whip a boost to attack the other player, then gives the force to resist the attack from the first player. Sound waves and the sense of hearing are invoked by the accompaniment sound of traditional musical instruments, such as the *okol* orchestra, whose musical equipment consists of *ghambang* and *dhuk-dhuk*, is successfully heard by people around it. This is because it utilises the principle of sound waves that propagate in air. The concept of pressure is invoked by a *lapalo* stroke influenced by force and cross-sectional area. Flexibility relates to the *lapalo* strength in hitting the opponent being affected by the cross-sectional area of the *lapalo* itself. The concept of body muscles and moments of inertia is when players perform stance movements that can strengthen muscles and moments of inertia to attack opponents. The concept of skin wounds and their healing occurs when the affected skin is lashed *lapalo*. All concepts that have been explored can actualise learning outcomes in the *Merdeka* Curriculum.

The limitation of this study is that it relies on indirect observation. Subsequent research should use field data through observation and interviews of *Ojhung* players directly, providing a more holistic and contextual insight into Ojhung culture. This research implies applying science concepts to *Ojhung* to improve people's science literacy. The results of this study can also actualise the *Merdeka* Curriculum because the concept of science in *Ojhung* is relevant to learning outcomes that emphasise everyday life. As a recommendation of this study, future researchers can develop learning instruments, such as teaching modules, teaching materials, worksheets and learning media, which internalize science concepts in the *Ojhung* tradition, improving pupils' understanding of local traditions and motivate them towards preserving this culture. Indigenous knowledge has contributed greatly to the development of modern science and technology, providing insights and practices that have been integrated into various fields. Moreover, indigenous knowledge can function as a learning stimulant to motivate and help learners construct a knowledge framework by offering unique perspectives and methodologies. This culturally rich knowledge base encourages critical thinking, creativity, and a deeper understanding of the natural world, fostering a more inclusive and holistic approach to education. By incorporating indigenous knowledge into the learning process, educators can create a more engaging and relevant curriculum that resonates with diverse student backgrounds and experiences.

Ethical Considerations

Two research committees have reviewed the study and approved it. Researchers have obtained approval from the owner of a YouTube channel, who uploaded a video of *the Ojhung* tradition for exploratory research. The photo of player *Ojhung* in this article is also kept anonymous to maintain his privacy. The participants involved in the FGD had declared their willingness to voluntarily participate in this study. By having their spoken consent declaration, the authors were able to get their voluntary informed consent. The procedures were carried out in accordance with applicable guidelines and regulations.

Acknowledgements

We gratefully acknowledge the Faculty of Mathematics and Natural Sciences of Universitas Negeri Surabaya for their generous funding support through *Penelitian Kebijakan Mahasiswa* 2022 contract number B/42538/LT.02.05/UN38.3/2022.

References

Abah, J., Mashebe, P., & Denuga, D. D. (2015). Prospect of integrating African indigenous knowledge systems into the teaching of sciences in Africa. *American Journal of Educational Research*, *3*(6), 668–673. https://doi.org/10.12691/education-3-6-1

Abbas, A. (2017). Kesenian ojhung dalam tradisi sedekah bumi di desa bunbarat kecamatan rubaru kabupaten sumenep. *Avatara: E-Jurnal Pendidikan Sejarah*, *5*(1), 83.

Abdigapbarova, U., & Zhiyenbayeva, N. (2022). Organization of student-centered learning within the professional training of a future teacher in a digital environment. *Education and Information Technologies*. https://doi.org/10.1007/s10639-022-11159-5

Anguera, M. T., Portell, M., Chacón-Moscoso, S., & Sanduvete-Chaves, S. (2018). Indirect observation in everyday contexts: concepts and methodological guidelines within a mixed methods framework. *Frontiers in Psychology*, *9*, 1–20. https://doi.org/10.3389/fpsyg.2018.00013

Aquino, J. G., Caliguid, M. P., Buan, A. T., Magsayod, J. R., & Lahoylahoy, M. E. (2018). Teaching Newton's 3rd law of motion using learning by design approach. *AIP Conference Proceedings*, *1923*. https://doi.org/10.1063/1.5019566

Astuti, L. D., & Wulandari, W. T. (2023). Pengaruh Gaya Pukul terhadap Bunyi Gong Suwukan Laboratorium Fisika FMIPA UNY. *Kohesi: Jurnal Sains Dan Teknologi*, *1*(8), 81–90. https://doi.org/10.3785/kohesi.v1i8.909

Cahyadi, O., & Mutiarasari, K. (2021). Penciptaan karya komposisi penataan gamelan pelog - salendro untuk aransemen musik sekolah. *Jurnal Pendidikan Tari*, *1*(2), 62–75.

Caicedo-Lopez, L. H., Contreras-Medina, L. M., Guevara-Gonzalez, R. G., Perez-Matzumoto, A. E., & Ruiz-Rueda, A. (2020). Effects of hydric stress on vibrational frequency patterns of Capsicum annuum plants. *Plant Signaling and Behavior*, *15*(7). https://doi.org/10.1080/15592324.2020.1770489

Casula, M., Rangarajan, N., & Shields, P. (2021). The potential of working hypotheses for deductive exploratory research. *Quality & Quantity*, *55*(5), 1703–1725. https://doi.org/10.1007/s11135-020-01072-9

Chinn, P. W. U. (2015). Place and culture-based professional development: cross-hybrid learning and the construction of ecological mindfulness. *Cultural Studies of Science Education*, *10*(1), 121–134. https://doi.org/10.1007/s11422-014-9585-0

Choppin, S., Clarkson, S., Bullas, A., Thelwell, M., Heller, B., & Wheat, J. (2021). Anatomical and principal axes are not aligned in the torso: Considerations for users of geometric modelling methods. *Journal of Biomechanics*, *114*, 110151. https://doi.org/10.1016/j.jbiomech.2020.110151

De Vega, N., & Nur, S. (2022). University Students' exchange perceive of kampus merdeka curriculum. *Proceedings of the 1st World Conference on Social and Humanities Research*, *654*, 157–161. https://doi.org/10.2991/assehr.k.220402.034

Dwianto, W., Damayanti, R., Darmawan, T., Sejati, P. S., Akbar, F., Adi, D. S., Bahanawan, A., Amin, Y., & Triwibowo, D. (2020). Bending strength of lignocellulosic materials in softening condition. *Indonesian Journal of Forestry Research*, *7*(1), 59–70. https://doi.org/10.20886/ijfr.2020.7.1.59-70

Elandt, R., Drumwright, E., Sherman, M., & Ruina, A. (2019). A pressure field model for fast, robust approximation of net contact force and moment between nominally rigid objects. *IEEE International Conference on Intelligent Robots and Systems*, *May*, 8238–8245. https://doi.org/10.1109/IROS40897.2019.8968548

Fatmawati, E. (2021). Strategies to grow a proud attitude towards Indonesian cultural diversity. *Linguistics and Culture Review*, *5*(S1), 810–820. https://doi.org/10.21744/lingcure.v5nS1.1465

Fauzi, A., Putra, P. D. A., & Ahmad, N. (2022). The Influence of Karapan Sapi Local Wisdom-Based LKPD on Critical Thinking Skills and Student Learning Outcomes. *ScienceEdu*, *5*(1), 8–11. https://doi.org/10.19184/se.v5i1.29252

Göbel, B., Mertig, I., & Tretiakov, O. A. (2021). Beyond skyrmions: Review and perspectives of alternative magnetic quasiparticles. *Physics Reports*, *895*, 1–28. https://doi.org/10.1016/j.physrep.2020.10.001

Gu, Y., & Zhang, J. (2020). Tensile Properties of Natural and Synthetic Rattan Strips Used as Furniture Woven Materials. In *Forests* (Vol. 11, Issue 12, p. 1299). https://doi.org/10.3390/f11121299

Halliday, D., Walker, J., & Resnick, R. (2014). *Fundamental of Physics* (10th ed.). John Wiley.

Hellström, J. (2009). Competitive Elite Golf. *Sports Medicine*, *39*(9), 723–741. https://doi.org/10.2165/11315200-000000000-00000

Humaidy, M. A. Al, & Ariwidodo, E. (2020). The Symbolic Interaction of Tandhe' in Sumenep Madurese. *Karsa: Journal of Social and Islamic Culture*, *28*(1), 172–191. https://doi.org/10.19105/karsa.v27i1.1584

Jainah, Z. O., Riza, M., Muhida, R., Prastyo, Y. D., & Seftiniara, I. N. (2022). Enhancing Hard Skill and Soft Skill Learning by Implementing the MBKM Program. *Nusantara: Jurnal Pendidikan Indonesia*, *2*(1), 165–180. https://doi.org/10.14421/njpi.2022.v2i1-10

Kandasamy, S., Vanstone, M., Oremus, M., Hill, T., Wahi, G., Wilson, J., Davis, A. D., Jacobs, R., Anglin, R., & Anand, S. S. (2017). Elder women's perceptions around optimal perinatal health: a constructivist grounded-theory study with an Indigenous community in southern Ontario. *CMAJ Open*, *5*(2), E411 LP-E416. https://doi.org/10.9778/cmajo.20160077

Karaoglu, B. (2020). Wave Optics. In *Classical Physics*. https://doi.org/10.1007/978-3-030-38456-2_23

Kementerian Pendidikan Kebudayaan Riset dan Teknologi. (2022). *Capaian Pembelajaran Pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah Pada Kurikulum Merdeka*. Badan Standar, Kurikulum, dan Asesmen Pendidikan.

Khusniati, M., Heriyanti, A.P., Aryani, N.P., Fariz, T.R. & Harjunowibowo, D. (2023). Indigenous science constructs based on Troso woven fabric local wisdom: a study in ethnoscience and ethnoecology. *Journal of Turkish Science Education, 20*(3), 549-566.

Kim, E.-J. A., Asghar, A., & Jordan, S. (2017). A Critical Review of Traditional Ecological Knowledge (TEK) in Science Education. *Canadian Journal of Science, Mathematics and Technology Education*, *17*(4), 258–270. https://doi.org/10.1080/14926156.2017.1380866

Kim, E.-J. A., & Dionne, L. (2014). Traditional Ecological Knowledge in Science Education and Its Integration in Grades 7 and 8 Canadian Science Curriculum Documents. *Canadian Journal of Science, Mathematics and Technology Education*, *14*(4), 311–329. https://doi.org/10.1080/14926156.2014.970906

Kim, T., & Park, S. (2020). Equivalent Data Information of Sensory and Motor Signals in the Human Body. *IEEE Access*, *8*, 69661–69670. https://doi.org/10.1109/ACCESS.2020.2986511

Kishore, J., Gupta, A., Jiloha, R. C., & Bantman, P. (2011). Myths, beliefs and perceptions about mental disorders and health-seeking behavior in Delhi, India. *Indian Journal of Psychiatry*, *53*(4), 324–329. https://doi.org/10.4103/0019-5545.91906

Klapuri, A. P. (2003). Multiple fundamental frequency estimation based on harmonicity and spectral smoothness. *IEEE Transactions on Speech and Audio Processing*, *11*(6), 804–816. https://doi.org/10.1109/TSA.2003.815516

Kosasih, A., Supriyadi, T., Firmansyah, M. I., & Rahminawati, N. (2022). Higher-Order Thinking Skills in Primary School: Teachers' Perceptions of Islamic Education. *Journal of Ethnic and Cultural Studies*, *9*(1), 56–76. https://doi.org/10.29333/ejecs/994

Kothari, C. R., & Garg, G. (2019). *Research Methodology : Methods And Techniques*. New Age International Publisher.

Kusewitt Jr., J. B. (1985). An exploratory study of strategic acquisition factors relating to performance. *Strategic Management Journal*, *6*(2), 151–169. https://doi.org/https://doi.org/10.1002/smj.4250060205

Landell-mills, N. (2021). *How insects fly according to Newtonian physics , including bees and butterflies*. *December*. https://doi.org/10.13140/RG.2.2.13994.98247

Lee, C.-P., & Shim, J. P. (2007). An exploratory study of radio frequency identification (RFID) adoption in the healthcare industry. *European Journal of Information Systems*, *16*(6), 712–724. https://doi.org/10.1057/palgrave.ejis.3000716

Leung, D. G., Carrino, J. A., Wagner, K. R., & Jacobs, M. A. (2015). Whole-body magnetic resonance imaging evaluation of facioscapulohumeral muscular dystrophy. *Muscle & Nerve*, *52*(4), 512–520. https://doi.org/https://doi.org/10.1002/mus.24569

Mackie, J. (2018). Business success among Southeast Asian Chinese: the role of culture, values, and social structures. In *Market cultures* (pp. 129–144). Routledge.

Maipita, I., Dalimunthe, M. B., & Sagala, G. H. (2021). The Development Structure of the Merdeka Belajar Curriculum in the Industrial Revolution Era. *Proceedings of the International Conference on Strategic Issues of Economics, Business and, Education*, *163*(ICoSIEBE 2020), 145–151. https://doi.org/10.2991/aebmr.k.210220.026

Maknuna, L. L., Mustamar, S., & Ningsih, S. (2013). Mantra dalam Tradisi Pemanggil Hujan di Situbondo: Kajian Struktur, Formula, dan Fungsi. *Publika Budaya*, *1*(1), 1–15.

Miles, M. B., Huberman, A. M., & Saldana, J. (2014). Qualitative data anaylsis: A methods soucebook. Thousand Oaks, California: Sage Publications, Inc.

Munandar, A., Hardi, O. S., & Dwi Sukanti, L. (2021). The Differences in Learning Activities by Using "RPP Merdeka"and "RPP K-13" for Elementary School Teachers in Jakarta. *Proceedings of the International Conference on Educational Sciences and Teacher Profession (ICETeP 2020)*, 68–72. https://doi.org/10.2991/assehr.k.210227.011

Nassi, B., Pirutin, Y., Shamir, A., Elovici, Y., & Zadov, B. (2020). Lamphone: Real-Time Passive Sound Recovery from Light Bulb Vibrations. *Cryptology*, 1–15.

Nie, F., & Olson, D. V. A. (2016). Demonic Influence: The Negative Mental Health Effects of Belief in Demons. *Journal for the Scientific Study of Religion*, *55*(3), 498–515. https://doi.org/https://doi.org/10.1111/jssr.12287

Nunes, C. E. P., Nevard, L., Montealegre-Z, F., & Vallejo-Marín, M. (2021). Variation in the natural frequency of stamens in six morphologically diverse, buzz-pollinated, heterantherous Solanum taxa and its relationship to bee vibrations. *Botanical Journal of the Linnean Society*, *197*(4), 541–553. https://doi.org/10.1093/botlinnean/boab044

Olorunnisola, Pitman, & Mansfield-William. (2005). Strength properties and potential uses of rattan–cement composites. *Journal of Bamboo and Rattan*, *4*(4), 343–352. https://doi.org/10.1163/156915905775008426

Peterson, J. S. (2019). Presenting a Qualitative Study: A Reviewer's Perspective. *Gifted Child Quarterly*, *63*(3), 147–158. https://doi.org/10.1177/0016986219844789

Pradana, F. G. A., Hidayat, N., Juniarisca, D. L., & Imron, A. (2019). The Potential of "Ojhung" Tradition Art as Sports Tourism in Sumenep District. *Social Sciences, Humanities and Education Conference (SoSHEC 2019)*, 222–224.

Prasetya, H. B. (2012). *Fisika Bunyi Gamelan: Laras, Tuning, dan Spektrum*. BP ISI Yogyakarta.

Purnomo, A. E., Yanuartuti, S., Mariasa, I. N., & Yermiandhoko, Y. (2022). Laras Slendro In Traditional Music Gamelan Banyuwangi Changes. *Jurnal Seni Musik*, *11*(2), 210–218. https://doi.org/10.15294/jsm.v11i2.63113

Purwanti, E. (2021). Preparing the Implementation of Merdeka Belajar – Kampus Merdeka Policy in Higher Education Institutions. *Proceedings of the 4th International Conference on Sustainable Innovation 2020–Social, Humanity, and Education*, *518*(ICoSIHESS 2020), 384–391. https://doi.org/10.2991/assehr.k.210120.149

Qodariyah, L., & Wahed, S. (2019). Local Wisdom Based Tourism in Sharia Tourism Perpective (Tourism Concept Study of Sumenep Regency Madura). *Proceedings of the International Conference on Social Science 2019 (ICSS 2019)*, 557–561. https://doi.org/https://doi.org/10.2991/icss-19.2019.130

Raditya, A. (2022). Ojhung di Atas Bukit: Budaya Magis Orang Madura Utara. *GHANCARAN: Jurnal Pendidikan Bahasa Dan Sastra Indonesia*, *4*(1), 1–20. https://doi.org/10.19105/ghancaran.v4i1.6099

Rahmasari, A., & Kuswanto, H. (2023). The effectiveness of Problem-Based Learning physics pocketbook integrating Augmented Reality with the local wisdom of catapults in improving mathematical and graphical representation abilities. *Journal of Technology and Science Education*, *13*(3), 886. https://doi.org/10.3926/jotse.1962

Redman-MacLaren, M., & Mills, J. (2015). Transformational Grounded Theory: Theory, Voice, and Action. *International Journal of Qualitative Methods*, *14*(3), 1–12. https://doi.org/10.1177/160940691501400301

Ridwan, M. (2018). Learning of Local Environmental Wisdom in Oral Literature of Madurese Traditional Song in Sumenep. *Journal of Innovative Studies on Character and Education* , *2*(1), 93–103.

Safdar, M. R., Akram, M., Sher, F., & Rahman, A. (2021). Socioeconomic Determinants of Caste-based Endogamy: A Qualitative Study. *Journal of Ethnic and Cultural Studies*, *8*(2), 39–54. https://doi.org/10.29333/ejecs/697

Said-Ador, N. K. (2017). Ethnochemistry of maguindanaons' on the usage of household chemicals: Implications to chemistry education. *Journal of Social Sciences (COES&RJ-JSS)*, *6*(2S), 8–26. https://doi.org/10.25255/jss.2017.6.2S.8.26

Saputra, M. R. D., & Kuswanto, H. (2018). Development of Physics Mobile (Android) Learning Themed Indonesian Culture Hombo Batu on the Topic of Newton's Law and Parabolic Motion for Class X SMA/MA. *Journal of Physics: Conference Series*, *1097*(1), 12023. https://doi.org/10.1088/1742-6596/1097/1/012023

Serway, R. A., & Jewett, J. W. (2014). *Physics for Scientists and Engineers with Modern Physics* (Ninth Edit). Brooks/Cole Cengage Learning. https://doi.org/10.5860/choice.34-3910

Sholahuddin, M. I., & Admoko, S. (2021). Exploration of Physics Concepts Based on Local Wisdom Kolecer Traditional Games. *PENDIPA Journal of Science Education*, *5*(1), 70–78. https://doi.org/10.33369/pendipa.5.1.70-78

Silvini, Y., Derlina, & Ginting, E. M. (2020). Application of Concept Physics in the Aceh Culture. *Journal of Physics: Conference Series*, *1485*(1), 12048. https://doi.org/10.1088/1742-6596/1485/1/012048

Singh, S., Arif, R. H., & Ethawi, Y. (2022). *Pathogenesis and Etiology of Hearing Loss in Children*. *August*, 1–32. https://doi.org/10.20944/preprints202208.0277.v1

Smith, C., Burke, H., & Ward, G. K. (2020). Globalisation and indigenous peoples: threat or empowerment? In *Indigenous cultures in an interconnected world* (pp. xviii–24). Routledge.

Solikhah, I. (2022). Revisiting the EFL curriculum in the outcome-based education framework and freedom to learn program. *Journal of Social Studies Education Research*, *13*(2), 243–264.

Sommerhoff, D., Szameitat, A., Vogel, F., Chernikova, O., Loderer, K., & Fischer, F. (2018). What Do We Teach When We Teach the Learning Sciences? A Document Analysis of 75 Graduate Programs. *Journal of the Learning Sciences*, *27*(2), 319–351. https://doi.org/10.1080/10508406.2018.1440353

Sonmez, Y. U., & Varol, A. (2020). In-Depth Analysis of Speech Production, Auditory System, Emotion Theories and Emotion Recognition. *8th International Symposium on Digital Forensics and Security, ISDFS 2020*, 6–13. https://doi.org/10.1109/ISDFS49300.2020.9116231

Stebbins, R. (2001). *Exploratory Research in the Social Sciences*. https://doi.org/10.4135/9781412984249

Sterling, A., Wilson, J., Lowe, S., & Lin, M. C. (2018). Impact sound neural network for audio-visual object classification. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *11219 LNCS*, 578–595. https://doi.org/10.1007/978-3-030-01267-0_34

Suarmika, P. E., Arnyana, I. B. P., Suarni, N. K., & Marhaeni, A. A. I. N. (2020). Indigenous science: what we can learn?(the exploration of balinese local wisdom for science learning). *Journal of Physics: Conference Series*, *1567*(4), 42016. https://doi.org/10.1088/1742-6596/1567/4/042016

Suarta, I. M., Noortyani, R., Yarsama, K., & Adhiti, I. A. I. (2022). The role of Teachers' Indigenous Knowledge and Cultural Competencies in Enhancing Students' Engagement and Learning Outcomes. *Journal of Ethnic and Cultural Studies*, *9*(1), 244–264. https://doi.org/10.29333/ejecs/1025

Suliyanah, Deta, U. A., Kurniawan, F. K., Lestari, N. A., Yantidewi, M., Jauhariyah, M. N. R., & Prahani, B. K. (2021). Literature Review on the Use of Educational Physics Games in Improving Learning Outcomes. *Journal of Physics: Conference Series*, *1805*(1), 010238. https://doi.org/10.1088/1742-6596/1805/1/012038

Sumarni, W., Sudarmin, S., Sumarti, S. S., & Kadarwati, S. (2022). Indigenous knowledge of Indonesian traditional medicines in science teaching and learning using a science–technology–engineering–mathematics (STEM) approach. *Cultural Studies of Science Education*, *17*(2), 467–510. https://doi.org/10.1007/s11422-021-10067-3

Sumarni, W., Sudarmin, Wiyanto, & Supartono. (2016). The reconstruction of society indigenous science into scientific knowledge in the production process of palm sugar. *Journal of Turkish Science Education*, *13*(4), 281–292. https://doi.org/10.12973/tused.10185a

Supiani, R. (2016). Penggunaan Kajian "Ojhung Pada Rangkaian Upacara Adat Ghadisa Di Desa Blimbing Kecamatan Klabang Kabupaten Bondowoso" pada Materi Tema Bangga Sebagai Bangsa Indonesia Kelas V. *FKIP E-PROCEEDING*, 101–105.

Suprapto, N., & Ku, C.H. (2022). 'Now you can stand on your own': Experiencing international doctoral students in science education through autobiographical research. *Journal of Turkish Science Education, 19*(2), 684-698.

Suprapto, N., Prahani, B.K., & Deta, U.A. (2021). Research trend on ethnoscience through bibliometric analysis (2011-2020) and the contribution of Indonesia. *Library Philosophy and Practice*, 2021, 1 - 17

Sutrisno, H., Wahyudiati, D., & Louise, I. S. Y. (2020). Ethnochemistry in the Chemistry Curriculum in Higher Education: Exploring Chemistry Learning Resources in Sasak Local Wisdom. *Universal Journal of Educational Research*, *8*(12A), 7833–7842. https://doi.org/10.13189/ujer.2020.082572

Taylor, R. I. (2022). Rough Surface Contact Modelling—A Review. *Lubricants*, *10*(5), 98. https://doi.org/10.3390/lubricants10050098

Thresa, P., Sundaram, V., Swamynathan, P. V., Kumar, A. K., Nisanth, M. B., & Chandran, K. A. (2019). Non invasive hearing aid using the natural amplification of ear through bone conduction. *Journal of Physics: Conference Series*, *1362*(1). https://doi.org/10.1088/1742-6596/1362/1/012056

Triaiditya, B. S. M., Setyaningsih, P., & Farhanto, G. (2018). Studi Biomekanika Posisi Kuda-Kuda Tengah pada Bela Diri Pencak Silat. *Prosiding Seminar Nasional IPTEK Olahraga (SENALOG)*, *1*(1 SE-), BIO-OR 1-7.

Venkatraman, J., & Nasiriavanaki, M. (2019). Biomechanics of Kumite Style Gyaku tsuki in Karate. *Biomedical Journal of Scientific & Technical Research*, *14*(3), 10656–10662. https://doi.org/10.26717/bjstr.2019.14.002550

Vincze, J., & Vincze-Tiszay, G. (2021). The Biophysical Function of the Human Eardrum. *International Journal of Information Technology and Applied Sciences (IJITAS)*, *3*(2), 103–107. https://doi.org/10.52502/ijitas.v3i2.42

Volfson, A., Eshach, H., & Ben-Abu, Y. (2022). History of science based dialogues on sound waves: From sound atoms to phonons. *Physical Review Physics Education Research*, *18*(1), 10123. https://doi.org/10.1103/PhysRevPhysEducRes.18.010123

Wahyudiati, D., & Qurniati, D. (2023). Ethnochemistry : Exploring the Potential of Sasak and Javanese Local Wisdom as a Source of Chemistry Learning to Improve the Learning Outcomes of Pre-Service Teachers. *Jurnal Pendidikan Sains Indonesia*, *11*(1), 12–24. https://doi.org/10.24815/jpsi.v11i1.26790

Wardani, K. S. K. (2021). Ethnosains dalam pembelajaran berbasis content local genius (Gamelan Bali). *Ekspose: Jurnal Penelitian Hukum Dan Pendidikan*, *20*(1), 1187–1194.

Warwick, K. (2020). Superhuman enhancements via implants: Beyond the human mind. *Philosophies*, *5*(3), 1–10. https://doi.org/10.3390/philosophies5030014

Wiyarsi, A., Çalik, M., Priyambodo, E., & Dina, D. (2023). Indonesian Prospective Teachers' Scientific Habits of Mind:A Cross-Grade Study in the Context of Local and Global Socio-scientific Issues. *Science & Education*. https://doi.org/10.1007/s11191-023-00429-4

Yang, Y., Liang, Y., Chen, J., Duan, X., & Guo, B. (2022). Mussel-inspired adhesive antioxidant antibacterial hemostatic composite hydrogel wound dressing via photo-polymerization for infected skin wound healing. *Bioactive Materials*, *8*, 341–354. https://doi.org/https://doi.org/10.1016/j.bioactmat.2021.06.014

Yin, R. K. (2011). *Qualitative research from start to finish*. The Guilford Press.

Yuliana, Sriyati, S., & Sanjaya, Y. (2017). Local wisdom of Ngata Toro community in utilizing forest resources as a learning source of biology. *AIP Conference Proceedings*, *1868*(1), 100007. https://doi.org/10.1063/1.4995217

Zidny, R., Sjöström, J., & Eilks, I. (2020). A Multi-Perspective Reflection on How Indigenous Knowledge and Related Ideas Can Improve Science Education for Sustainability. *Science and Education*, *29*(1), 145–185. https://doi.org/10.1007/s11191-019-00100-x

Zohuri, B. (2019). Directed-Energy Beam Weapons. In *Directed-Energy Beam Weapons*. https://doi.org/10.1007/978-3-030-20794-6

Zuraida, A., Maisarah, T., & Wan-Shazlin-Maisarah, W. M. Y. (2017). Mechanical, physical and thermal properties of rattan fibre-based binderless board. *Journal of Tropical Forest Science*, *29*(4), 485–492. http://www.jstor.org/stable/44371427

Zuza, K., Van Kampen, P., De Cock, M., Kelly, T., & Guisasola, J. (2018). Introductory university physics students' understanding of some key characteristics of classical theory of the electromagnetic field. *Physical Review Physics Education Research*, *14*(2), 20117. https://doi.org/10.1103/PhysRevPhysEducRes.14.020117