Ethno-physics Studies on "Ani-Ani" Traditional Rice Harvesting Tools as Physics Learning Media

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Abstract: The aim of this research is to analyze the physics concept of "ani-ani" a traditional rice harvesting tool as a physics learning material. With the aim of describing the results of the physics concept analysis study on the use of rice harvesting equipment to design physics learning materials in the study of the use of rice harvesting equipment. This research uses a qualitative descriptive method with data collection techniques in the form of observation, questionnaires and interviews and the data obtained is then analyzed, verified and reduced, then constructed into scientific knowledge and interpreted into high school physics concepts. The results obtained from this research are an analysis of the physical concepts of reaping or ani-ani starting from the mechanical advantages of using ani-ani, the pulling force exerted by the fingers and the pressure exerted by the fingers on the rice stalk so that the rice stalk is cut. The results of the concept analysis study were then used as draft physics learning materials for high school students. According to the relevant high school syllabus, namely basic competency 3.7 about particle dynamics (Newton's law) and 3.3 about static fluids (solid pressure).

Keywords: Ethno-physics of ani-ani; Physics Learning Media; Rice harvest; Traditional

Introduction

Education is an effort to empower human potential to inherit, develop and build civilization in the future (Astuti & Bhakti, 2021). One of the efforts to build civilization is to increase understanding of the surrounding environment, especially with regard to culture that is the legacy of previous generations (Putri et al., 2022). Cultural values are local wisdom as a form of community character (Hidayati et al., 2020) that depends on each region, especially Indonesia which consists of various tribes, ethnicities and traditions (Mazid et al., 2020; Noor & Sugito, 2019). Cultural values are expected to be able to awaken the spirit of nationalism in the younger generation and be proud of being Indonesian. Culture will be better known if it is included in the learning process, one of which is in the fields of science and physics.

Physics is an empirical science, meaning that everything learned in physics is based on the results of observing natural phenomena (Agustin et al., 2021). Natural phenomena in physics include materials, humans and interactions between humans and other materials. The law of natural phenomena can theoretically be studied in the physics learning process.

Physics learning is learning that implements everyday life with physics principles (Bao & Koenig, 2019; Karniadakis et al., 2021; Yosua et al., 2020). In general, the physics learning process in schools is still focused on books and is very rarely implemented in the cultural reality around students (Pratama et al., 2021; Wulansari & Admoko, 2021). The content of the material being taught is also not much integrated with local culture and content (Dewi et al., 2021). Reflecting on this condition, it is necessary to develop ways of learning, one of which is a cultural approach. Physics learning will be more attractive to students if physics learning in the classroom is not separated from everyday experiences and environments (Georgiou et al., 2021; Libman, 2010).

So, learning physics in high school can be integrated with their practical activities in the world of agriculture.

One of the agricultural activities, especially rice, which is familiar and often carried out by farmers is the process of harvesting rice (Limpo et al., 2022). The tools commonly used by farmers are reapers or "ani-ani" (Tahir, 2021). The hereditary custom of cutting rice has become a culture which has turned out to be a philosophical teaching of our ancestors in the embodiment of applying transcendent fertility and prosperity (Liu et al., 2022). So, if learning is related to the environment and culture of students, it will provide a deeper level of understanding of the learning being taught.

Based on the description above, it is necessary to conduct further research on the analysis of physics concepts in traditional rice harvesting tools as physics learning materials (Mbilinyi et al., 2005) With the aim of describing the results of the study of physics concept analysis on the use of rice harvesters to design physics learning materials in the study of the use of rice harvesters. It is hoped that by integrating physics into the rice harvester, high school students will become more interested and easily understand physics material.

Method

The type of research used is qualitative research with the method of literature analysis by describing problems that can be discussed clearly and comprehensively (Labra et al., 2020). According to (Nana Sudjana, 2001) with the library study method, data is collected for analysis and then presented in the form of results and discussion, so that conclusions can be drawn. This research was carried out in June 2023 which took place at a high school in the Batam City area. The purpose of this study is to analyze the concept of physics in "ani-ani" traditional rice harvesting equipment.

In this study using descriptive qualitative methods with data collection techniques in the form of observation, questionnaires and interviews then the data obtained is then analyzed, verified and reduced and then constructed into scientific knowledge and interpreted into high school physics concepts (Harahap, 2020).

Result and Discussion

Reap or often called "ani-ani" is one of the tools used in agriculture, namely traditional farming tools (Hasbi & Yusriadi, 2022; Kalalo & Febby, 2022; Nugroho et al., 2023), especially rice which are simple in shape and are driven using human power to harvest rice (Kamaluddin,

2019). The main parts of ani-ani consist of 3 parts namely pugut, apan-apan and pulung.

Pugut is made of flattened metal or a kind of small knife. Ani-ani stalks are generally made of bamboo twigs (pulung) with a diameter of ± 2.5 – 3 cm. At the end of the stalk which is made of bamboo, it is usually made tapered which functions so that it can be tucked into hair buns or in the seams of bamboo walls. While the board as a place to place the blade or knife plate has a size of about 5 x 8 cm with a board thickness of no more than 1 cm. The width of the knife blade itself is also not more than 1 cm. The reaping or ani-ani structure can be seen in Figure 1 and Figure 2.
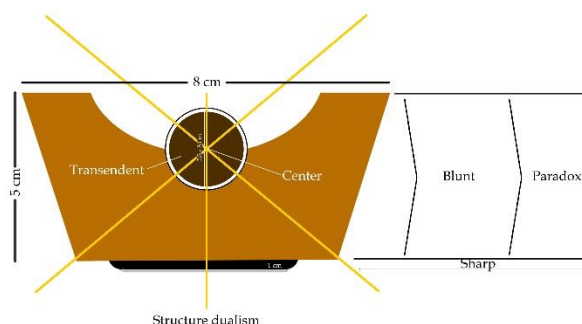

Figure 1. Sketch of the harvest (ani-ani) seen from above
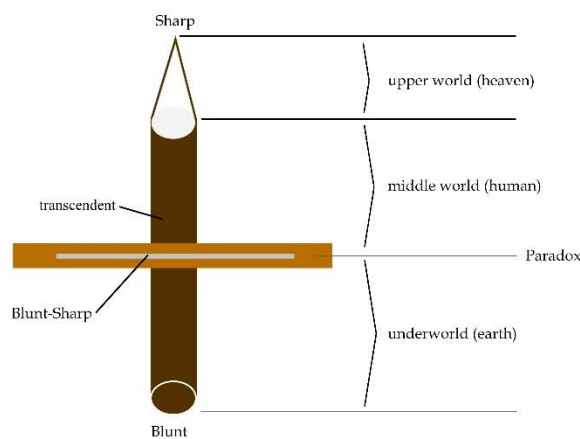

Figure 2. Sketch of the harvest (ani-ani) seen from the side

In the traditional rice farming process, ani-ani is used during harvesting, its function is to pick rice during harvest (Iqbal et al., 2020; Pakiding & Tahendrika, 2023). How to use, ani-ani held using the right hand, three fingers (index, middle finger and thumb) above and the other two fingers (Raap, 2021).

Analysis of the concept of physics in the use of reaping or ani-ani farming tools in this study describes the physics concepts contained in the reaping or-ani-ani farming tools used by farmer including the mechanical advantages of using ani-ani. The summary of the concepts of physics on the use of ani-ani by farmers is written in Table 1.

Table 1. The results of the analysis of the concept of physics on reaping or ani-ani

Concept	Community Knowledge	Physics Concept Analysis
Simple Machine	Reap is an agricultural tool used by farmers to facilitate rice harvesting activities	A simple machine is a tool that can facilitate human work
Force	Tuai consists of 3 main parts namely pugut, apan-apan and pulung which are used to cut rice stalks.	The pull of the ring finger and little finger will produce a style. Ani-ani is a third type of lever, namely the position of the power point between the fulcrum and the load point.
	In its use for harvesting, rice stalks are pulled using the ring finger and little finger.	The movement of the ring finger and little finger is an example of the Pull style. Pull force is a force produced due to the pull on a thing or object.
Pressure	At the time of harvest, the rice stalk is in the pugut position. After the stalk is pulled, the rice stalk will be cut off.	Pressure is a comparison between the value of the force on the outside of the cross-section.

Simple Plane analysis on harvest or ani-ani

Simple machine analysis that works during the harvesting process is shown in Figure 3. The fulcrum in using ani-ani is on the part of the hand holding the pulung. This part serves as a pedestal or support position. The point of power in using ani-ani lies on the upper finger which is given a power force, namely the force needed to pull the rice stalk. Then the load point on the ani-ani is on the lower finger which is used to pull the rice stalk at the bottom. At the load point there will be a load force, namely the gravity caused by the third load, namely the power point between the load point and the fulcrum.
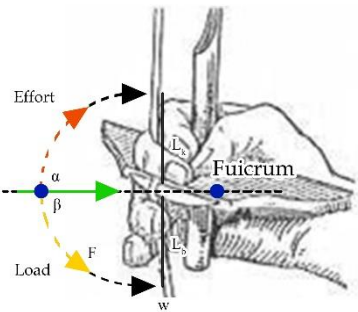
Figure 3. Simple plane analysis of the harvesting process

In a lever, the load force on the ani-ani is a combination of the ani-ani's gravity and the force of the shaft pulled by the finger. The basic movement of reaping is pulling the rice stalk. The farmer's movement pulls the stalk using the index finger and middle finger, directing the stalk to the pugut then the ring finger and little finger pull the lower stalk. Mathematically, the amount of effort to harvest rice is expressed in equation 1.

$$w = F \; x \; \frac{L_k}{L_b} \tag{1}$$

Where (w) is the weight of the load, (F) is the pulling force of the ring finger and little finger, (Lk) is the length of the stalk flanked by the index and middle fingers, (Lb) is the length of the span flanked by the ring and little fingers. The longer the position of the stalk to the pick, the greater the force required so that the greater the weight of the load. The shorter the position of the stalk to the pick, the smaller the force required so that the weight of the load is smaller.

Analysis of the style that works on the harvest or ani-ani

According to the force, the harvesting process consists of two main force components, namely pushing and cutting the stalk (Mulyati et al., 2019; Tualle et al., 2023). Analysis of the forces acting during the harvesting process is shown in Figure 4.
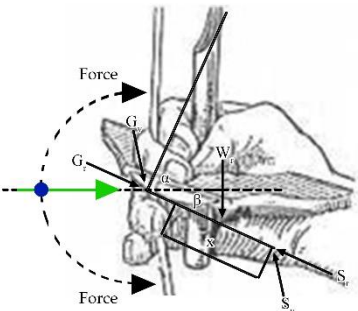
Figure 4. Force analysis on the harvesting process

Based on these two forces, the total force that occurs in the harvesting process can be approximated by the

sum of the resultant forces acting statically with the variable finger weight (Wv), A as the force field (Sr), the angle of the upper finger pull (α), the angle lower finger pull (β) which is expressed by equation 2.

$$F = S_r * A + W_v - G_r \qquad (2)$$

Where for Sr is the load-bearing force while Gr is the force due to load-bearing. The resultant force in the harvesting process on the stalk is shown in equations 3 and 4.

$$G_r = G_v \frac{1}{Cos\,(90-\beta)} \qquad (3)$$

$$S_r = S_v \frac{1}{Cos\,(90-\beta)} \qquad (4)$$

Analysis of pressure on harvest or ani-ani

Analysis of the pressure law that works during the harvesting process is shown in Figure 5.

Figure 5. Analyze the pressure on the harvest or ani-ani

Based on the tensile force exerted by the finger on the rice stalk, the rice stalk will be pressed against the pugut. The pulling force of the finger against the cross-sectional area of the pugut exerts pressure on the rice stalk, mathematically the amount of pressure on the rice stalk is expressed in equation 5.

$$P = \frac{F}{A} \qquad (5)$$

Where (P) is the pressure that occurs on the rice stalk, (F) is the finger pulling force against the rice stalk, and (A) is the cross-sectional area of the pugut.

The larger the cross-sectional area of the pugut, the smaller the pressure of the rice stalks. Meanwhile, the smaller the cross-sectional area, the greater the pressure of the rice stalks. If a large force is applied, but the cross-sectional area is small, it will put a lot of pressure on the rice stalks, making it easier to cut the rice stalks.

Conclusion

Based on the results of analysis and ethnophysics studies on traditional rice harvesting tools, it can be concluded that there are several physics concepts in the use of ani-ani in harvesting rice. Analysis of the physics concept of reaping or ani-ani starts from the mechanical advantages of using ani-ani, the pulling force exerted by the fingers and the pressure exerted by the fingers on the rice stalks so that the rice stalks are cut off. The results of the study of the concept analysis are then used as a draft of physics learning materials for high school students. According to the syllabus at the relevant high school, namely basic competency 3.7 regarding particle dynamics (Newton's law) and 3.3 regarding static fluid (solid pressure).

Author Contributions
The main author, Akrom Chasani, contributed to designing research, conducting research, and writing research articles. The second author, Fakhruddin, played a role in guiding the research to writing articles. All authors have read and agree to the published version of the manuscript.

Conflicts of Interest
The authors declare no conflict of interest.

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