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Ethnoscience of Physics-Math: Calculation of Energy and Wages of Hoeing Farmers in Indonesia

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Abstract: The purpose of this study is to describe the analysis of farmers' economic concepts, especially the wage system of land hoe labourers. The low wage value of land hoe labourers is a deep concern considering the amount of energy expended by farmers in spending their potential throughout the day on the farm. In this context, the use of mathematical ethnoscience in human life is something that may not be clearly observed. This study becomes very interesting, when the awareness of local power to apply mathematical concepts is realised as an amplifier of human needs in solving their life problems. Life's problems are increasingly complicated in the construction of inevitable needs. This research method is a qualitative research method with a descriptive approach. This research operationally examines various sources of literature relevant to the above research context. This research is qualitative descriptive research using the content analysis method to obtain the results that in the use of hoes there are several physics concepts about mechanics including the concepts of force, rotational dynamics, work and energy. Based on the results of data analysis and discussion, it can be concluded that there are several physics concepts in the use of hoes in cultivating the soil starting from the mechanical advantages of using a hoe, the moment of force when swinging a hoe, the compressive force exerted by the hoe, the lifting force when lifting the soil, the pulling force when pulling the soil, and the effort and energy expended during hoeing activities.

Keywords: Ethnoscience; Human Life; Mathematics; Physics

Introduction

One of the agricultural activities that familiar and often carried out by farmers is tillage. Equipment for cultivating land that is still commonly used by farmers is a hoe. the use of hoes can not only be done in the world of rice fields, in everyday life hoes can be used, because in everyday life it is quite familiar (Arifi et al., 2021). It is necessary to conduct further research on the analysis of physics concepts on the use of hoes by farmers as physics learning materials. With the aim to describe the results of the study of the reality on the use of agricultural tools hoes by farmers and to design physics learning materials on the study of the use of agricultural tools hoes by farmers (Gorjian et al., 2021).

In other side, a Brazilian scientist, Ubiratan D'Ambrosio, came up with a concept that links learning mathematics learning with the cultural background that students have and understand. This concept became known as ethnomathematics. In general ethnomathematics can be seen as a concept of learning mathematics within a cultural and anthropological framework (Chrissanti, 2019). Therefore, ethnomathematics is seen as relevant not only to develop students' mathematical skills, but also to strengthen local wisdom values in the student (Latif & Talib, 2021; Novianti et al., 2022; Putra et al., 2021). So in this context ethnomathematics is not actually a new knowledge, but it has been known since the introduction of mathematics itself (Fradi et al., 2019). Ethnomathematics is an approach to learning mathematics that is associated with a cultural group so that existing cultural products can be used as a source of its learning (Sutarto et al., 2021).

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In this research it is connected with the physics. The link with physics is the energy used by farmers when using agricultural tools such as hoes (Adi, 2020). The calculation will mathematically relate to the wage rate of farm labourers every day. This is the practice of physics and maths in the daily life of a farmer.

Figure 1. Famer Energy and Payment/Day. Source: Google.com

In other words, it can be interpreted that Ethnomathematics is a series of community activities that are still inherent today and in which mathematical concepts are contained (Adawia et al., 2019).

Method

This research is a theoretical study with a qualitative approach, with a literature study method (Patri & Heswari, 2022). This research model tries with all its might to elaborate various scientific sources that will strongly support the construction of the analysis of a particular study (Patton, 2020). This research method is a qualitative research method with a descriptive approach. This research operationally examines various sources of literature relevant to the context of the above research. The results of the reflection found that the need for ethnoscience mathematics literacy was met with representative local sources.

The type of research used in this study is descriptive research with a qualitative approach (Matović & Ovesni, 2023). The data taken, identified in the following order: data collection; data sorting; data analysis; conclusion making. As for data analysis, there is a predetermined sequence in accordance with the empirical steps taken, namely as follows: Examination of data; suspected data findings; Data confirmation; Diagnosis; and Action. The stages of reviewing the research results include reducing information, presenting it, and drawing conclusions (Siregar, 2023).

Result and Discussion

Physical Principles of Hoeing as a Simple Tool for Farm Labourers

Hoe is one of the tools used in the scope of agriculture, a traditional agricultural tool that is simple in shape and driven using human power to cultivate the soil and make crop land (Soedarto & Ainiyah, 2022). The main parts of the hoe consist of three parts, namely doran, tanding and hoe blade. In the doran there is still an eggplant handle and purusan, and in the hoe blade there is still a hollow and a hoe landepan, all of which have their respective functions in one unit into a hoe. In this study, the focus of researchers is on hoes used to cultivate agricultural land (Arifi et al., 2021).

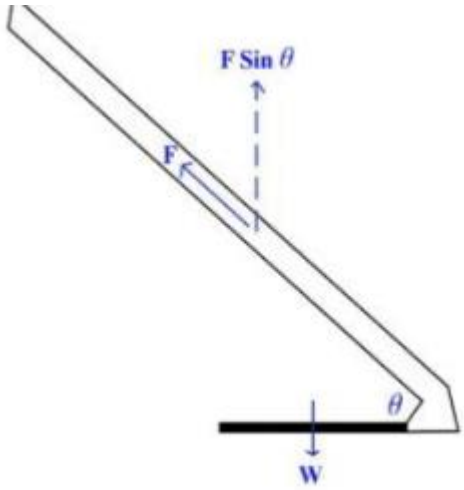

Figure 2. Angle of Ǿ & magnitude of force. Source : (Arifi et al., 2021).

When the farmer lifts the soil When the farmer lifts the soil with a hoe upwards, there will be an upward lifting force exerted on the hoe, so that if he wants to lift the soil weighing w, the farmer will issue a force F greater than w so that the object or soil can be lifted. However, it can be noted that the position of the force on the hoe forms an angle of Ǿ (Arifi et al., 2021).

In carrying out levelling activities from this equation it can be seen that land then make an effort, because that when farmers want to move effort is the amount of force exerted the same amount of soil as the force that to move or move the the same and the same distance, then the thing that an object or objects. In activities influence in the amount of effort that nyervis, the ground is moved so that evenly issued is the value of the angle that to the entire surface. So that the soil formed between the hoe and the doran. pulled as far as distances.

The amount of effort is directly proportional to then the farmer gives a pulling force of the magnitude of the force, the displacement and the value of cos F (Saleh &

Bahariawan, 2018), but if you notice that of the angle formed by the hoe blade the pulling force that the farmer exerts on the doran and doran. So in the same distance and forming an angle of θ. So that the force the same amount of force, then the effort that works parallel to the distance expended will be affected by the value of cos θ is so mathematically the amount of effort expended. The most closely related thing written with the equation as with effort is energy.

$$W = F \cos \theta \, . \, S \quad (1)$$

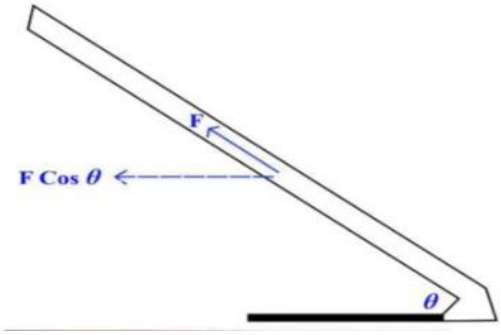

Figure 3. Effort when hoeing formula

Furthermore, energy is the ability to make an effort. When a farmer lifts a hoe to swing it into the ground, the farmer needs energy to lift the hoe. Because the hoe is lifted to a certain height, the potential energy equation applies when the farmer lifts the hoe (Setiawan et al., 2023; Sujana, 2014) to swing it to the ground by the Formula 2.

$$E_p = m.g.h \quad (2)$$

Analysis of physics concepts on use of hoe farming tools in this study describes the concepts of physics contained (Rose, 2013) in the hoe farming tools used by farmers including the mechanical advantage of using hoes (Saragih et al., 2021), the angle of the hoes of the farmers, the magnitude of the moment of force when operating the hoe and the effort during hoeing activities farmers, the magnitude of the moment of force when operating the hoe and the effort during hoeing activities (Wulandari et al., 2023).

The Use of Ethnomathematics in Farmer Wage Calculation

Although this learning can build the character of students who not only understand their culture but also able to apply it in their everyday life (Atmojo et al., 2019; Chrissanti, 2019; Nurcahyani et al., 2021). Ethnomathematics can improve student the ability to master material which has an impact on increasing students' problem solving skills (Astuningtyas et al., 2017). Written symbols, pictures and physical objects are mathematical ideas that have mathematical values that can be applied in everyday life by the community in general (Ajmain et al., 2020). One of them is through ethnomathematics (Fajriyah, 2018). The objectives of mathematics are in line with the idea of mathematical literacy (Fajriyah, 2018). Ethnomathematics is the result of the relationship between culture and mathematics. While academic mathematics is a science that will be delivered to students with a variety of methods. Mathematics is the science of quantity, structure, space, and change (Fajriyah, 2018).

Ethnomathematics-based mathematics is solving mathematical problems (Sarwoedi et al., 2018). Without learning the concept of mathematics beforehand, without learning the concept of mathematics. concepts before hand, the Sidoarjo community has applied these concepts in their daily life using ethnomathematics (Rahmawati & Muchlian, 2019), and in the context of payment system for farmers (Lestari, 2019). The reason why sellers do not use tools (scales) is because it has become a tradition and habit. In addition, the seller also gets more profit than selling using the system per kilo or scale and hours of work per day (Adawia et al., 2019). The payment can be shown in fact that so cheap. Number operations (addition and multiplication); includes activities carried out to find out how many items are available or how much money must be pay (Nursangaji et al., 2023).

The Central Statistics Agency (BPS) reported that the average nominal wage of farm labourers was IDR 59,226 per day in December 2022. This figure increased by 0.22% compared to the previous month (month-to-month/mtm) of IDR 59,096 per day. However, the real wage of farm labourers in December 2022 decreased by 0.73% compared to November 2022, namely from IDR 51,830 to IDR 51,453 per day. Nominal wages are the average daily wages received by labourers in exchange for work. Meanwhile, real wages are the purchasing power of the income/wages received by labourers /workers.

Conclusion

Based on the results of data analysis and discussion, it can be concluded that there are several physics concepts on the use of hoes in cultivating the soil starting from the mechanical advantage of using a hoe, the moment of force when swinging a hoe, the compressive force exerted by the hoe, the lifting force when lifting the soil, the pulling force when pulling the soil, and the effort and energy expended during hoeing activities.

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Author Contributions

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Conflicts of Interest

In this research, there is no tug of interest and or hidden interests among the researchers. In addition, this research is also not an order from any funder because it is independent research.

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