

MATHEMATICAL IDEAS EMBEDDED IN WATER DEBIT PRACTICES OF SAND SELLERS IN CISEUPAN: AN ETHNOMATHEMATICS STUDY

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Abstract

Indonesia is a country rich in local cultural practices that not only reflect traditional values but also hold great potential for the development of contextual learning based on local wisdom. One such form of wisdom is reflected in the economic activities of the community of Kampung Ciseupan, South Cimahi, in the form of sand sales practices that have been passed down from generation to generation and contain various mathematical concepts that have not been widely explored. This study aims to explore the mathematical concepts embedded in these cultural practices, particularly the concept of flow rate that emerges in sand loading and unloading activities. The approach used is ethnography, in line with the principles of ethnomathematics, which examines mathematical practices from the perspective of the cultural practitioners themselves. Data was collected through field observations and semi-structured interviews with the main participant, Mrs. LM, a sand seller. The researcher served as the primary instrument in observing, exploring, and analyzing the connection between cultural activities and mathematical concepts. The research findings indicate that sand selling activities contain concepts of debit, volume, distance, speed, and time that are implicitly present in community practices. These findings suggest that local culture can serve as an authentic, contextual, and relevant source of mathematical learning for students' daily lives, and can encourage students to understand and appreciate their own culture.

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INTRODUCTION

Education Indonesia is a country with a rich and deep cultural diversity. Each region has its own unique and distinctive cultural characteristics, ranging from local languages, customs, traditional arts, belief systems, to local economic practices that have been passed down from generation to generation. This culture is not only a symbol of a community's identity, but also shapes the framework of thinking, way of life, and value system that applies in everyday life. Culture does not exist in a vacuum; it grows and develops alongside the social practices of the community. One example of a local cultural practice that reflects this is the community in the Ciseupan area, Cibeber Village, South Cimahi District, Cimahi City, which has made sand selling a part of their economic tradition. This business has been passed down from generation to generation and has become an important part of the dynamics of local community life. Since 2015, sand selling and storage activities have grown rapidly, making it not only an economic activity but also a part of the local culture that shapes the character and mindset of the community in that area.

Education and culture have a very close and inseparable relationship. Education is an important tool in the process of preserving and transmitting culture from one generation to the next. In anthropological studies, education is viewed as a process of transforming the social and cultural systems within a society. Tilaar (2004) states that education is a process of acculturation, meaning that education plays a role in shaping culturally aware individuals while also making culture the primary context for the teaching-learning process. Education rooted in culture is more meaningful because it provides contextual and relevant learning experiences for students. Therefore, the integration of culture and education is important to produce graduates who are not only academically intelligent but also have character and a love for their nation's local values. In this context, (Fajriyah, 2018) mentions that cultural practices can be a vehicle for instilling mathematical concepts and recognizing the diversity of ways in which communities develop their mathematical activities authentically.

Mathematics is often associated with being an abstract, exact science, detached from social and cultural dimensions. This perspective makes mathematics feel distant from the reality of students' lives. However, many experts emphasize that mathematics is inherently a product of culture. (Bishop, 1994) states that mathematics is a form of culture because it emerges from humanity's need to explain, understand, and organize its life experiences. In line with this, (Pinxten, 1994) refers to mathematics as a symbolic technology that grows from the skills and cultural activities of society, not merely formal formulas. This concept is reinforced by (D'Ambrosio, 1985), who introduced the term ethnomathematics, an approach that acknowledges the existence of mathematical forms developed and used within specific cultural communities, distinct from academic mathematics taught formally in schools. Ethnomathematics reflects how cultural communities, including tribes, professional groups, and age groups, apply mathematical principles in the context of their lives. Hardiarti (2017) adds that a person's understanding of mathematics is greatly influenced by their cultural background, because what they do is based on what they see, feel, and experience in their environment. (Gerdes, 1994) also emphasizes that ethnomathematics is not limited to ethnic contexts but encompasses all cultural groups that have unique ways of applying and understanding mathematics according to their social realities.

Unfortunately, in the practice of mathematics education in schools, cultural approaches such as ethnomathematics are still rarely implemented. Mathematics education tends to be conventional, teacher-centered, and abstract, making it difficult for students to relate the material they learn to their own life experiences. The perception that mathematics is difficult remains a stigma from elementary school through to university. This is due to teaching models that have not yet utilized contextual approaches and lack opportunities for exploration for students. Kurniasih & Sani (2014) emphasize that 21st-century learning, especially within the framework of Education 4.0, requires the integration of technology and interactivity. Learning should be collaborative, challenging, and meaningful, utilizing resource sharing, virtual teaching materials, and providing space for students to explore their surroundings. However, in reality, many learning processes remain one-way instructional and fail to leverage local potential as a learning resource, particularly in mathematics education.

This is where ethnomathematics becomes highly relevant as an approach that bridges the gap between academic mathematics and students' contextual experiences. Rahmawati & Muchlian (2019) state that although mathematics is linear and systematic, its integration with more flexible and soft culture can make mathematics learning more fluid and easier to understand. This approach has proven effective in countries like Japan and China, which use ethnomathematics in their education and have successfully improved students' mathematical understanding (Achor et al., 2009). In Indonesia itself, ethnomathematics practices have long been part of community life, such as in determining traditional holidays, measuring land, distributing harvests, and designing symmetrical buildings (Aditya, 2018; Tandililing, 2013; Hartoyo, 2012). Therefore, it is important to explore and document local cultural practices that contain mathematical elements, such as those found in sand trading activities in Ciseupan, to be incorporated into contextual teaching materials.

This research aims to contribute to two main aspects: theoretical and practical. From a theoretical perspective, this research expands understanding of the role of mathematics as part of culture and strengthens the ethnomathematics approach in bridging formal mathematics with real life. From a practical perspective, the results of this research can be used as a reference for teachers in designing contextual mathematics learning, utilizing local culture as a source of learning. In this way, students can more easily understand mathematical concepts because the material they learn is relevant to their daily lives. This is expected to increase students' interest in and understanding of mathematics, while also fostering cultural awareness and national character. In addition, this research also has the potential to become the basis for the development of a culture-based mathematics learning model, in line with the demands of the 21st-century curriculum and the principles of education 4.0 as explained by (Kurniasih & Sani, 2014), namely learning that is open, contextual, collaborative, and oriented towards character building and the preservation of local culture.

METHOD

This study uses an ethnographic approach, which is an empirical and theoretical approach that aims to obtain in-depth descriptions and analyses of a culture through the direct involvement of researchers in the field. This approach allows researchers to understand the way of life of a community based on the original perspective of the cultural actors

themselves (Djamba & Neuman, 2002). In Geertz's (1977) view, ethnography is tasked with producing thick descriptions that depict the complexity of conceptual structures inherent in community life, including assumptions that are often unspoken but considered normal.

This research was conducted in Kampung Ciseupan, South Cimahi District, in October 2022. This location was chosen purposively because the community carries out local economic activities that are rich in cultural values and practices, one of which is the traditional sand selling business, which is closely related to mathematical elements, particularly in terms of water flow and material volume.

This type of research is exploratory and descriptive in nature. Exploratory research is used to obtain basic information that can serve as a foundation for further research or as a basis for decision-making (Ritonga, n.d.). This study includes preliminary exploration activities (preliminary observation), field exploration for data collection, and identification of the relationship between local cultural practices and the mathematical concepts contained therein.

Data collection was conducted through field observations, semi-structured interviews, and documentation. The researcher used tools such as a mobile phone for photo and video documentation, measuring tools (tape measure) for measuring sand volume, and writing tools for recording field findings. The main subject in this study was Mrs. LM, a sand seller in the area. The interview instrument used was an open-ended questionnaire aimed at exploring information related to daily work practices, such as the volume of sand per truck, the time required for loading and unloading, and the estimated water flow used in the process.

The research stages began with an initial site survey, the development of interview instruments, scheduling of activities, and the conduct of interviews and direct observations in the field. All collected data, including field notes, interview results, and visual documentation, were analyzed to identify the relationship between the sand trading practices and mathematical concepts, particularly regarding flow rate and volume measurement. This research generally aims to reveal the form of mathematical knowledge contained in local cultural practices and how these practices can be understood as a concrete form of ethnomathematics that lives in the daily life of the Ciseupan Village community.

RESULTS AND DISCUSSION

The findings in this study were obtained through direct observation and in-depth interviews with a sand seller located in the Ciseupan area, South Cimahi District. Based on the data collected, it is known that the activity of opening a sand stall has become part of the local culture that has been passed down from previous generations. For the residents of Ciseupan, the sand selling business is not merely an economic activity but also holds social value, as it is believed to create employment opportunities in the surrounding community.

Additionally, the profession of sand seller is considered to have low risk. This is due to the characteristics of sand, which does not easily deteriorate and can be stored for a long time, unlike commodities such as food or agricultural products that quickly lose quality.

Therefore, this business is deemed more stable and promising compared to other types of businesses.

The sand stall that was the subject of this study has been in operation since 2017 and remains active to this day. The raw material for sand is sourced from outside the region, specifically from Cimalaka (Sumedang Regency) and Garut. To support its operations, the sand business owner has two trucks used for loading and unloading activities. Each truck can carry 8.5 cubic meters of sand. The loading and unloading process takes approximately one hour to unload sand from one truck.

This activity is closely tied to the application of relevant mathematical concepts. One of the most evident concepts is the concept of flow rate, as taught in the Mathematics curriculum at the fifth-grade level of elementary school. In this context, the flow rate concept is used to calculate the amount of sand (in volume units) unloaded within a specific unit of time. In addition to the concept of flow rate, other mathematical concepts such as distance, speed, and time are also applied, particularly in the process of transporting sand from the source location to the sales site. If this research is further developed, it may be possible to explore the concept of spatial geometry, as sand is also a primary material in the production of bricks. However, in this study, the researcher focused solely on examining the concept of flow rate in the practice of sand sales.

Field observation data was obtained through interviews with Mrs. LM (46 years old), a sand entrepreneur in the area. The following are excerpts from the interviews conducted by the Researcher (P) and the Informant (N):

- Researcher : *What are the origins and development of the sand sales business culture in Ciseupan?*
- Informant : *The sand-selling business has existed for a long time and has grown rapidly since 2015, along with the increasing development in Cimahi.*
- Researcher : *What is the meaning and reason behind the community, including you, engaging in this business?*
- Informant : *The sand business was chosen because it offers promising prospects, low risks, and can create job opportunities in the surrounding area.*
- Researcher : *When did you start this business, and what are the requirements?*
- Informant : *The business started in 2017 with the main requirements being storage land, labor, and sand supply from outside the area.*
- Researcher : *Where does the sand come from, and how is it transported?*
- Informant : *The sand is sourced from Cimalaka, Sumedang, and Garut. The transportation process takes approximately 3 hours, including 1 hour for loading and 2 hours for travel.*
- Researcher : *What is the capacity of the trucks used, and how much sand can they carry?*
- Informant : *Mrs. LM has two trucks measuring 3.6 m x 1.8 m x 110 m, each capable of transporting 8.5 m³ of sand. The tractor-trailer can carry up to 25 m³.*
- Researcher : *What are the benefits of the sand sales business for the local community?*
- Informant : *It provides a practical solution for buyers because the sand is more readily available and easier to access.*



Figure 1. Loading and unloading sand in one truck

To understand the relationship between sand sales practices and the mathematical concepts that can be identified within them, particularly the concept of debit, it is important to review the basic scientific principles that underlie them. One of the great figures in the history of mathematics, Archimedes, discovered a method for determining the volume of an object by submerging it in water and measuring the amount of water displaced by the object. This approach aligns with the ideas proposed by (Eves, Howard, 1964)

From this approach, the concept of flow rate emerged, which is the measure of the volume of a fluid flowing in one unit of time. To calculate flow rate, one must understand units of volume (such as cubic meters) and units of time (such as hours or minutes), as flow rate is the ratio between volume and time. This understanding is highly relevant in elementary school mathematics education and can be explained contextually through community economic activities, such as the sale of sand in Ciseupan.

For example, a pond is filled with water through a pipe with a flow rate of 1 liter per second, meaning that every second, 1 liter of water flows from the pipe. This concept of flow rate is also applied in the cultural practice of sand sellers. The flow rate of sand can be calculated based on the known volume and time. According to an interview with Mrs. LM (46 years old), one truck can hold 8.5 m^3 of sand. Additionally, the time required to load sand into one truck is one hour. Based on this data, the flow rate of sand can be calculated using the following formula:

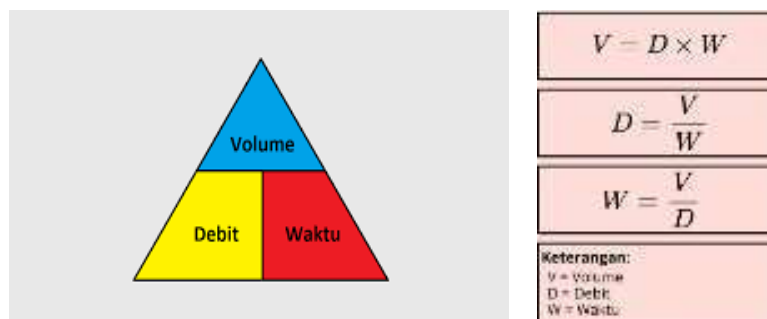


Figure 2. Formulas for finding volume, debit, and time

From this formula, the flow rate is calculated using the formula $\frac{\text{Volume}}{\text{Time}}$. Then, we calculate the water flow rate for this sand seller by substituting the known volume and time.

Given:

$$V = 8,5 \text{ m}^3$$

$$W = 1 \text{ jam}$$

Question: What is the flow rate of sand being unloaded from the truck?

Answer:

$$D = \frac{V}{W}$$

$$D = \frac{8,5}{1}$$

$$= 8,5 \text{ m}^3/\text{jam}$$

Thus, the flow rate of sand being unloaded from one truck is $8.5 \text{ m}^3/\text{hour}$.

This finding indicates that the practice of sand sales, which has become part of the culture of the Ciseupan community, is closely related to mathematical concepts. In addition to flow rate, this practice also reflects the application of concepts such as distance, speed, and time. Moreover, the integration of mathematical principles in the sand selling practices may extend beyond mere calculations of flow rate, distance, speed, and time, as it also reflects a deeper cultural understanding of quantitative relationships within the community. For instance, the negotiation processes during sales can illustrate the application of ratios and proportions, which are fundamental concepts in mathematics. This interplay between culture and mathematics not only enhances the understanding of ethnomathematics but also highlights the need for educational frameworks that recognize and incorporate local practices in teaching mathematical concepts. Such an approach could lead to more relatable and effective learning experiences for students, as demonstrated in recent studies that emphasize the importance of contextualizing mathematical education within cultural practices (Arianto et al., 2024). Recent studies have shown that such community-based mathematical applications can enhance students' engagement and understanding of mathematics when integrated into educational curricula (Putra, 2025).

Furthermore, by bridging traditional knowledge with modern educational practices, educators can create a more inclusive learning environment that respects and values diverse ways of knowing. For instance, integrating local measurement techniques used by sand sellers into classroom activities can provide students with practical applications of geometry and measurement, thus reinforcing their mathematical skills in a culturally relevant context (Supriyadi et al., 2022). Ultimately, this approach not only aids in the comprehension of mathematical concepts but also empowers students by affirming the significance of their cultural heritage in the learning process. If this research is further developed, the concept of three-dimensional shapes could also be explored, as sand is the primary raw material in the production of bricks, which incorporate three-dimensional geometric elements.

CONCLUSION

The practice of sand sales in Kampung Ciseupan, South Cimahi, is a local culture that has developed alongside economic dynamics and has been passed down through generations as part of the community's identity. This tradition has been actively carried out since 2015 and has played a role in creating job opportunities and maintaining economic stability. Research indicates that this practice incorporates mathematical concepts such as flow

rate, volume, and the relationship between distance, speed, and time. For example, the process of loading and unloading sand reflects the concept of flow rate, which is relevant for elementary school mathematics education. Additionally, spatial geometry concepts can be explored since sand is used in the production of bricks. Through an ethnomathematics approach, this activity serves as a contextual learning resource that bridges academic mathematics and students' real-world experiences. These findings are expected to be integrated into culture-based mathematics learning in schools around the South Cimahi area. Furthermore, this research is also expected to inspire other educators and researchers to continue exploring and utilizing the richness of local culture as a vehicle for meaningful, enjoyable, and relevant learning experiences for students.

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