Overcoming the difficulty of understanding systems of linear equations through learning ethnomathematics

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Abstract. Middle school students have difficulty in understanding the system of linear equations. Ethnomathematics learning was one alternative to overcome it. The purpose of this study was to describe ethnomathematics learning techniques to overcome students' difficulties in understanding systems of linear equations. This research was part of development research. This is part of student analysis. The subjects of this study were 38 junior high school students in the Kota Bengkulu. The application of ethnomathematics learning was given to the subject. The instrument of this study was the researchers themselves with interview guides and observation sheets. It was an interview about the ability of students to understand systems of linear equations. Data were analyzed qualitatively with fixed comparison techniques. The results of this study are the difficulty of students understanding the system of linear equations can be overcome through learning ethnomathematics. The horizontal mathematization used the culture of the fishermen of Bengkulu people "bundled fish, rice as small, relaxed". This culture makes it easy for students to recall prerequisite concepts, making it easier for students to do interconnection between concepts. This makes it easy for students to achieve the principles of elimination, substitution and mixtures. The conclusion of this study is that learning ethnomathematics about Bengkulu fisherman culture can overcome the difficulties of students in understanding the system of linear equations.

1. Introduction
School mathematics is the first formal deductive material faced by students. That is something that is not easy to deal with, especially how to understand mathematical concepts. Students need the ability to think logically, think creatively and solve problems. Also, mathematics learning requires students to communicate actively, both verbal and written communication [1]. In addition, students feel mathematics is something scary, especially problem solving [2]. This is a cause of students having difficulty in understanding mathematics.

One concept that is difficult for students to understand is a two-variable system of linear equations. According to Pulungan & Suhendra, students make mistakes in solving problems in the form of the system of linear equation in two variables. It is a misconception, interpretation of language, procedures, and calculations. Students have difficulty understanding problems and are wrong in the process of answering problems [3]. Students with average ability experience difficulties in mathematical modeling, determine problem solving strategies about systems of linear two-variable equations. Students do not use methods of elimination, substitution methods, or mixed methods. They do mathematical procedures, but are not correct in mathematical operations and are wrong in determining the final answer [4]. Errors about the system of two variable linear equations were also
detected in the study. There are two studies that have collected errors made during the completion of linear equations on paper and in interactive algebra learning environments [5].

Errors and difficulties of students in understanding the concept of a system of linear equations two variables, need to be overcome with a learning approach. That is one of the ways needed to improve students' cognitive processes. The learning approach that can overcome them is ethnomathematics [6]. Ethnomathematics is studying aspects of mathematical culture. It is presenting the mathematical concepts of the school curriculum in ways in which these concepts are related to student experience and everyday culture. Ethnomathematics approach [8] can improve mathematical abilities. That approach is for the mathematics curriculum and is intended to make school mathematics more relevant and meaningful for students [9]. In the ethnomathematics approach, the mathematical literacy perspective for developing human capital is based on mathematical conceptions as a strong and neutral instrument for solving individual and social problems [10].

According to Herawaty, et.al., through ethnomathematics learning, students can develop the ability to solve problems through self-reflection on planning, monitoring and evaluating the implementation of thought processes [11]. In the study, after students' initial abilities are controlled, the average ability of mathematical understanding of students who study material oriented to ethnomathematics is higher than students given non-ethnomathematics material [12]. Therefore, mathematics in high school should be taught by implementing the mathematics learning model employing a realistic mathematics education approach based on ethnomathematics in Bengkulu. The implementation of the model will enhance the understanding of mathematics concepts and the abstractions ability of high school students [13]. Thus, the research question was how to overcome students' difficulties in understanding the two-variable linear equation system. In this study we applied the ethnomathematics learning approach.

2. Method
This research is part of development research. This is part of the analysis of student needs. We conduct in-depth interviews with research subjects. It is to find out the difficulties of students in understanding the concept of a two-variable system of linear equations. Furthermore, suitable approaches can be determined to overcome them. The subjects of this study were 38 junior high school students in the Kota Bengkulu. Subjects selected by snowball technique. The main instrument of this study is the researchers themselves, guided by student task sheets and observation sheets. The study was conducted in the even semester of 2018. We apply mathematics learning with the ethnomathematics approach. The learning was carried out in four teaching and learning times. Data were analyzed descriptively. That is a percentage analysis. Also, qualitative analysis and the constant comparative technique.

3. Results and Discussion
Based on the research data on the understanding of junior high school students about the two-variable linear equation system in the Kota Bengkulu, there were found a number of student errors, namely conceptual errors, principle errors, misunderstandings, and operating errors. When traced, these errors are caused by several factors of difficulty. These difficulties can be described based on excerpts from interviews with middle school students in the Kota Bengkulu.

Footage 1: (Q: Interviewer, AF: Student)
Q: Try to explain the meaning of a two-variable linear equation system?
AF: ... it is a mathematical sentence with two variables ...
Q: ... Complete your answer?
AF: ... in my opinion the sentence is complete ...

Footage 1 gives the meaning that, AF has difficulty understanding the concept of a two-variable linear equation system. He was unable to express his understanding. According to Widada [14], this subject has difficulty doing abstraction. It is a process of transitioning from concrete to abstraction for a set of the same things and the name of the set will then be the name of the concept [14]. This makes
it difficult for him to learn more. Such students need learning that starts with something close to his mind. That is the ethnomathematics approach.

Footage 2: (Q: Interviewer, TH: Student)

Q: How can you register set members \{(x, y) \in \mathbb{R} | 2x + y = 5 \text{ and } 3x - 2y = 4\}?

TH: ... there is no result Sir ...

Q: Why is that?

TH: ... because I don't know how to do it ...

In accordance with Footage 2, TH has difficulty in understanding the techniques of solving a system of linear two-variable equations. That is a principle difficulty. These students need a more contextual learning approach. The aim is to make it easier for him to carry out mental activities and synergy with his iconic and kinesthetic activities. This approach allows students to optimize their visual, auditory and kinesthetic performance through hands-on activities, and mind-on activities. This requires contextual learning media. According to Widada, learning media that contain mathematical problems that meet the characteristics for conceptual mathematical processes, allow students to invention/reinvention [15] and develop concepts or principles in mathematics [14].

Footage 3: (Q: Interviewer, YD: Student)

Q: Consider the problem that you have solved the system of equations?

YD: ... 2x + y = 5 and 3x - 2y = 4 ... then 2x = 5-y ... eg x = 0 means 0 = 5-y and y = 5.

Q: What next?

YD: ... yes, the result is x = 0 and y = 5 ... that's the solution ...

Footage 3 gives the meaning that YD has difficulty in principle and operating in a system of linear two-variable equations. That is a difficulty that must be addressed immediately, the results of Widada's research, through complete mathematical activity, students were able to find answers to contextual problems. Next, give contextual problems that are similar in such a way that the pattern is obtained and with vertical mathematical activity [16], the concepts and principles of the system of linear variables are achieved. The results of the application of this learning media, obtained more than 82% of junior high school students in the Kota Bengkulu were able to achieve concepts and principles about the system of linear two-variable equations correctly [17].

To overcome students' difficulties in understanding the system of two-variable linear equations, we apply learning to the approach of ethnomathematics. Various Bengkulu cultures are related to our linear equations analysis. It is part of the needs analysis in a research development. We find ethnomathematics relevant to the following description.

Bengkulu is a province in Indonesia that has cultural diversity. The area is quite extensive, with long beaches, mountains and dense forests. With the vast ocean, Bengkulu people are very close to fishing activities (see Figure 1). Abundant fish gave rise to the very well-known philosophy of Bengkulu society, which is "a bunch of fish, rice as small, relaxed". It is their culture that is close to the minds of children and adults in the Bengkulu region. Philosophy can be used as an ethnomathematics approach in mathematics learning.
Based on ethnomathematics about Bengkulu fishermen culture, two-variable linear equation system learning starts with contextual problems such as the following. "Two Bengkulu fishermen go to sea simultaneously. Each catch of fish is sold in bonds and partly exchanged with rice. Fisherman A obtains 5 ikat fish catches and 1 cup of rice which is valued at IDR. 265,000. Fisherman B receives 4 catches and 1 cup of rice with a value of IDR. 215,000. How much is the price of bundled fish and rice as little as? "This problem, call it Problem 1.

Based on learning with the starting point is Problem 1, then student difficulties can be overcome. They were able to solve the problem with the first step, drawing it (see Figure 2).

Based on Figure 2, there were 67% of students completing it through elimination techniques such as Figure 3. They eliminated the same things. It is 4 bunches of fish and 1 cup of rice. This process is horizontal mathematization. Students collaborate with friends in their groups to solve problems correctly.
Based on the elimination process of Figure 3, the result is a bundle of fish worth IDR 50,000, see Figure 4. Also, they continue to replace a bunch of fish with IDR 50,000 as can be seen in Figure 5. This process produces one cup of rice, replacing tie fish with IDR 200,000.

Figure 3. Intemitively eliminating 4 fish bundles and 1 cup of rice

Figure 4. The result of elimination is a bundle of fish

Figure 5. Substitution of 4 fish bundles produces 1 cup of rice

Based on Figure 5, through the mathematical process students produce a settlement is the price of a bundle of fish IDR 50,000 and one cup of rice IDR 15,000. By utilizing the results of the mathematics, students continue the mathematical process vertically, towards formalization. Suppose that 1 fish string is F, and one cup of rice with C. They can make a mathematical model with $5F + C = 265,000$ and $4F + C = 250,000$. Students make use of Figure 3, obtained:
Based on Figure 5, then $4F + C = 215,000 \rightarrow 200,000 + C = 215,000 \rightarrow C = 15,000$. That is the end result $F = 50,000$, and $C = 15,000$. The price of a bundle of fish is IDR 50,000 and 1 cup of rice costs IDR 15,000.

Apart from the sea, Bengkulu has quite extensive forests. In the forest there are still very many durian trees. Children and adults await the arrival of the durian season. Therefore, waiting for the windfall to be a pleasant culture for the people of Bengkulu as shown in Figure 6. The crops will be sold at the market and at the crossroads in the Kota Bengkulu. It is one culture that is close to students' minds. This culture is part of the horizontal matematization process as an ethnomatematics approach. That's the first point for students.

![Figure 6. Tradition of picking up Durian](http://merawa82.blogspot.co.id/)

In the Kota Bengkulu, there is also a tradition of making Kue ‘Tat’. That is Bengkulu's cultural heritage from generation to generation, like a grandmother cooking it (see Figure 7). Also, it is done when the religious holidays come. This is done, because the Kota Bengkulu is a religious city. At present, tat cake cooking is not only for help, but has become a commodity for home-based businesses. The cake has been sold in stalls, in the school canteen and in the super market. People of Bengkulu like the cake. Therefore, tat cake is very close to the child's mind. That is the starting point for children. Horizontal matematization thoughts. It is also one of the ethnomatematics approaches.
Figure 7. Bengkulu Tradition of Tat Cake

(Source: https://www.anazkia.id/2016/06/tart-bengkulu-dari-felda-kedangsa.html)

Based on the tradition of durian collapse and cake ‘tat’, we provide the following contextual problems. "Durian collapse in Bengkulu has almost the same size, so the price is the same for every durian. Ujang buys 2 durians and 1 cup cake ‘tat’, at a price of IDR 90,000. Also, Joko bought 1 durian and 1 cup cake ‘tat’. Joko pays IDR 65,000. What is the price of a durian, and a bowl of cake ‘tat’?" We call this a Problem 2.

Based on Figure 7, through the mathematical process as the stages in Problem 1, the processes are in Figure 8 through Figure 12 respectively. It is a horizontal mathematical process, which is directed by students to the vertical mathematical process. These processes are addressing students’ difficulties in understanding the concept of a two-variable system of linear equations.

Figure 8. Translating Problem 2 in the picture
Figure 9. Elimination of 1 durian and 1 bowl of cake ‘tat’

Figure 10. A durian worth IDR 25,000

Figure 11. Substitution of a durian with IDR 25,000

Figure 12. A 'tat' cake bowl worth of IDR 40,000
The day-to-day mathematical process in Figures 8 through 12 is a trigger for students to carry out vertical mathematical processes. It begins with the example of the price of durian with \( D \), a bowl of cake ‘tat’ with \( T \). This produces a 2D linear equation system \( + T = 90,000 \) and \( D + T = 65,000 \). Furthermore, the process produces the principle of elimination and substitution as follows.

\[
\begin{align*}
2D + T &= 90,000 \\
D + T &= 65,000 \\
\end{align*}
\]

Subtracting the second equation from the first gives \( D = 25,000 \). This value of \( D \) substituted to \( D + T = 65,000 \) produces \( T = 40,000 \). This is the solution to Problem 2, which is the price of a IDR 25,000 durian, and the price of a bowl of cake kue ‘tat’ IDR 40,000. Until this mathematical process, there were 78% of students who were able to solve the Problem 2. Thus, the ethnomathematics approach was very useful to overcome the difficulties of students in understanding the concept of a two-variable linear equation system.

The cultural diversity of Bengkulu society is an attraction for us to use it as a medium for developing the ethnomathematics approach. Another culture that is no less popular is the culture of burning lemang and cooking tapai black sticky rice. It is the ancestral culture of the Bengkulu people, mainly from the Masat District in South Bengkulu Regency. Lemang is a food made from white sticky rice cooked in bamboo and burned (see Figure 13).

![Figure 13](https://www.sarihusada.co.id/Nutrisi-Untuk-Bangsa/)

**Figure 13.** Culture of Bakar Lemang and Tapai Bengkulu, Indonesia

(Source: [https://www.sarihusada.co.id/Nutrisi-Untuk-Bangsa/](https://www.sarihusada.co.id/Nutrisi-Untuk-Bangsa/))

Based on the culture of eating lemang mixed with black sticky rice, we can make contextual problems. This problem is called Problem 3. Problem 3 is "Bu Upik buys 2 sticks of lemang and 2 cups for IDR 60,000. Mr. Uncu likes tapai and buys 5 tapai dishes and 1 stick of lemang for IDR 60,000. Without knowing the price of 1 stick of lemang and 1 tapai cup determine which is more expensive? Determine the price of each?"

By using a horizontal mathematical process, it turns out that 87% of students are able to finish correctly. They started by translating Problem 3 with pictures. Look at Figure 14.
Based on Figure 14, it can be mathematical in such a way that it is concluded that the price of 1 stick of lemang is more expensive than the price of 1 cup tapai. The student argues that the price of 2 tapai dishes is worth 1 lemang (Argument 1). Based on this argument, the mathematical process can proceed like Figure 15.
According to Figure 15. For example L = a *lemang*, C = one cup tapai. Based on Figure 14, the system of linear equations is obtained as follows:

\[
\begin{align*}
2L + 2C &= 60.000 \\
L + 4C &= 60.000 - L - 2C &= 0
\end{align*}
\]

**Figure 15.** Advanced mathematical process Figure 14
L - 2C = 0 → L = 2C, this is an argument that the price of one stick of lemang is more expensive than the price of one stick of rice. That is the argument, L = 2C. Figure 15, shows that L = 20,000 and C = 10,000. Thus, the price of a IDR 20,000 lemang and a price of IDR 10,000.

How does the writer know, where is the score?

The number of students who are able to understand the concept of a two-variable linear equation system increases from 56% to 87%. That is a direct impact of learning ethnomathematics. This supports the results of previous studies such as Widada [14] that the use of appropriate and appropriate contextual learning media can improve students’ abilities in the process of achieving mathematical concepts and principles as well as improving student mastery [14]. The mathematical problem solving models are higher than before being given the models of learning [2]. The average ability of students' mathematical understanding of higher ethnomathematics-oriented materials students who are given non-ethnomathematics materials [13]. Students solved mathematical problems through matematization process based on ethnomathematics. Students were aware that the ethnomathematics were the starting point of horizontal matematization activity [11]. After learning with the ethnomathematics approach, the abstract character level can be explained to solve the problem, he tries to make a new statement outside the original statement by referring to the statement [18]. Thus, the very potential ethnomathematics approach can overcome students' difficulties in understanding mathematics. This is a reasonable result, and we recommend that it be applied in learning school mathematics.

4. Conclusions
Based on the description of the results of the research and discussion, we conclude that some students’ difficulties in understanding the concept of a two-variable linear equation system are difficulties in understanding, difficulty understanding principles, difficulty understanding problems, and operating difficulties. These difficulties can be overcome through the ethnomathematics learning approach. Like Bengkulu fishermen culture, the culture waits for the windfall and cake ‘tat; and the tradition of burning lemang and making black sticky rice tapai. It is used for horizontal mathematical processes and is an analogy for vertical mathematical processes. Also, the number of students who are able to understand the concept of a two-variable linear equation system increases from 56% to 87%.

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