Students' mathematical communication ability in the ethnomathematical arias model

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Abstract. This research is motivated by the low mathematical-communication-ability of junior high school students. This study aims to determine whether the use of the ethnomathematical ARIAS-model is effective in mathematical-communication-ability. The study design was a pretest-posttest-control-group-design. The population in this study were eighth grade students of SMP Negeri 1 Karangampel Indramayu. The research sample consisted of 57 students (27 students in the experimental class and 30 students in the control class). Data collection techniques using pretest and posttest; pretest to know students' initial mathematical-communication-ability before and posttest to find out students' last mathematical-communication-ability after teaching and learning. Early mathematical-communication-ability was also used to determine the normality and homogeneity of the experimental and control class. Data were analyzed using parametric analysis of mean test, proportion test, average difference test, proportion difference test, and gain difference test. The results of this study indicate that the ARIAS-model with ethnomathematics nuances is better than problem-based learning in mathematical-communication-ability.

1. Introduction
The 2013 curriculum is the Indonesian national curriculum which encourages students to make better observations, questions and answers, what they get or know after receiving subject matter and students are expected to have good competence in attitudes, skills and knowledge. The Common Core State Standards for Mathematics and the National Council of Teachers of Mathematics supported students learn mathematical proof and generalization. The Common Core State Standards for Mathematics and the National Council of Mathematics Teachers recommends that in applying mathematics learning in schools, teachers must pay attention to five mathematical abilities, namely: connections, reasoning, communication, problem solving, and representation. Therefore, in the learning process the teacher plays an important role in developing students' mathematical-communication-ability, so that students can solve the problems they face.

The results of the Trends in International Mathematics and Science Study (TIMSS) 2015 \cite{2} showed that the average score obtained by Indonesia was 397 and ranked 44 out of 49 participating countries. \cite{3} which states that the results of the analysis show that the majority of Indonesian students have difficulty at the initial stage of completing a task, namely understanding context-based tasks and turning them into problems or mathematical models. This is consistent with the results of observations...
made in class VIII SMP I Karangampel Indramayu that students’ mathematical-communication-ability were low, based on test results that students who can reach the actual graduation limit (APL) of 65.05 were 14 students out of 31 students who took the test. Another factor that causes the low mathematical-communication-ability caused in the learning process, communication between students and teachers was still lack during learning.

One alternative learning model that can be used to foster students' mathematical-communication-ability was the ARIAS-model with an ethnomatics nuance. The ARIAS-model with the nuances of ethnomathematics connects mathematics material taught with Indramayu culture, so that in the learning process students get knowledge about mathematical material as well as knowledge about Indramayu culture. Lee [4] believed that ethnomateamatics is a concept for increasing knowledge about the development of mathematics in various cultures. Ethnomathematics can be used as a bridge to study the relationship between academic mathematics and the real world [4-5], created through the learning process by teachers and students.

Based on the background of the problem, this study discussed the mathematical-communication-ability of students in the ARIAS-model with the nuances of ethnomathematics. The purpose of this study is to study the effectiveness of the ARIAS-model with ethnomathematics nuances in students' mathematical-communication-ability.

The National Council of Mathematics Teachers revealed that mathematics communication is one of the important basic competencies of mathematics and mathematics education. Mathematical-communication a fundamental mathematics education objective that involves cognitive domain and social daily-activity [6]. Therefore, every student must have good mathematical communication. One of several components which could affect the success in mathematics learning is the need to attend to precision both calculation competence and language ability. Learning mathematics in the classroom should help students to communicate their idea [7]. Mathematical language or mathematica-communication is an important part of Mathematics learning as a means to exchange mathematical ideas and tools to clarify understanding of the problem.

Indicators of mathematical-communication-ability used in this study according to Sumarmo [6] include: (1) expressing real objects, situations, and daily events in the form of mathematical models (pictures, tables, diagrams, graphs, algebraic expressions); (2) explaining mathematical ideas and models (pictures, tables, diagrams, graphs, algebraic expressions) into ordinary language; (3) explain and make learning mathematical questions; (4) listen, discuss and write about mathematics; (5) reading with understanding of written presentations; and (6) make guesses, formulate arguments, formulate definitions and generalizations.

ARIAS-model is a learning model developed from the ARCS learning model developed by John M. Keller. According to the John Keller ARCS-Model of Motivational Design Theory Model, there are four steps to promoting and maintaining motivation in the learning process. There are four components to the ARCS-model, and it stands for Attention, Relevance, Confidence, and Satisfaction. The ARCS-model supports the creation, stimulation and emphasis of motivation by teachers so students are motivated to learn and motivated to solve problems [8]. Siahaan [9] stated that the ARIAS-model can be used by teachers as a basis for good learning and can increase student motivation and learning outcomes. The ARIAS-model consists of five components, namely Assurance, Relevance, Interest, Assessment, and Satisfaction.

In mathematics education, ethnomathematics is the study of the relationship between mathematics and culture. According to [10] that ethnomathematics was a research program that focuses on the relationship between mathematics and culture. Rosa and Orey [11] argued that ethnomathematics refers to group members in a cultural environment that were identified by cultural traditions, codes, symbols, myths, and special ways used to reason and conclude. In this research, ethnomathematics was the traditional culture of the Indramayu region, including in it the tepakan gambar or wayang, ngarot, cimplo, and telitian pari.

(1) Playing “Tepakan Gambar”. Playing tepakan gambar or wayang as one of the activities that instill mutual respect and obey the rules. This game is often done by children in Indramayu. The
Indramayu community said the card was used as a wayang. Cards are played directly to the players. The card consisting of two surfaces will then fall to the ground with one of the surfaces exposed.

(2) Ngarot. The Ngarot tradition is a traditional ceremony found in Lelea Village, Indramayu. The Ngarot tradition means thank you for the arrival of the growing season. The Lelea community has a unique expression of thanks in welcoming the growing season, namely with Ngarot. The purpose of the Ngarot tradition is to invite young people to work together in farming, especially farming. In addition, the Ngarot tradition aims to foster healthy relationships, get to know each other, to adjust their attitudes, desires, behavior in accordance with cultural customs. Sometimes the ceremonial traditions of the agrarian community also often become a place to find a mate in the village. Traditional Ngarot ceremonies are always held in December on the 3rd week and are always held on Wednesday because it is considered sacred.

(3) Cimplo. For Indramayu Regency's natives, who until now still adhere to the customs of their ancestors, every time they enter the month of Bala (Java) or the month of Sapar (Islam) the locals hold a thanksgiving by making a cake "Cimplo" (a type of apem made from rice flour mixed with yeast). Indramayu residents assume that the existence of the Cimplo cake is an implementation to reject the reinforcements (drive away bad luck) for its citizens. The month "Safar" or "Bala" also coincides with the rice growing season by the majority of the population of Indramayu, so with such a blessing, hopefully the Indramayu people will flourish and prosper.

(4) Telitian Pari. Telitian Pari activities as one of the activities that instill discipline with a rule and agreement, responsible attitude, mutual respect, friendly attitude full of harmony, and others. After the harvest season there is usually a collection of Telitian Pari (a kind of social gathering). Each member of the Telitian Pari gathered with a number of pre-determined rice. Then, after everything is collected, a lottery is conducted to determine who has the right to bring the collected rice. The results obtained are usually used as capital to hold a celebration event, as capital to rent agricultural land, or also to pay for rice pawns.

2. Research Methods

2.1. Research Design

This study used a mixed method with the kind of sequential explanatory design, which in this study combined research methods of quantitative and qualitative research in order. Writing this article aims to determine the effectiveness of a treatment, so that the method used is only quantitative research methods. The type of research design as Figure 1 used ‘Pre-test Post-test Control Group-Design.’

![Figure 1. Pre-test Post-test Control Group Design](image)

Description: E = experimental class; K = control class; X₁ = treatment of the experimental class, using the ARIAS-model with ethnomathetic nuance; X₂ = treatment of the control class, using the PBL-model; O₁ = pretest measurement results; O₂ = posttest measurement results.

The study design used two groups, namely the experimental group and the control group. Subjects in the two groups were given an initial ability test, then in the experimental group were treated using the ARIAS-model with ethnomathematics nuance and in the control group using the PBL-model, then given the final communication-mathematics test.
2.2. Research Location
This research was conducted at SMP 1 Karangampel Indramayu West Java Indonesia. All participants were in class VIII. The study sample consisted of 57 students divided into two classes. The experimental class consists of 27 students, while the control class consists of 30 students.

2.3. Data Analysis
Data collection techniques were carried out namely the initial ability test and the test of mathematical communication ability. Data analysis techniques in this study include testing the initial data analysis and hypothesis testing. The initial data analysis test was the normality test using the Kolmogorov-Smirnov test and homogeneity test using the Levene test. Hypothesis testing includes mean test (t-test), Z proportion test, mean proportional test, difference test, and difference gain average test.

3. Results and Discussion
The preliminary data analysis carried out was the normality test on the results of the students' initial mathematical ability test to see whether the sample came from a population that was normally distributed. The results of the normality test show that the significance value of the experimental class was 0.092 > 0.05 and the control class was 0.200 > 0.05. Based on these results, at the level of \( \alpha = 5\% \), it can be concluded that students' initial mathematical abilities in both classes are normally distributed. To find out whether the two classes have the same variant, the homogeneity test is carried out. The homogeneity test results show that the significance value is 0.395 > 0.05, meaning that the results of the students' initial mathematical ability tests from both classes are homogeneous. The results of the students' initial mathematical ability test are used to calculate the value of the Actual Pass Limit (APL). APL value of mathematical communication ability is 49.85.

Before conducting a hypothesis test, the prerequisite test was first performed, namely the test for normality and homogeneity in the value of mathematical communication ability of the experimental class students and the control class. The results of the normality test show that the significance value of the experimental class mathematical communication ability is 0.058 > 0.05, and the significance of the mathematical communication ability of the control class is 0.200 > 0.05. Based on these results, at the level of \( \alpha = 5\% \), it can be concluded that the value of mathematical communication ability of students in both classes was normally distributed. The homogeneity test results show that the significance value is 0.252 > 0.05, which means that the results of tests of mathematical communication ability of students from both classes are homogeneous. The statistical data of students' mathematical communication skills are presented in Table 1.

| Class    | Maximum score | Minimum score | Mean  |
|----------|---------------|---------------|-------|
| Experiment | 80.56         | 30.56         | 54.94 |
| Control   | 50.00         | 18.06         | 31.43 |

The results of the students' mathematical communication ability in Table 1 show that the mathematical communication ability of the experimental class students are better than the control class students. This can be seen from the average value of the mathematical communication ability of the two classes. The average value of mathematical communication ability of experimental class students is 54.94 while the average communication ability of the control class is 31.43. Hypothesis test results can be seen in Table 2.
The results shown that students in the ARIAS-model with ethnomathematics nuance had better learning outcomes than problem based learning, as conventional learning. Students in both classes were accustomed to group learning and discussion. However, in ARIAS-model with ethnomathematics nuance of students were more active in discussion than conventional learning. Students in both classes were accustomed to group learning and discussion. But there are some students who tend to be passive, causing less understanding of the material being studied. In the learning process using the ARIAS model with ethnomathematics it not only refers to the large-region of the variety of human civilization such as cultural traditions; also refers to the special characteristic of ‘lifestyles’ and ‘working ways’ in various communities of students.

Based on Table 2, using $\alpha = 5\%$ the t-test obtained $t_{\text{count}} = 2.140$ more than $t_{\text{table}} = 1.706$ then it can be interpreted that the average value of mathematical communication ability has been completed or has exceeded the Actual Pass Limit (APL). In the z-test of proportion test the value of $z_{\text{count}} = 0.33$ less than $z_{\text{table}} = 1.645$ then it can be interpreted that the proportion of students who complete mathematical communication ability in the ARIAS model with ethnomathematics nuance is at most 75%. In the average difference test, the value of $t_{\text{count}} = 8.32$ more than $t_{\text{table}} = 1.673$ then it can be interpreted that the average value of students' mathematical communication ability in the ethnomathematics nuance is more than the average mathematical communication ability of students in the problem based learning model. In the different proportion test, the value of $z_{\text{count}} = 5.46$ more than $z_{\text{table}} = 1.645$ then it can be interpreted that the proportion of students’ mathematical communication ability in the ARIAS model with ethnomathematics nuance is more than the proportion of students' mathematical communication ability in the problem based learning model. In the gain average difference test obtained value $t_{\text{count}} = 6.98$ more than $t_{\text{table}} = 1.1673$ then it can be interpreted that the average difference in the value of mathematical communication ability of students in the ARIAS model with ethnomathematics nuance more than students in the problem based learning model.

This study aims to find out how effectiveness the used of the ARIAS model with ethnomathematics nuance on the mathematical communication ability of Grade VIII students of SMPN 1 Karangampel. A learning can be said to be effective if all hypothesis tests performed are fulfilled. The data used in hypothesis testing are the results of tests of mathematical communication ability of students in the class that apply the ARIAS model with ethnomathematics nuance (as experimental class) and another class that apply the PBL model (as control class). Based on the results described previously, that the average value of communication ability of students has been completed or more than APL with a value of $t_{\text{count}} = 2.140$. Based on the test results of mathematical communication ability can be seen that of the 27 students who took the tests in the experimental class were 21 students have reached the APL, the remaining 6 students did not complete individually. The number of students who have completed reached APL as much as 77.8%. This shows that the proportion of students who complete the test of mathematical communication ability does not exceed 75%. This is indicated because there were some students who have not understood the material being studied. In the learning process using the ARIAS model with ethnomathematics nuance, students are actively involved in learning and group discussion, but there are some students who tend to be passive, causing less understanding of the material being studied. Hadi [12] argued, students who were lazy to learn and find out difficult to remember the material, and will make many difficulties in following learning using the ARIAS model with ethnomathematics nuance. The another reason that ethnomathematics not only refers to the large-region of the variety of human civilization such as cultural traditions; also refers to the special characteristic of ‘lifestyles’ and ‘working ways’ in various communities of students [13].

| Table 2. Summary of hypothesis test results |
|----------------|----------------|----------------|
| Hypothesis Testing | Calculated Value | Table Value |
| T-test | 2.140 | 1.706 |
| Proportion Test Z | 0.33 | 1.645 |
| Average Different Test | 8.32 | 1.673 |
| Proportion Test | 5.46 | 1.645 |
| Average gain difference test | 6.98 | 1.673 |
| Average difference test | 1.706 |

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classes. It can be seen during the learning process of students became more active to ask questions about things they do not understood. The learning process took placed students were quite active in discussing and asking questions. Based on the results of the study [14], it was suggested that mathematics teachers make an effort qualified learning materials and integrate local culture in mathematics learning. According to observation showed not only about mathematical material, but students also asked about the culture or ethnomathematics used in the problems given. This shown that there were some students who did not know about the culture around of Indramayu district; so that in the learning process the teacher also explained about the culture around the environment the students in Indramayu. In the learning process students had high interest and initiative to present the results of their discussion in the class. When the teacher informs that the results of the group discussion must presented in the class, student presented in group took the initiative and they were confident presented the results of their discussion. This shown that learning with the ARIAS-model with ethnomathematics nuance could motivate students to increase their mathematical abilities, in this case the mathematical-communication-ability.

The ARIAS model with ethnomathematics nuance is develop students' mathematical communication ability when students are actively involved in learning. But in this study there were students who were less active in learning, which resulted in a lack of student understanding of the material being taught. This results in the results of classical completeness of no more than 75%. Overall students' mathematical communication ability in the ARIAS model with ethnomathematics nuance were better than students in the PBL model. As research result [15] using the learning model of ARIAS is more effective than PBL on the concept mastery of temperature and heat in high school students. The ARIAS model with ethnomathematics nuance was effective to improved students' mathematical communication ability.

4. Conclusion
Based on the results and discussion above, it can be concluded that the application of ARIAS models with ethnomathematics nuance was quite effective in being able to shaped the students' mathematical communication ability. This can be seen from: (1) the average value of students' mathematical communication ability in the class applying the ARIAS model with ethnomathematics nuance had reached completeness; (2) the proportion of students who achieved mathematical communication ability in the ARIAS model with ethnomathematics nuance was at most 75%; (3) the average value of students' mathematical communication ability in the ARIAS model with ethnomathematics nuance was more than the average mathematical communication ability of students in the PBL model; (4) the proportion of students 'mathematical communication ability in the ARIAS model with ethnomathematics nuance was more than the proportion of students' mathematical communication ability in the PBL model; (5) the average difference in the value of students' mathematical communication ability in the ARIAS model with ethnomathematics nuance was more than students in the PBL model. The use of the ARIAS model with ethnomathematics nuance was not only for 'opportunity' a specific material, but also can be used for some another material. Through this study, the use of ARIAS models with ethnomathematics nuance is expected to be one of the choices of learning model that can improve student learning outcomes and especially to increase students' mathematical communication ability.

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