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Ethnomathematics integrated realistic mathematics education to improve students' interpersonal intelligence

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Abstract

The development of mathematics education that can act as a bridge between culture and mathematics is necessary for student. This study examines the feasibility and efficacy of learning mathematics using Realistic Mathematics Education (RME) and ethnomathematics to enhance students' interpersonal intelligence. Students from junior high school were the subjects of this study. This study developed learning model through design research. Data collection were implemented using questionnaires. In addition, this study employed expert validation and interpersonal intelligence questionnaire sheets as the instruments. Based on data analysis, it was determined that: 1) Mathematics learning through ethnomathematics integrated RME was declared valid or feasible to be applied in mathematics learning to improve students' interpersonal intelligence; 2) The dimensions of interpersonal intelligence achieved by students include discussion (social communication) and cooperation

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(social sensitivity). Therefore, learning mathematics using ethnomathematics integrated RME could be applied for learning mathematics in junior high school.

Keywords: Mathematics learning, RME, ethnomathematics, ınterpersonal intelligence, learning model.

1. Introduction

Learning mathematics is not only learning that focuses on knowledge, but also learning that can improve comprehension, skills, and analytical abilities so that students can solve everyday mathematical issues (Amalia et al., 2017). Mathematics is synonymous with a series of numbers, symbols, and formulas whose completion requires mathematical arithmetic operations. However, in the world of education, many consider mathematics to be a challenging subject (Amiluddin & Sugiman, 2016). Therefore, teachers require an effective and efficient method or strategy for teaching mathematics efficiently.

According to Hardiarti (2017), mathematics is a culture that allows mathematics to permeate all facets of human life. In many facets of Indonesian cultures, such as sculptures, batik patterns, things used in traditional ceremonies, and even some historical artifacts, a relationship between life and mathematical elements exists, whether consciously or not. Integrating multiple cultural components of society with mathematics can be used and exploited as a learning method that is still relatively new in Indonesia's education system (Bishop, 1991).

Interpersonal intelligence is one of Howard Gardner's eight proposed intelligence. In response to students' communication difficulties, Daniyati and Sugiman (2015) claimed that interpersonal intelligence plays a role in mathematics education in schools. In order to receive assistance in solving a math problem, students must communicate with brighter peers or the instructor. Thus, interpersonal intelligence will facilitate students' knowledge exchange during learning activities. For example, discussing with the instructor or with peers. This engagement will assist students in communicating their challenges in comprehending the lecture so that they may be resolved promptly.

Interpersonal intelligence will shape interaction patterns when creating partnerships to compensate for each other's shortcomings and share strengths (Barseli et al., 2019). With interpersonal intelligence, pupils get vital knowledge-expanding information. This connection can aid students' advancement, including cognitive development. Individual skill in social interaction is required for learning. Therefore, interpersonal intelligence plays a significant role.

1.1. Conceptual or theoretical framework

Realistic Mathematics Education (RME) is one of the learning methods that may help pupils acquire knowledge and fresh experiences in mathematics so that mathematics becomes more relevant (Laurens et al., 2017). RME is a learning method that enables students to actively participate in comprehending and finding mathematical concepts in their way, based on their prior knowledge, experience, and the given material. Culture is one feature that can be established through innovations in RME-integrated mathematics learning relevant to students' daily life.

According to Supiyati and Halqi (2020), ethnomathematics is a relatively new branch of mathematics that can be used as a teaching method. Ethnomathematics is a field of study that can serve as a bridge between learning mathematics and culture. According to Destrianti (2019), ethnomathematics applies mathematics to cultural activities involving mathematics, such as counting, measuring, designing buildings or tools, playing, finding locations, etc. Through ethnomathematics, mathematical ideas can be studied via cultural practices, allowing students to understand better how

their culture relates to mathematics and allowing educators to instill national values that impact character education.

Establishing mathematics education that can serve as a bridge between culture and mathematics is essential. RME can be developed as an innovation in the learning process for mathematics learning. Using ethnomathematics to develop instructional materials has been proven to enhance learning and provide suitable instructional materials (Fitriyah et al., 2018).

The development of mathematics learning through ethnomathematics-integrated RME can be used to enhance the interpersonal intelligence of junior high school pupils, as measured by their ability to adapt well to their peers, the environment, and society. A person's self-esteem, motivation, and Intelligence level might be affected by their adaptability. In addition, interpersonal intelligence encompasses student activities involving interactions with peers, teachers, and community members.

1.2. Related research

According to research conducted by Fitriyah et al. (2018) and Disnawati (2019), the efficiency of teaching materials employing ethnomathematics is 84.5 and 80%, respectively. This efficiency level corresponds to the mastery of classical learning attained after pupils have completed their studies (Lakapu et al., 2020). Using ethnomathematics as a teaching tool provides advantages beyond the effectiveness and usability of instructional materials. It is evidenced by the study from Ndiung and Jediut (2021), which employed ethnomathematics by including *Manggara* cultural artifacts in mathematics instruction. This research indicated that ethnomathematics could enhance students' creative thinking abilities and make learning more engaging. Furthermore, this study demonstrated the possibilities of using ethnomathematics-based learning methods to enhance many intellectual abilities.

1.3. Purpose of the study

This current study constructs ethnomathematics-integrated RME for teaching mathematics. In the development of mathematics learning using ethnomathematics-integrated RME, the researchers wanted to highlight the *Javanese* cultural wedding tradition, as marriage is an intrinsic aspect of human traditions and rituals. In other words, researchers seek to establish a connection between mathematics learning through RME and some customs observed in *Javanese* wedding processions so that it could be a new step in mathematical problem-solving and be accompanied by an increase in interpersonal intelligence. Eventually, this study attempts to answer the following question: Does the ethnomathematics integrated RME learning model could increase students' interpersonal intelligence?

2. Method

2.1. Participants

This study employed design research as its method of inquiry. The participants in this study were 30 students from Nur Azizi Junior High School, North Sumatra, Indonesia. In addition, two experts were involved in validating the developed learning model. This research was authorized by the Department of Education, which oversees the school.

2.2. Data collection tools

The development model applied in this study is a blend of the models developed by Plomp (2013) and Gravemeijer and Cobb (2006). The Plomp model consists of three phases: (1) preliminary study; (2) development or prototyping; and (3) assessment (Plomp, 2013). Gravemeijer and Cobb's development model was used in the prototype design phase of the development phase, specifically: (1) the trial

preparation phase (preparing for the experiment); (2) the design trial phase in the classroom (experimenting in the classroom); and (3) the retrospective analysis phase (Gravemeijer & Cobb, 2006).

Table 1

Expert Validation Sheet Grid

Rated Aspect	Indicator
Introduction	Supporting theory of learning models
	Background on the development of learning models
	The objective of developing a learning model
Content/Implementation	Description of the learning model
	Learning model syntax
	The social system of learning models
	Use of learning model approach
	Learning steps
Evaluation/Closing	Evaluation and assessment
	Desired learning outcomes

Table 2

Students' Interpersonal Intelligence Questionnaire Grid

Dimensions of Interpersonal Intelligence	Indicator
Social sensitivity	Friends or social circle
	Not easily influenced
Social understanding	Dealing with a problem
	Independent
	Self-rating
	Values and self-confidence
Social communication	Strong argument

Table 3

Assessment Score of Expert Validation Sheet

Score	Category
5	Highly acceptable
4	Acceptable
3	Moderately acceptable
2	Fairly acceptable
1	Not acceptable

Researchers employed expert validation sheets and student interpersonal intelligence questionnaires as data collection instruments. The expert validation sheet grid on the developed learning model is shown in Table 1. In addition, the dimensions of interpersonal intelligence assessed in this study are presented in Table 2. Meanwhile, the scale used for the validation process and assessing students' interpersonal intelligence are shown in Tables 3 and 4, respectively.

Table 4

Self-Assessment Scale of Students' Interpersonal Intelligence Questionnaire

Score	Category
4	Strongly Agree
3	Agree
2	Disagree
1	Strongly Disagree

2.3. Data collection process

The data collection process was done in several stages. The early stage entails the development of an ethnomathematics-integrated RME learning model with the syntax presented in Table 5. In addition, Figure 1 illustrates the learning material presented in the developed learning model. Then, two expert validators who are junior high school mathematics teachers assessed and provided feedback on the proposed learning model. After the learning model has been revised based on expert advice, it can be utilized.

Meanwhile, interpersonal intelligence data was acquired from students before and after the deployment of the developed learning model. Students completed a questionnaire following the learning process. This study did not distinguish its subjects. Hence there was no control group. Nonetheless, the same subject was involved, which received different learning materials with and without learning models. Finally, the difference in interpersonal intelligence scores before and after implementing the learning model was determined at the end of the investigation.

Table 5

Syntax of Ethnomathematics Integrated RME Learning Model with Javanese Cultural Wedding Tradition

Learning Stages	Student Activities
Cultural apperception of *Javanese* wedding traditions	• Understanding information about Javanese wedding traditions with the topic of mathematics in students' daily lives about quadrilaterals and triangles. • Creating a positive self-perception of Javanese wedding traditions and mathematics. • Understanding the relationship between Javanese wedding traditions and the topic of mathematics in solving problems about quadrilaterals and triangles. • Self-motivating in learning mathematics through the application of Javanese wedding traditions and their use in mathematics.
Representation and understanding of contextual issues with *Javanese* wedding traditions	• Students were grouped into several groups. • Understanding the problems related to Javanese wedding traditions as a starting point for learning individually and in groups. • Learning to find their ideas or knowledge (as a hypothesis) to be able to solve the problems given.

Learning Stages	Student Activities
	• Connecting real objects or images presented in ideas or mathematical models. • Explaining ideas verbally or in writing using real objects or pictures.
Solving contextual problems by following the tradition of calculating *weton* (*Salaki Rabi*) for *Javanese* wedding traditions	• Describing the given contextual problem. • Stating the problem in mathematical symbols. • Interpreting the mathematical concepts studied. • Determining strategies and developing skills in solving mathematical problems related to Javanese wedding traditions about quadrilaterals and triangles. • Performing problem-solving calculations based on prior knowledge. • Working together in completing tasks in groups.
Comparing and discussing the results of problem-solving based on *Javanese* wedding traditions	• Presenting the results of problem-solving. • Explaining and giving reasons for each answer. • Understanding the answers of other students. • Confirming other answers. • Expressing disapproval of other answers supporting by reasons. • Looking for other alternative solutions. • Listening, discussing, and writing alternative solutions.
Concluding and presenting the findings of mathematical objects based on *Javanese* wedding traditions	• Understanding written math presentations. • Discussing the results of the work so that conclusions can be drawn from completing the correct answers. • Presenting the results of the answers as an alternative solution that is correct and systematic. • Reflecting on each step taken and the problem-solving results obtained.

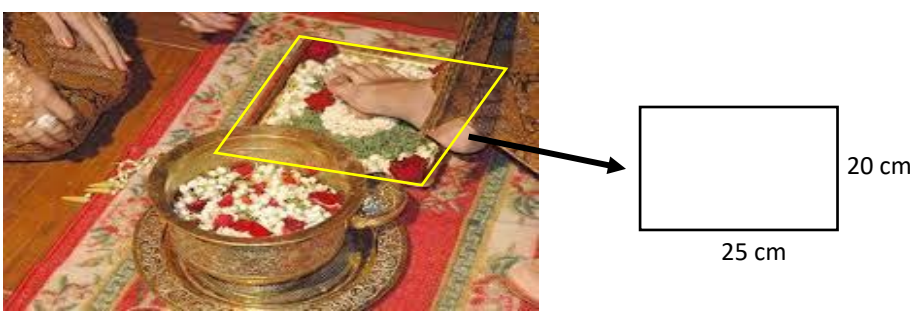

Figure 1

The rectangle on the "Nginjak Tigan" Tradition

Figure 1 depicts the tradition of stepping on a *Tigan* (small carpet) at a traditional *Javanese* wedding. The marked images reveal that this tradition includes a rectangular element, specifically a 25 cm × 20 cm rectangle. The question for students is: calculate the rectangle perimeter!

First stage: understanding contextual issues.

Known: $length\ (l) = 25\ cm$ *and* $width\ (w) = 20\ cm$

Problem: Rectangle perimeter

Second stage: solving contextual problems

Answer: To determine the perimeter (P) of a rectangle, use the formula for the perimeter of a rectangle.

$$P = 2\ x\ (l + w) = 2\ x\ (25\ cm + 20\ cm) = 2\ x\ 45\ cm = 90\ cm$$

Third stage: comparing and discussing the answers with others.

Final stage: concluding.

So, the rectangle's perimeter is 90 cm.

2.4. Data analysis

Data from the expert validation were analyzed by accumulating the acquired scores, then checking them according to the criteria in Table 6. Meanwhile, data from the interpersonal intelligence questionnaire were analyzed by accumulating the scores acquired by each student prior to and following the implementation of the learning model and then converting each score to a maximum scale of 4 using the following equation:

$$x = \frac{Total\ score\ of\ student}{Maximum\ score} \times 4$$

Table 6

Criteria for Validating the Developed Learning Model

Score (x)	Validity Category	Remarks
$40 < x \leq 50$	Extremely Valid	Very good to be used
$30 < x \leq 40$	Valid	May be used with minor revisions
$20 < x \leq 30$	Moderately Valid	May be used with major revisions
$10 < x \leq 20$	Invalid	Should not be used

Furthermore, the average score was obtained by dividing the total scores from all students by the number of students.

$$\bar{x} = \frac{\sum x_i}{n}$$

The collected data is then projected into a diagram to illustrate changes in the students' interpersonal intelligence before and after the learning model implementation.

Table 7

Interpersonal Intelligence Criteria

Score	Eligibility Criteria

$3.26 < x \leq 4.00$	Very Good
$2.51 < x \leq 3.25$	Good
$1.76 < x \leq 2.50$	Moderate
$1.00 < x \leq 1.75$	Bad

3. Results

The validation of mathematics learning by ethnomathematics-integrated RME begins with developing an RME-based mathematics learning model that incorporates *Javanese* cultural wedding traditions into a learning syntax for solving math problems. The RME mathematics learning model begins with the perception of *Javanese* culture, followed by the representation and comprehension of contextual problems, contextual problem solving, a discussion of the results of problem-solving, and concluding activities and the presentation of mathematical object findings. At the end of the learning model development, expert validation was performed to evaluate the established learning model.

Students were requested to complete a questionnaire assessing their interpersonal intelligence based on syntax and the reaction or communication principle that occurs during learning. Tables 8 and 9 display the results of expert validation and student interpersonal intelligence scores, respectively.

Table 8

Results of Expert Validation of the Ethnomathematics Integrated RME Model

Assessment Indicator	Validator	
	I	II
Supporting theory of learning models	4	4
Background on the development of learning models	4	3
The objective of developing a learning model	4	4
Description of the learning model	3	4
Learning model syntax	4	3
The social system of learning models	3	3
Use of learning model approach	4	4
Learning steps	4	4
Evaluation and assessment	4	4
Desired learning outcomes	4	4
Total	38	37
Conclusion	Valid	Valid
Average	37.5	

Table 8 shows the validators' decision which indicated that learning mathematics using ethnomathematics integrated RME was valid and may be used in the learning process with minor revision. Input from the validator was utilized to revise the developed mathematics learning model for its feasibility.

Figure 2 demonstrates the results of a questionnaire assessing students' interpersonal intelligence before and after the implementation of the developed learning model. This data was gathered from 7 questionnaire indicators completed by 30 students. The data has been converted to a 5-point scale so that the final findings can be classed according to the predetermined criteria.

The maximum scores attained by students prior to and following the implementation of the learning model are 3.23 (good) and 3.97 (very good), respectively. The minimum scores obtained by students prior to and after the implementation of the learning model were 1.70 (bad) and 3.00 (good), respectively. Meanwhile, the average scores obtained by students prior to and following the implementation of the learning model were 2.70 (good) and 3.53 (very good), respectively. Based on these findings, it may be concluded that students' interpersonal intelligence has increased.

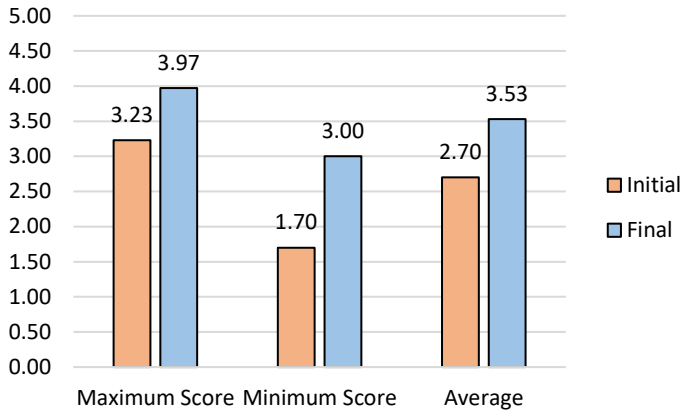

Figure 2

Changes in Student Interpersonal Intelligence

4. Discussion

It is evident that the interpersonal intelligence of 30 students averaged a score of 3.53 with very good criteria. The students' interpersonal intelligence has risen compared to their interpersonal intelligence prior to implementing ethnomathematics-integrated RME learning model. This result demonstrates pupils' social sensitivity and communication skills. Students can express thoughts and communicate effectively as long as the learning model is used in the learning process, as demonstrated by the research method.

RME was derived from Freudenthal's (1971) assertion that mathematics is an integral component of human life (Gravemeijer, 2008). According to him, students should be able to reinvent mathematics by controlling and analyzing real-world circumstances or by establishing connections between mathematics and processes that are significant to them. Freudenthal determined numerous perspectives on RME, including "mathematics must be tied to reality" and "mathematics as a human activity."

RME is a viable method for improving and enhancing students' mathematical idea comprehension. RME can enhance the logical, analytical, and creative thinking of pupils, as well as their interpersonal intelligence. By presenting students with problems in context, RME aims to make learning mathematics more engaging and meaningful. One of the efforts to incorporate RME in mathematics education is to use the connections between parts of life, including traditional cultures and mathematics (Revina & Leung, 2019). Ethnomathematics reveals, as discussed previously, the connections between mathematical components in this culture.

Ethnomathematics is a blend of two distinct subjects, culture and mathematics, with a tight interaction in everyday life. Local culture can take the shape of artifacts, architecture, clothing motifs,

weaving, ornamentation, kinship, traditions, spiritual links, and modes of communication (Rosa et al., 2016). As showed by this current study, ethnomathematics is portrayed using tradition of *Javanese* cultural wedding ceremonies.

Interpersonal intelligence, meanwhile, is intelligence in recording and recognizing individuals, including their atmosphere, temperament, motivation, and goals, with the goal of understanding and interacting with others (Efendi, 2005). A person's mastery of social communication abilities is their capacity to use the communication process to form and cultivate warm interpersonal relationships. Practical listening skills, effective speaking skills, public speaking abilities, and practical writing skills are required communication skills. Training is required for four fundamental communication skills: providing feedback, expressing feelings, supporting and responding to others, and embracing oneself and others. Interpersonal intelligence is one of the communication talents with an empathic, motivational, and perceptive attitude necessary for establishing connections. This definition indicates that issues in the learning process can be resolved by fostering intergroup contact.

The mathematics learning through ethnomathematics integrated RME in groups resulted in improving interpersonal intelligence dimensions throughout the reading and discussion processes. This demonstrates that students' social sensitivity develops through friendships and that kids can convey vital information through efficient communication. In addition, when writing and answering questions on the whiteboard, pupils needed more confidence and resisted writing on the whiteboard. Therefore, the researcher highlighted one student who was confident and capable of communicating mathematical concepts. This indicates that interpersonal intelligence plays a crucial role in the classroom mathematics learning process.

5. Conclusion

Based on the results of the analysis and discussion in this research and development, some conclusions were drawn, including: 1) Mathematics learning through ethnomathematics integrated RME was declared valid or feasible to be applied in mathematics learning to improve students' interpersonal intelligence based on expert validation which obtained a score of 37.5; 2) The dimensions of interpersonal intelligence achieved include discussion (social communication) and cooperation (social sensitivity). Therefore, learning mathematics with ethnomathematics integrated RME is deemed effective for use in teaching mathematics in junior high school.

6. Recommendations

The author offers several insightful suggestions for educators, schools, and related research. Teachers and educators are expected to be able to innovate in learning by properly applying an approach to learning mathematics, to create a learning environment that encourages active student participation in the learning process, is enjoyable, and contains material that is simple to comprehend. Schools are expected to be able to conduct and provide training for teachers in the use of approaches to learning, particularly in mathematics lessons, so that the learning process becomes more diverse and engages students' interest in learning mathematics. Future researchers can do further study by developing an RME learning model that measures not only students' interpersonal intelligence, but also other intelligences. In addition, researchers can use research subjects from levels of education other than junior high school to determine the impact at various levels of education.

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