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Implementing Realistic Mathematics Education for Elementary Schools in Indonesia

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***Abstract*—In mathematics learning, concepts and contexts are required that students are able to learn from real-life environment. However, teachers generally equip students with formulas without being accompanied by the ability to comprehend basic concepts. Mathematics learning will indeed be enjoyable if it is not only textbook-based but also followed by real-life experience. This study aims to investigate whether local cultural context could foster students' concept understanding in mathematics learning, particularly plane figures. Therefore, the research will, firstly, describe plane figures learning that uses the Indonesian Realistic Mathematics Education approach via iceberg and, secondly, discover students' improvement in concept comprehension after applying the approach. 50 elementary school students participated in the research, which employed experimental and descriptive methods. Further, the study results demonstrate an increase in concept comprehension, indicated from the increase in student learning achievement based on the average score of the experimental class and of the control class (88.40 and 72.91 respectively). Next, the independent sample t-test suggests t-count is higher than t-table, therefore Ho is rejected and Ha accepted. Thus, the learning outcomes of the class using the PMRI approach linked to Palembang's cultural context has increased.**

Keywords—realistic mathematics education; plane figures; Palembang culture

I. INTRODUCTION

Mathematics is a science that necessitates to be perceived by everyone, especially students who are in formal education [1]. One of the topics in mathematics studied since the elementary level is plane figures. Plane figures are part of geometry in the form of two-dimensional constructs that have been learnt from elementary to high school level. The tendency that occurs while learning plane figures, as far as students are concerned, is that they only memorize formulas and solve simple questions.

Generally, there are two types of plane figures (i.e. straight and curved lines). So, a plane figure is possibly constructed from straight lines, curved lines, or both straight and curved lines. The straight-line plane figure consists of rectangles and triangles. Quadrilaterals such as parallelogram, rectangle, square, rhombus, kite and trapezoid are examples of concepts, while "parallelogram is a quadrilateral that has pairs of parallel opposite sides," are an example of a definition [2]. Next, the curved-line plane figure includes a circle.

Plane figure learning is grounded on van Hiele's theory. This theory explains the development of students' way of thinking in geometry learning, which comprises five stages [3]. Table 1 describes the five thinking levels by van Hiele. It is shown that the thinking levels by van Hiele consist of: (1) ability to express mathematics ideas orally, in writing, and visually, (2) ability to interpret and evaluate mathematics ideas orally, in writing, and visually, (3) ability to apply terms, symbols, and structures to demonstrate situation and mathematical problems.

TABLE I. THINKING LEVELS BY VAN HIELE

Thinking levels	Objects of thinking
Visualization	Shape and shape types
Analysis	Shape characteristic
Informal deduction	The relationship between the characteristics
Formal deduction	Deduction systems and the characteristics
Appropriateness	Analysis of deductive systems

In fact, teachers rarely utilize certain contexts in mathematics learning. The use of context is actually important indeed, in accordance with the concept, when learning starts. It means that learning should begin with a situation known to students, so that it can motivate them to learn and learning mathematics does not seem difficult anymore [4]. An approach that underlines contexts is PMRI (*Pendidikan Matematika Realistik Indonesia*, or Indonesia's Realistic Mathematics Education) approach. PMRI is a mathematics approach that employs, in its learning, "real world" context, models, students' production and construction, interactive, intertwinement.

Furthermore, PMRI is adapted from RME (Realistic Mathematics Education) in the Netherlands that views mathematics as a human activity. RME emphasizes mathematics education as a process of performing mathematics in reality that leads to a result, mathematics as a product [5]. Despite the fact that PMRI is based on RME learning, it is developed and adapted in accord with Indonesia's context and culture. Consequently, the context used in questions or problems is preferably some occurrences that students could imagine.

The researchers use the PMRI approach, which aims to improve students' conceptual understanding of plane figures. The context employed in this research is Palembang's culture. Palembang, which is located in Sumatra island, Indonesia and the capital city of South Sumatra Province, has a variety of cultures in the form of historical buildings, traditional houses, transportation, shopping centers including '*rumah limas*' (Palembangnese traditional house), 'trans-musi' (a mode of public transportation in Palembang), and malls [6]. The overall context used aims to construct students' initial knowledge about two-dimensional figures.

The improvement of students' conceptual understanding is in line with the improvement of student learning achievement. The concept understanding is the student's ability to: (1) explain the concept, meaning the students are able to re-tell what has been communicated to them; (2) apply concepts in different situations; (3) develop some consequences of the concept's existence, meaning the students perceive a concept, and as a result, they have the ability to solve each problem correctly [7].

In order to achieve meaningful comprehension, it is imperative that mathematics learning is directed at developing mathematical connection capabilities between various ideas, understand how mathematical ideas are interrelated each other so that they construct a thorough comprehension, and use mathematics in contexts outside of mathematics [8]. The PMRI characteristics include: (1) the usage of the context in exploration; (2) the utilization of model; (3) the use of student creations and contributions; (4) interactivity; (5) linkages; and (6) employing Indonesian natural and cultural characteristics [9].

The reform of mathematics education is based on two pillars, namely: (1) the ability of teachers to create a problem-oriented classroom culture and invites students in interactive learning and (2) designing learning activities that can encourage re-invention of mathematics together with teachers' ability to help the rediscovery process. Thus, the PMRI requires a change in the attitude of teachers in teaching and treating students [10]. This realistic type is in the idea of iceberg floating in the middle of the sea. Concerning the iceberg model, there are four levels of activity, namely: (1) mathematical environmental orientation; (2) props model; (3) building stone; (4) formal mathematics [11], as in Fig. 1.

Fig. 1 is the example of iceberg in a multiplication operation that begins with an informal statement using objects around, then continues with a number line until finally the concept of multiplication is formulated.

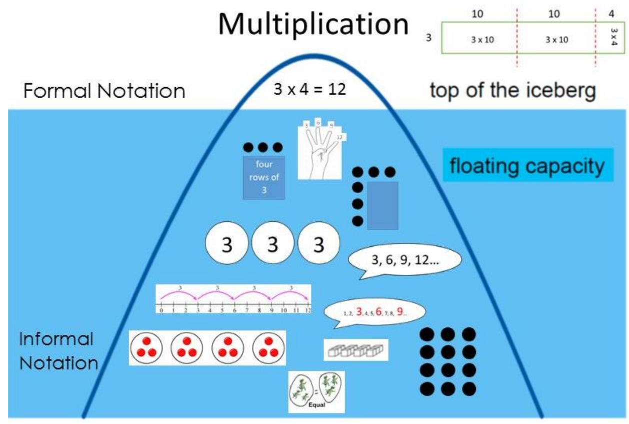

Fig. 1. Example of multiplication iceberg.

II. METHOD

The type of research used is experimental and descriptive research methods. The research design is Non-equivalent Groups Pretest-Posttest Design [12].

Group	Pretest	Treatment	Posttest
A →	O →	X →	O
B →	O →	→	O

Annotation:
A : Experimental Class
B : Control Class
O : Pretest and posttest on mathematics concept comprehension
X : The treatment of mathematics learning using the PMRI approach in the context of Palembang culture.

The population of this study was all fourth grade students of one of elementary schools in Palembang in the 2018/2019 academic year, as shown in table 2. However, the research sample was the pupils in IVA and IVB classes, as in table 3.

TABLE II. RESEARCH POPULATION

No	Class	Male	Female	Amount
1	IV.A	15	10	25
2	IV.B	14	11	25
3	IV.C	17	9	26
Total		46	30	76

TABLE III. RESEARCH SAMPLE

No	Class	Male	Female	Amount	Description
1	IV.A	15	10	25	Experimental class
2	IV.B	14	11	25	Control class

Data collection technique employed the test of mathematics' concept comprehension on plane figures (i.e. eight written essay questions and interview sheets). Besides, there were also observation sheets to investigate the implementation of explorative learning in the experimental class. The instrument of the test was validated by a fellow mathematics lecturer and the teacher of the elementary school where the research would be conducted.

Furthermore, the test is a series of questions or exercises as well as other tools used to measure skills, intelligence, abilities or talents possessed by individuals or groups [8]. The questions provided had firstly been tested their validity and reliability. Data analysis technique used in this research was homogeneity test and statistical test of parameter t (t test). The t-test employed independent sample t-test using SPSS 19.

III. RESULTS AND DISCUSSION

The results of this study are as follows: 1) The description of plane figure learning applying PMRI approach related to Palembang's cultural context by using the iceberg phenomenon, 2) The increase in concept comprehension, indicated from the increase in student learning achievement based on the experimental class' average score, compared to the control one's.

Firstly, the description of plane figure learning applying PMRI approach, on the topic 'Introducing Plane Figures', is demonstrated in Fig. 2. It demonstrates clearly the iceberg of the plane figures. The stability of the floating iceberg is supported by a group of ice at the bottom of the sea. In the first stage, students are taught to solve daily difficulties (formal mathematics). This stage is referred to as a mathematical environment orientation stage. Doing mathematical activities is the basis of developing mathematical understanding that demands more proportions; by providing a number of mathematical activities in real-life context by looking at objects in their surrounding which have two-dimensional form (or plane figure), for instance doors, kites, and rhombuses.

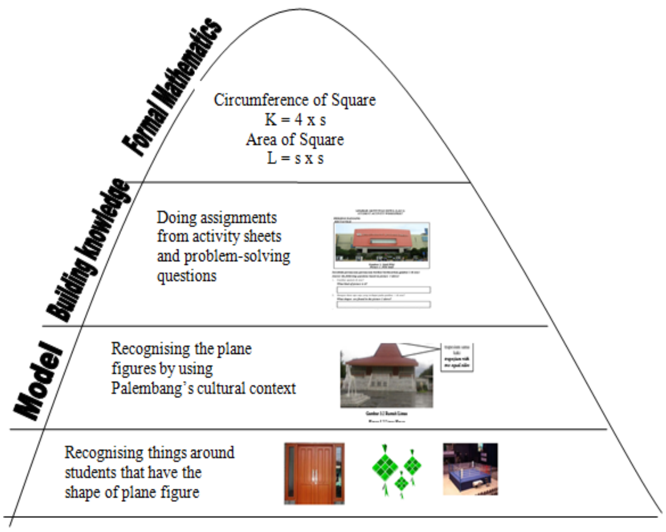

Fig. 2. Iceberg of plane figure.

The second stage is the use of Palembang's cultural context to explore the students' thinking ability. This stage emphasizes the students' ability to understand the usage of context in plane figure learning in order to perceive mathematical principles. For example, what kinds of plane figures are in the picture of limas house, without having to describe it in mathematical language.

Next, the third stage is building stone, in which the students' activities begin to lead to mathematical comprehension, in the form of activities to discover the plane figure's characteristics and formulas. It is then followed by problem-solving questions as an important bridge to attain the conceptual understanding of plane figure.

The following stage is under the formal mathematics stage. During the training process of students' ability, these pupils are at the stage of environmental orientation, for instance, the problems raised by them are as simple as possible. A number of two-dimensional figures in the context of local culture are presented as an instance. Students are assigned to describe the amount of the plane figures and their size by using a ruler. They are then directed to determine the circumference and area of plane figures of each picture. This sort of simple question raises various types of student answers.

Furthermore, the study results demonstrate an increase in concept comprehension, indicated from the increase in student learning achievement based on the average score of the experimental class (X1) = 88.40 while in the control class (X2) = 72.91. As well as that, the independent sample t-test suggests $t_{count} \geq t_{table}$ (i.e. $5.96 \geq 1.667$), therefore H_0 is rejected and H_a accepted. Thus, the learning outcomes of the class using the PMRI approach linked to Palembang's cultural context has increased.

Finally, the RME course participants also gained a better understanding of RME's principle. Several researchers showed that RME materials had a positive influence on students and teachers in Indonesia as well [13–17].

IV. CONCLUSION

Based on the discussion above, it can be concluded from this research that the use of the PMRI approach in the cultural context of Palembang is most likely to improve the students' concept understanding of plane figures. It is evident from the differences in the students' learning achievement between the control class and the experimental one.

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REFERENCES

[1] Fatqurhohman, "Pemahaman Konsep Matematika Siswa dalam Menyelesaikan Masalah Bangun Datar," Jurnal Ilmiah Pendidikan Matematika, vol 4, no. 2, pp. 127–133, 2016.

[2] M.T. Budiarto, S. Khabibah, and R. Setianingsih, "Construction of High School Students' Abstraction Levels in Understanding the Concept of Quadrilaterals," International Education Studies, vol 10, no. 2, pp. 148–155, January 2017.

[3] Lisnani, "Design Research on Plane Figure Learning by Using Picture Story and Pairing Game to Improve Mathematical Communication Skills of Second Grade of Primary School Students," Journal of Physics Conference Series 1040, pp. 1–9, June 2018.

[4] R.I.I. Putri, "Pembelajaran Materi Bangun Datar melalui Cerita Menggunakan Pendekatan Pendidikan Matematika Realistik Indonesia (PMRI) di Sekolah Dasar," Jurnal Pendidikan dan Pembelajaran, vol. 18, pp. 234–239, 2011.

[5] L. Anwar, I.K. Budayasa, S.M. Amin, and D. de Haan, "Eliciting Mathematical Thinking of Students through Realistic Mathematics Education," Indonesian Mathematical Society Journal on Mathematics Education, vol. 3, no. 1, pp. 55-70, 2012.

[6] Hadi, "Reforming Mathematics Learning in Indonesian Classroom through RME," Journal ZDM Mathematics Education, vol. 40, pp. 927–939, 2012.

[7] J.M. Duffin and A.P. Simpson, "A Search for Understanding," Journal of Mathematical Behavior, vol. 18, no. 4, pp. 415-427, 2000.

[8] National Council of Teachers of Mathematics, Principles and Standards for School Mathematics. Reston, VA: NCTM, 2000.

[9] R.K. Sembiring, K. Hoogland, and M. Dolk, A Decade of PMRI in Indonesia. Bandung-Utrecht: APS International, 2010.

[10] A. Fauziah, R.I.I. Putri, Zulkardi, and Somakim, "Primary School Student Teachers' Perception to Pendidikan Matematika Realistik Indonesia (PMRI) Instruction," Journal of Physics Conference Series 943, pp. 1–8, 2017.

[11] S. Haji, "Pendekatan Iceberg dalam Pembelajaran Pembagian Pecahan di Sekolah Dasar Infinity," Jurnal Ilmiah Program Studi Matematika STKIP Siliwangi Bandung, vol. 2, no. 1, pp. 75–84, 2013.

[12] J.H. McMillan and S. Schumacher, Research in Educations - A Conceptual Introduction, 5th ed. Addison Wesley: Longman Inc., 2001.

[13] R. Sundayana, T. Herman, J.A. Dahlan, and R.C.I. Prahmana, "Using ASSURE Learning Design to Develop Students' Mathematical Communication Ability," World Transactions on Engineering and Technology Education, vol. 15, 245, 2017.

[14] S. Hadi, Effective Teacher Professional Development for the Implementation of Realistic Mathematics Education in Indonesia, Dissertation. Enschede: University of Twente, 2002.

[15] D. Armanto, Teaching Multiplication and Division Realistically in Indonesian Primary School: A Prototype of Local Instruction Theory, Dissertation. Enschede: University of Twente, 2002.

[16] B. Tanujaya, R.C.I. Prahmana, and J. Mumu, "Mathematics Instruction, Problems, Challenges, and Opportunities: A Case Study in Manokwari Regency, Indonesia," in World Transactions on Engineering and Technology Education, vol. 15, no. 287, 2017.

[17] K. Wahyu, S.M. Amin, and A. Lukito, "Motivation Cards to Support Students' Understanding on Fraction Divisions," International Journal on Emerging Mathematics Education, vol 1, no. 1, pp. 99-120, March 2017.