Students' mathematical representation ability in Kudus local wisdom-based Open-Ended Learning

Himmatul Ulya and Ratri Rahayu

Mathematics Education Department, Universitas Muria Kudus, Gondangmanis Bae Kudus, Central Java, Indonesia

himmatal.ulya@umk.ac.id

Abstract. This research examines the effectiveness of Kudus local wisdom-based open-ended learning to improve learners' mathematical representation ability. This research was done in the third grade during the even semester. This research is quantitative with several stages, such as promoting the preliminary study, planning, and implementing. This research used a nonequivalent control group design. The applied technique of collecting data was the test technique. The techniques of analyzing the data consisted of a test of minimum standard mastery achievements, an average difference test, and an N-gain test. The findings showed that (1) the learners' mathematical representation ability reached the minimum standard mastery, (2) the average mathematical representation ability of the learners were better than those taught conventionally, and (3) the mathematical representation ability were improved.

1. Introduction

Representation ability is one of the ability in mathematics. This ability is needed for the learners as applied by the National Council of Teachers of Mathematics. Mathematical representation ability is the basic and important ability to develop learners' mathematics ideas because ideas or notions in mathematics must be represented through various texts, tables, figures, models, etc. However, the fact showed that public primary school learners still had lower mathematics ability and needed to be improved.

Heretofore, the realization of mathematics learning has been only limited to material sharing without developing learners' mathematical representation. The learning was mostly dominated by the teacher. He only shares the material for a semester so that learning was not meaningful. It neglected the importance of learners' mathematics ability. It made learners had difficulties in learning mathematics. In understanding the mathematics concept, learners had difficulties. They had difficulties solving problems concerning daily life problems and communicating the solution to the problems. This paradigm should be fixed by the teacher. Thus, learners could study mathematics meaningfully and not only spending their time memorizing the mathematics formulas.

The occurring learning problems should be solved by teachers so that learners' mathematical representation ability could be improved. It aims to explore the learners' ability in solving problems and expressing the solution into verbal forms, figures, tables, symbols, or mathematics models, etc. When monotonous and procedural learning is always taught, it will lead to less optimal mathematics learning outcomes. It could be seen from the evaluation result of the National Council of Teachers of Mathematics.
Mathematics (TIMSS) in 2015 and Programme for International Student Assessment (PISA) in 2015. They showed that Indonesia was the lowest-sixth and seventh rank (6, 7).

Open-ended learning could be an alternative to change this paradigm and habituate learners to learn actively, creatively, and happily. Thus, they could achieve optimal mathematics learning outcomes. Open-ended learning could allow learners to experience and enrich knowledge by finding, understanding, and solving problems in various ways. Constructivist learning trains learners to develop various methods, ways, or approaches to obtain the appropriate answers (8).

This learning model could be integrated by instilling Kudus' cultural elements. Kudus is a city in Central Java, Indonesia. Kudus' cultural representation in mathematics learning could be used as a learning strategy to improve learners' mathematical representation ability. These integrated cultures could be local wisdom or local excellence in Kudus. Thus, learning would be more meaningful and joyful. Local wisdom-based learning could realize an education that provides specific characters for human life and further education (9). A mathematics learning correlated to local excellence influences the efforts to preserve the local cultures (10). Through local wisdom-based mathematics learning, subjects would obtain mathematics learning experience (11). This would facilitate learners to understand mathematics concepts concerning the culture around the daily life environment.

Muhammadiyah 1 Kudus primary school is a school in Kudus municipality, Indonesia. Based on the school's mathematics teacher's information, the teacher's applied learning activity had not made the learners active. In fact, they seemed easily bored. The less active learners were not confident and motivated to learn mathematics. They also had less curiosity about mathematics. Students' mathematical representation ability were still low since they were not habituated to engage mathematical representation questions. Thus, most of them had difficulties while being engaged in such problems. The learners had various difficulties, such as understanding the questions, creating the illustration of the problems, changing a variable into a mathematics model, applying the concept to solve problems, and presenting the solution. Open-ended learning with Kudus local wisdom was expected to improve learners' mathematical representation ability. The learners were mostly from Kudus, and they would obtain real illustrations during learning mathematics.

A previous finding of learners' mathematical representation ability provided a learning intervention with this open-ended learning (12). Teachers could share their experiences for learners during developing their mathematical representation ability to elicit learners' personal representations (13). One of the representations was local wisdom, precisely the local excellence, as Kudus's traditional culture. It was consistent with a previous study that concluded that contextual learning learners would have better mathematical representation ability than those taught conventionally (14). Culture-based learning could help learners learn by observing and analyzing social activity, local excellence, and historical places concerning mathematics concepts. Thus, learning would be more meaningful (Rahayu et al., 2018). A previous study about contextual-integrated open-ended learning by applying local wisdom could improve the learners' mathematics ability. From the explanation, the problem formulation consisted of how the effectiveness of Kudus local wisdom-based open-ended learning was to improve learners' mathematical representation ability. This research aims to examine the learning effectiveness of open-ended based on Kudus local wisdom to improve the learners' mathematical representation ability.

2. Research methods
This is quantitative research with these following stages:
1) Preliminary Study Stage
   It consisted of field-problem identification by revealing learners' responses toward mathematics learning, interviewing the teachers, and reviewing the literature.
2) The Planning Stage
This stage consisted of research and learning instrument arrangement, started from syllabus, lesson plan, module, Mathematical representation Test questions (MRT). These instruments had to be validated by experts.

3) The Implementation Stage

This stage examined the Kudus local wisdom-based open-ended learning toward the learners' mathematical representation ability.

This research was conducted in Muhammadiyah 1 Primary School in its third grade. The classes were IIUA as the control group while III UB as the experimental group. The applied quantitative design was a nonequivalent control group design. It is a quasi-experimental design, as shown in Table 1.

| Groups          | Pre-test | Intervention | Post-test |
|-----------------|----------|--------------|-----------|
| Experimental    | A        | X            | O         |
| Control         | A        | K            | O         |

In this design, the subjects were not grouped randomly. The reason was this research had been adjusted to the field situation and condition. The data collecting technique was a test technique to measure the learners' mathematical representation ability. The initial data analysis techniques consisted of normality, homogeneity, and (t) tests. Meanwhile, dealing with final data analysis consisted of normality, homogeneity, learning completeness, average difference, N-gain, and regression tests.

3. Result and discussion

Based on the initial data, from the daily test results of both groups, the results showed both groups were from a normal distribution and homogeneous population that did not have any differences for both samples. The final data of this research were from both groups' mathematical representation ability. The data were then tested in terms of their normality and homogeneity before promoting further tests. The results of the required test showed that both groups were from a normal and homogeneous population.

3.1. Learning completeness test

This test analyzed the learners' standard mastery achievements in terms of their mathematical representation ability after being intervened. The learning completeness test consisted of two types of completenesses. They were individual and classical learning completenesses. The individual learning completeness was based on the minimum mastery standard (KKM), 75. Meanwhile, the classical learning completeness was at least 75% of individuals reached the completeness. The individual learning completeness could be analyzed by a party t-test while the classical was analyzed by a party proportional test.

The proposed hypothesis for individual learning completeness test was $H_0: \mu = 75$ (the learners had not reached the minimum standard mastery) while $H_1: \mu \geq 75$ meant the ability had reached the minimum standard mastery. The obtained values, $t_{o bs} = 22$, as compared to a value $t_{tab} = 22$ with $df = 22$. 

![Equation]

The proposed hypothesis for classical learning completeness test was $H_0: \mu = 75$ (the learners had not reached the minimum standard mastery) while $H_1: \mu \geq 75$ meant the ability had reached the minimum standard mastery. The obtained values, $t_{o bs} = 22$, as compared to a value $t_{tab} = 22$ with $df = 22$. 

![Equation]
and $\alpha = 0.05$. It was 1.72. If $t_{\text{count}} \geq t_{\text{table}}$, then $H_0$ is denied. The t-test value obtained a score of 3.70. It meant that $t_{\text{count}} \geq t_{\text{table}}$. Thus, $H_0$ was denied. Therefore, the learners' mathematical representation ability intervened by Kudus local wisdom-based open-ended learning reached the minimum standard mastery.

The proposed hypothesis for the classical learning completeness test of the experimental group was $H_{01}: \mu_{\text{e}} = 0.75$ (learners that were deemed complete after reaching a percentage of 75%) while the $H_{11} \mu_{\text{e}} > 0.75$ showed that more than 75% of learners reached the completeness. The obtained $z_{\text{count}}$ value was compared to a value $z_{\text{table}}$ with $\alpha = 0.05$. It was 1.64. If $z_{\text{count}} \geq z_{\text{table}}$, then $H_0$ is denied. The z value obtained a score of 1.81. It meant that $z_{\text{count}} \geq z_{\text{table}}$. Thus, $H_0$ was denied. From the test, the learners that reached the minimum standard mastery were higher than 75%. Thus, their mathematical representation ability after the intervention reached the classical learning completeness. The learners' mathematical representation ability taught by Kudus local wisdom-based open-ended learning reached the learning completeness from both tests.

### 3.2. Average comparison test

This test analyzed the existence of both groups' significant differences in mathematical representation ability average. It would be the basis of deciding whether the experimental group's mathematical representation ability was better than the control group taught conventionally or not. This test used an independent sample t-test assisted by SPSS. The proposed hypothesis was $H_{01}: \mu_{\text{e}} = \mu_{\text{c}}$. It meant there was no difference between both groups' mathematical representation ability average. On the other hand, $H_{11} \mu_{\text{e}} \neq \mu_{\text{c}}$, meant there was a difference between both groups' mathematical representation ability average. The hypothesis test criteria were: $H_0$ would be denied if the significant score, $\text{Sig. (2-tailed)}$ was less than 0.05. The analysis results assisted by SPSS are shown in Table 2.

#### Table 2. The output of mathematical representation ability average difference test

|                | Levene's Test for Equality of Variances | t-test for Equality of Means | 95% Confidence Interval of the Difference |
|----------------|----------------------------------------|-----------------------------|------------------------------------------|
| F              | Sig. (2-tailed) | t | df | Mean Difference | Std. Error Difference | Lower | Upper |
| Value          | Equal variances assumed | 3.789 | 0.058 | 9.624 | 41 | 0.000 | 35.798 | 3.720 | 28.286 | 43.310 |
|                | Equal variances not assumed | 9.245 | 27.959 | 0.000 | 35.798 | 3.872 | 27.865 | 43.730 |

From the table, the $\text{Sig. (2-tailed)}$ shows 0.000, meaning that it is less than 0.05. From the result, $H_0$ is denied. It meant there was a difference between both groups' mathematical representation ability average. The learners' mathematical representation ability comparisons of both groups are shown in Table 3.

#### Table 3. The learners' mathematical representation ability average

| Groups          | N  | Mean | Std. Deviation | Std. Error Mean |
|-----------------|----|------|----------------|-----------------|
| Experimental    | 23 | 81.35| 8.222          | 1.714           |
| Control Group   | 20 | 45.55| 15.527         | 3.472           |
The table shows the experimental group's mathematical representation ability average is better (81.35) than the control group (45.55). It meant there was a difference between both groups' mathematical representation ability average. The experimental group taught by Kudus local wisdom-based open-ended learning was better than the control group taught conventionally.

3.3. N-Gain Test
From the pre-intervention and post-intervention, the learners' ability improvement could be found by the N-gain test. The N-gain test was used to calculate mathematical representation ability improvement. It was done by calculating the magnitude differences between the pre-test and post-test. Then, the results were divided into the differences between the maximum value and the pre-test score. The summary of the individual's mathematical representation ability improvement, calculated by the N-gain test, is presented in Table 4.

| Criteria | Numbers of the Learners | Percentage |
|----------|-------------------------|------------|
| Low      | 7                       | 30.43%     |
| Moderate | 12                      | 52.17%     |
| High     | 4                       | 17.39%     |

Table 4 shows that 12 learners had average improvement on mathematical representation competence. It means that the most improvement on learners' mathematical representation competence was on average level, that is 52.17%. Learners who had low mathematical representation competence improvement was 30.43% or 7 learners, while those who had the high improvement was 4 learners (17.39%). The learners' mathematical representation ability are classically presented on Table 5.

| Pretest Mean | Posttest Mean | (g) |
|--------------|---------------|-----|
| 56.91        | 81.35         | 0.57|

Table 5 indicates that the improvement on the learners' mathematical representation ability classically reached 0.57 or 57% in percentage. It shows that the mean of the students' mathematical representation ability classically belongs to medium criterion. Based on gain test, it was concluded that learners' mathematical representation ability improved by means of the implementation of Kudus local wisdom-based open-ended learning.

The learners' representation ability improved through open ended learning with the basis of local excellence. The improvement on the learners’ mathematical competence classically belongs to medium category. The improvement on this mathematical representation is due to the fact that open ended learning provided learners with experiences in both interpreting problems and generating distinctive ideas yang to solve problems (17,18). The representation brought up by the learners was the expressions of mathematical ideas that they presented to find a solution for the encountered problem. Open ended learning model promises opportunities for learners to think freely in solving a certain problem based on their own ways. This was in order that they could grow their competence, creativity, and critical thinking in solving open problems so as to impact on their self-development towards better direction (19). With open ended learning model, learners were able to express their ideas about the solutions through various representations.

The role of teachers in exploring various activities in mathematics learning highly influences learners’ mathematical thinking ability. Mathematic ideas presented by the teacher guru in various
representations will contribute great influences on the students in learning mathematics. The teacher’s ability is to utilize guessing and checking systematically and efficiently while solving the problems and explaining their solution and reasoning to the learners (20).

The mathematics learning which implemented local culture from the learners’ current region helped learners in visualizing the abstract mathematical concept. It influenced the learners in interpreting the meaning of symbols so as to enable them to implement this in solving open-ended questions (21,22). The advantage which was gained when learners learned mathematics’s material of Kudus cultural context was that they can learn concretely so as to ease them in understanding the taught materials. It is linear with the previous research, which states that culture-based mathematics learning can improve mathematics’ learning achievement (23). Besides, this kind of learning experience will last longer in their memory, having a better transfer effect, and boosted their mathematic ability (24).

4. Conclusion
The conclusion of this research is that Kudus local wisdom-based open-ended learning was effective to improve the The learners’ mathematical representation ability with the following details.

1. The learners’ mathematical representation ability taught by implementing Kudus local wisdom-based open-ended learning has achieved learning completeness.
2. The mean of learners’ mathematical representation ability when Kudus local wisdom-based open-ended learning was implemented was better than the mean of that when conventional learning was implemented.
3. The learners’ mathematical representation ability improved through the implementation of Kudus local wisdom-based open-ended learning.

5. References
1. NCTM. Principles and Standards for School Mathematics. Reston, VA: National Council of Teachers of Mathematics; 2000.
2. Yuniawatika. Meningkatkan Kemampuan Representasi Matematik Siswa Sekolah Dasar Melalui Pembelajaran Matematika dengan Strategi REACT (Studi Kuasi Eksperimen di Kelas V Sekolah Dasar Kota Cimahi). Eduhumaniora. 2011;4(2).
3. Handayani H. Pengaruhi Pembelajaran Kontekstual Terhadap Kemampuan Pemahaman dan Representasi Matematis Siswa Sekolah Dasar. Didakt J Pendidik Guru Sekolah Dasar. 2015;1(1):142–9.
4. Siswono TYE. Implementasi Pendidikan Karakter dalam Pembelajaran Matematika. In: Prosiding SNPM UIN Syarif Hidayatullah Jakarta. 2012. p. 1–12.
5. Hendriana H. Pembelajaran Matematika Humanis dengan Metaphorical Thinking Untuk Meningkatkan Kepercayaan Diri Siswa. J Infinity. 2012;1(1):90–103.
6. Mullis, I.V.S. et al. TIMSS 2015 International Results in Mathematics. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College; 2015.
7. OECD. PISA 2015 Results in Focus. 2015.
8. Murni. Open-Ended Approach in Learning to Improve Students Thinking Skills in Banda Aceh. Int J Indep Res Stud. 2013;2(2):95–101.
9. Ihsan M. Gusjigang; Karakter Kemandirian Masyarakat Kudus Menghadapi Industrialisasi. 2017;10(2):153–83.
10. Rahayu R. Permainan Edukasi Berbasis Keunggulan Lokal dalam Pembelajaran Matematika. In: Prosiding Seminar Nasional Psikologi Universitas Muria Kudus. 2016. p. 1–11.
11. Ulya H. Pembelajaran Matematika Berbasis Etnomatematika untuk Membangun
Karakter Cinta Tanah Air dan Kreativitas Belajar Matematika. Pros Semin Nas Psikol. 2016;29–39.

12. Untarti R, Jazuli A. Pendekatan Pembelajaran Open-ended untuk Meningkatkan Kemampuan Representasi Matematis. In: Prosiding Seminar Nasional Matematika dan Pendidikan Matematika UNY. 2015. p. 609–16.

13. Yuniarti Y. Peran Guru dalam Meningkatkan Kemampuan Representasi Matematik dalam Pembelajaran Matematika. Eduhumaniora. 2013;5(1).

14. Hutagol. Pembelajaran Kontekstual Untuk Meningkatkan Kemampuan Representasi Matematis Siswa Sekolah Menengah Pertama. J Infin. 2013;2(1):85–99.

15. Rahayu R, Ulya H, Kartono, Isnarto, Kurniasih N. Collaborative Assessment Using QR-Code on Ethnomathematics Learning for Pre-Service Teacher. Int J Eng Technol. 2018;7(2.13):413–7.

16. Sugiyono. Metode Penelitian Pendidikan (Pendekatan Kuitatif, Kualitatif dan R&D). Bandung: Alfabeta; 2010.

17. Wulansari N. Penerapan Model Pembelajaran Open Ended untuk Meningkatkan Kemampuan Representasi Maematis Peserta Didik Kelas V Sekolah Dasar. Educare. 2019;17(1):70–7.

18. Ulya, H.; Rahayu R. Kemampuan Representasi Matematis Field Intermediate dalam Menyelesaikan Soal Etnomatematika. Aksioma J Progr Stud Pendidik Mat. 2020;9(2):451–66.

19. Agustin E, Atep S, K Y. Pengaruh Pendekatan Open Ended Terhadap Kemampuan Berpikir Kreatif Matematis Siswa Kelas V. Mimb Sekol Dasar. 2015;2(2):133–46.

20. Capraro MM, An SA, Ma T, Rangel-Chavez AF, Harbaugh A. An investigation of preservice teachers’ use of guess and check in solving a semi open-ended mathematics problemNo Title. J Math Behav. 2012;31(1):105–16.

21. Sarwoedi, Marinka, D.O., Febriani, P., dan Wirne IN (2018). Efektivitas Etnomatematika dalam Meningkatkan Kemampuan Pemahaman Matematika Siswa. J Pendidik Mat Raflesia. 2018;3(2):171–6.

22. Rahayu R, Ulya H, Kartono, Isnarto. A practicality analysis of collaborative assessment model based on ethnomathematics. J Adv Res Dyn Control Syst. 2019;11(7):366–73.

23. Sochima S, Unodiaku. Effect of Ethno-Mathematics Teaching Materials on Students’ Achievement in Mathematics in Enugu State. J Educ Pract. 2013;4(23):70–8.

24. Ulya H, Rahayu R, Riyono A. Integration Of Products Assessment in Mind Mapping Learning to Enhance Mathematical Communication. J Phys Conf Ser. 2019;1175(12142):1–8.

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