Student worksheet usage effectiveness based on realistics mathematics educations toward mathematical communication ability of junior high school student

R N Ismail 1, I M Arnawa 2, and Y Yerizon1

1 Mathematics Department, Universitas Negeri Padang, Padang, Indonesia
2 Mathematics Department, Universitas Andalas, Padang, Indonesia

*Corresponding author: rafkinasuhaismail25@gmail.com

Abstract. The purpose of this research is to examine the effectiveness of student worksheet (LKPD) based on realistic mathematics educations (RME) of class VIII of Junior High School. This is a development research with Plomp Model. The research design employs quasi experiments with Only-Posttest Control Group Design. This research took place in Public Junior High School (SMPN) Padang of class VIII. The sample is determined by purposive sampling. The treatment toward experiment group is learning by using LKPD based on RME. Meanwhile, control group is using student book according to curriculum 2013. The research instruments are test items, learning observation sheet, and learning device which had been tested for validity and practicality in the development research stage. Data analysis is conducted through t test for the mean difference test and the Scheffe test for the effectiveness of the LKPD test. The research result showed that students’ mathematical communication ability of class VIII of Junior High School (SMP) by using LKPD based on RME is better than student who uses student book. Finally, it can be concluded that LKPD based on RME is effective in improving students’ mathematical communication ability.

1. Introduction
Mathematics learning plays a very important role in the mastery of knowledge and technology as it is also useful in enriching students with critical thinking ability, logic, analytic, systematic, critical, innovative, and collaboration ability. Considering the importance and the purpose of mathematics learning, hence mathematics learning process at school should be able to improve optimum thinking ability. However, today school mathematics learning has yet provided the students opportunity to develop their mathematical communication ability [1].

Mathematical communication is of vital importance in mathematics learning. It is one of the competences that has to be possessed and developed by the students. However, research result shows that student mathematical communication ability of Junior High School has yet well fulfilled [2].

Today school learning process has yet been able to improve students’ communication ability. This is supported by the observation result toward teacher in classroom learning implementation. Prolonged exposure toward this would yield a negative impact for both students’ communication ability and students’ learning result. So, it can be concluded that student encounters difficulty on their mathematical communication ability.
The problem experienced by the students about mathematical communication ability cannot be separated from the role of teacher. One of them is on the use of learning device, where students have yet been able to found out or to construct their own knowledge about the learning material. Based on the result of preliminary research toward LKPD, it is found that the material in LKPD is presented in short without proper explanation of the process on how the concept formulated toward the students. Moreover, LKPD has yet present activity material to encourage student to actively participate in the learning such as discussion or group work. As the effect, students are less trained to think critically, creatively, and discourage to communicate their own opinion. Next, the item questions in LKPD also has yet linked to the real life situation, so that it is failed to train students’ communication ability.

The facts above are in line with the result of research interview with some mathematics teachers in SMPN 7 Padang. Teacher only employ student school book, without necessarily design their own LKPD. Teacher employs LKPD available in the market. The LKPD available in the market is not necessarily suit the needs and the condition of the students. Often, it is aimed to merely add the students’ exercise bank for the students.

Prolonged toward this, students will fell bored and therefore less motivated on learning. Regarding this problem, it is of vital importance to improve mathematical communication ability by improving learning process through appropriate approach to be implemented on mathematics learning in classroom. One of the approaches that is expected to be able to improve students’ mathematical communication ability is realistic mathematics education (RME). This approach employs real world that can be imagined or real in students’ mind as the starting point to develop mathematics idea and concept. This approach provides space for students to communicate to one another in developing strategy and in building mathematics concept [3].

The guidance used by students to obtain learning information can be derived from LKPD which accomplished with clear instruction for the students to conduct the activity. The arrangement of LKPD is considering characteristics, material, and students’ cognitive ability to direct the students to find a concept and principle, so that students can construct their own knowledge. [4]

The learning process conducted by teacher is aimed to facilitate students to be critical and creative in learning. Learning should be students centered, so that students will be able to communicate and collaborate with their teacher and peers. LKPD is an additional learning material that teacher can use as an instrument to promote students’ learning activity improvement in finding the mathematical process.

Learning based on realistic mathematics educations (RME) is learning conducted to train students to think critically and well trained in solving problem, creative, innovative, and be able to communicate and collaborate. Learning device based on RME which integrates critical thinking, creative, communicative, and collaborative (4C’s) is expected to open their mindset, to develop ideas, and to improve students’ thinking creativity. Learning based on RME can accommodate student’s knowledge in learning as well as improving their mathematics ability of problem encountered by students in their daily life.

RME approach emphasized that mathematics is understood as human activity. Mathematics learning based on RME is doing mathematics. Daily life problems (contextual problem) are the most important part of RME. Students are not considered as a passive mathematics receiver, but the students are given chance to find again mathematics under adult guidance. RME toward mathematics are as follow: (1) mathematics need to be close to students and relevant to everyday life situation.

Learning device based on RME will not only help the students to understand the concept, but also help the students to comprehend the material application into their daily life problems. Learning approach based on RME explains 5 characteristics of RME [5]. The developed learning device in this research is effective LKPD based on RME class VIII of semester I. The effective of LKPD is viewed by its potential impact in the form of students’ mathematical communication ability quality test as well as students’ motivation.

There are two effectiveness aspects that have to be fulfilled by LKPD, namely: 1) Expert opinion and practitioner based on their experience which states that the LKPD is effective. 2) Operationally,
LKPD is to provide the result as expected [6]. This development research is to see the effectiveness of LKPD based on RME toward students’ mathematical communication ability. Based on the above explanation, this research is aimed to reveal whether LKPD based on RME can improve students’ mathematical communication ability of class VIII SMP.

2. Methods
This is a development research by employing Plomp model, starting form preliminary research stage, prototyping stage),[7] and assessment stage. The assessment stage is to conduct the field test to class VIII SMPN 7 Padang to see the effectiveness. The impact of LKPD based on RME toward students’ mathematical communication ability of class VIII SMP by using quasi experiments design through selecting experimental class and control class.

Instrument being used to collect data on this research is LKPD based on RME instrument in the preliminary stage, validity stage, and practicality stage [7]. The result average score of LKPD based on RME is 3.69 with very valid category. Meanwhile, the presentation, usage practicality, reading effectiveness, and LKPD based on RME time allocation have fulfilled practicality category. It is evidence that the average score is 3.37 and the percentage of practicality is 84.05%.

The instruments employed to collect effective data are as follow:

1. Mathematical communication ability test, it is an essay test. In order to conduct well prepared test, it is of vital importance to consider the following steps:
   a. Making test grid based on the indicator
   b. Arranging based on the test grid
   c. Test validation employed is expert validation. The questions that will be given are validated by 3 validators.

2. Effectiveness questionnaire based on the experts
   The questionnaire will be given to many experts to estimate and to consider whether the LKPD based on RME approach can improve students’ mathematical communication ability. Prior to the usage, the effectiveness questionnaire will be validated by a validator.

Data were analyzed by using descriptive statistics and descriptive technique. The analysis toward LKPD effectiveness based on RME approach is supported by the result of test data analysis on mathematical communication ability.

3. Result and discussion.
After conducting sequence of research step on LKPD based on RME approach, the research result can be described as follow. LKPD that has been tested on validity and practicality will be tested to class VIII SMPN 7 Padang in order to see the effectiveness. The effectiveness of LKPD can be seen from the students’ test result of mathematical communication ability. The description of analysis result toward each instruments are as follow: the test result of students’ mathematical communication ability can be seen from the comparison of experiment class with RME approach and control class with scientific approach. The final test score of both experiment and control class will then be processed by using descriptive statistics, and the result can be seen in the following table. Table 1. Score Descriptive Statistics of Control Class and Experiment Class.

| Table 1. Score Descriptive Statistics of Control Class and Experiment Class |
|---|---|---|---|---|
|     | N  | \(\bar{x}\) | SD  | Max Score | Min Score |
| Control Class | 32 | 55   | 9.58 | 73.33     | 33.33     |
| Experiment Class | 32 | 81.46| 9.69 | 100       | 60        |
The above table shows that the average score test result of experiment class is higher than test result of control class on students’ mathematical communication ability. The difference of average experiment class test and control class test is 24.46. Meanwhile, the variance of test result of experiment class is higher than control class. These revealed that students’ mathematical communication ability test result in experiment class is higher and more homogenous than control class with scientific learning approach.

In order to obtain a more thorough result about the improvement of students’ mathematical communication ability after employing learning based on RME, the next step is to conduct statistics test toward data of result test of both classes. Before conducting hypothesis test, normality test of both classes will be conducted. Based on the normality test toward test result data of control class, it can be obtained that the distribution of test score data of students’ mathematical communication ability of control class is distribute normally. Next, based on the normality test toward experiment class test result data, it can be obtained that P-Value 0.063 with \( \alpha=0.05 \) and \( N=32 \). P-value is > 0.05, so it can be concluded that the distribution of score test data of experiment class of experiment class is distributed normally.

Meanwhile, variance homogeneity test is conducted by using F test, in which P-value is 0.950. Since P-value obtained is more than real standard of \( \alpha=0.05 \) so it can be concluded that data test of both classes have homogeneity variance. Since the result of experiment class and control class is distributed normally and homogeneity, thus the statistics test employed for hypothesis test is t test. Based on analysis test result of control class and experiment class, it can be obtained that \( t_{count} = 10.99 \) and \( t_{table}=1.645 \). P-Value = 0,000 with \( \alpha=0.05 \) and degree free (df) = 61. Critical area of t hypothesis test is \( t_{count} \geq t_{\alpha} \). So, it can be concluded that \( H_0 \) is rejected. It means that the average test result of students’ mathematical communication ability in experiment class is higher than average test result of students’ mathematical communication ability in control class. In short, it can be stated that students’ mathematical communication ability is improving after using LKPD based on RME.

Descriptive result analysis is also supported by effectiveness prediction questionnaire in which according to the experts is aimed to obtained information about the effectiveness of LKPD based on prediction and consideration of the experts and students’ answer analysis on mathematical communication ability test. The analysis result of questionnaire data effectiveness according to the experts can be seen in Table 2 as follow.

| No | Statement                                                   | %    | Category |
|----|-------------------------------------------------------------|------|----------|
| 1  | LKPD encourages student to actively asking questions         | 83.33| Effective|
| 2  | LKPD trains students to be able to express their opinion     | 83.33| Effective|
| 3  | LKPD can improve students’ creativity                       | 83.33| Effective|
| 4  | Students will be motivated to learn mathematics              | 83.33| Effective|
| 5  | LKPD creates a fun learning environment                     | 83.33| Effective|
| 6  | LKPD facilitates students understanding toward learning material | 83.33| Effective|
|    | **Average**                                                 | 83.33| **Effective** |

Table 2 shows that each statement which describes effectiveness is 83.33% with effective category. It means that, LKPD based on RME is effective according to the experts.

Hypothesis test revealed that the result of students’ mathematical communication ability on experiment class is better than control class. The experiment class is implemented based on RME, meanwhile control class by using student book with scientific based. The result of hypothesis test result is a general conclusion. Therefore, it is of vital importance to describe students’ mathematical
communication ability of sample class of each indicator based on students’ score and students’ answer. Below is students’ answer based on the test result when working on story type question of SPLDV.

Based on indicator (1) State daily life event in language/symbol/mathematics model (can be in the form of picture, diagram, graphic, or mathematics expression). Students’ answer score is 61.72% which can answer with score 2 or 3 in experiment class and 42.97% in control class. Following is the sample of students’ answer on question of this indicator 1.

3.1. **Indicator Question 1.**
Food x contains 4 units of vitamin A and 2 units of vitamin B per kilogram. Food y contains 4 units of vitamin A and 6 units of vitamin B per kilogram. These foods will be used to produce mix food which contains 28 units of vitamin A and 24 units of vitamin B. Create the mathematics model of this problem and answer it by using graphic method.

![Figure 1. The example of students’ answer Sample Class for question No.2](image)

The above picture shows that students in the experiment class are able to answer the question related with the indicator which explains idea, situation, and mathematics relation in written form with concrete or real object, using language, sign or mathematics symbol, and mathematics expression. However, students are failing to state problem solving by using graphic. This is supported by the fact there is only 1 student who is able to answer 3 questions correctly (the students’ average score is 2.06). 2) Read, discuss, and write a mathematics presentation.

3.2. **Question for Indicator 2.**
Mr. Rahmat has a garden in a square shape. This garden has already equipped with wire fence. The length of the wire required for the whole garden is 44m.

a. How to determine the periphery of Mr. Rahmat's garden?
If the length of the garden is 8 meter longer than its width, determine how to find the length and the width through substitution method.

Indicator number 2 can be found at question number 3. The percentage of students in the experiment class who are able to achieve maximum score in this indicator is 62.50% and 42.19% for students in control class. The average score obtained by students in the experiment class of indicator number 2 is higher than control class, 2.5. Meanwhile the students' average score in control class is 1.69. The example of students' answer toward the above question in relation with indicator number 2 is as following:
The above picture shows that numerous students in the experiment class can answer correctly (achieve score 3) meanwhile none of the students in control class who are able to answer correctly and therefore none achieve score 3. This is due to mistake in reading the question or mistake in operating and in writing the correct answer.

3.3. Question Indicator 3.
Find the pattern or mathematical traits to make generalization with students’ own language. In the following is the question for indicator 3:

A small scale home industry produces two kinds of white bread. In the production there are two raw ingredients, namely wheat flour and margarine. 400 gram of wheat flour and 200 gram of margarine is required to produce the first bread. Meanwhile, 200 gram of wheat flour and 200 gram of margarine is required to produce the second bread. Every day, this home industry spends 40 kg of wheat flour and 30 kg of margarine. For every piece of sold bread, the owner gained Rp.400 for the first bread type and Rp. 300 for the second bread type.

a. Create the mathematics model of the above problem
b. Determine the problem solving through method combination of elimination and substitution
c. How much is the profit gained?

Based on the students’ answer in the experiment class, it can be inferred that they are able to solve this kind of problem. It is evidence that they can model the question as 64.06% answer correctly. Meanwhile, students in the control class failed to provide correct respond toward the question which is related with indicator number 3 that is to correctly model the problem given. There are only 36.72% students who are able to answer correctly in control class. This suggests that students in the experiment class have a better ability than students in the control class in terms of indicator 3.
3.4. Question Indicator 4.

Draw conclusion, arrange evidence, and provide reason toward freedom in solving the problem. In the following is the question for indicator 4:

A year ago, the total amount of a mother and her child’s age is 48 years. 3 years later, the mother’s age is 5 years older than twice of her child’s age. Determine the mother’s age and her child’s age for 5 years ahead.

It is evidence that the percentage of students in the experiment class who reach maximum score is higher in number than students in control class. The percentage of students in the experiment class who reach maximum score is 65.63% and percentage in control class is 38.28%. The average score obtained by the students in the experiment class of indicator number 4 is higher than average score in control class that is 2.63, meanwhile the average score of students in control class is 1.53. The sample of students’ answer for indicator number 4 is as following:

**Figure 4. Students’ answer Experiment Class for Question No.4**
Based on the explanation of each indicator of mathematical communication ability along with the description result of data analysis that has been conducted, it is evidence that students’ mathematical communication ability in experiment class is better than students’ mathematical communication ability in control class. This is due to experiment class conducted learning by employing LKPD based on RME which engaging students’ participation actively in the learning process through its 5 characteristics.

LKPD based on RME contains contextual problems and exercise questions in the form of mathematical communication ability; hence it is different from the previous learning which is lack of contextual and mathematical communication ability questions. It means that students’ mathematical communication ability can be improved if they are train to solve the mathematical communication problem. This is also supported by Rafki NI and Made Arnawa. "There is increased capacity of the logic and mathematical communication students after learning through assisted CTL approach work sheets 21 century Junior High School In Padang in aggregate materials with an average of the index gain normalization namely 0.54.[11] The other research with learning based on RME were also conducted by Maria Agustina Kleden, (2017), and Rizqa Yunisha, (2016).[13, 14]

Learning based on RME approach also require students to improve their mathematical communication ability as can be seen in the research conducted by Made Arnawa (2016), Ahmad Fauzan, Yerizon (2013)[16,17]. Isabel Val,(2017), Nor Khoiriyah, (2016). [12,15] which concluded that students’ mathematical communication ability can be improved after conducting learning based on RME. Finally, it can be concluded that learning device based on RME can improve students’ mathematical communication ability.

4. Conclusion
This is a development research aimed to produce LKPD based on Realistic Mathematics Education (RME). LKPD for mathematics learning material for class VIII is two variable linear equations system. The result of effectiveness test revealed that LKPD based on RME is fulfilling effective criteria since it is provide impact toward students’ mathematical communication ability. It means that, the average test of students’ mathematical communication ability after using LKPD based on RME is improving in comparison to the average test of students’ mathematical communication ability in control class. Next, the score percentage of each indicator of mathematical communication ability is improving after implementing LKPD based on RME, particularly on two variable linear equations system learning topic.

References
[1] Kemendikbud 2013 Materi Pelatihan Guru Implementasi Kurikulum 2013. Jakarta: Badan Pengembangan Sumber Daya Manusia Pendidikan Dan Kebudayaan Dan Benjamin Mutu Pendidikan
[2] Izzati I, Nur N and Suryadi D 2010 Komunikasi Matematik dan Pendidikan Matematika Realistik Pros. Sem. Nas. Mat. Pend. Mat. (Yogyakarta: UNY) ISBN: 978-979-16353-5-6
[3] OECD 2016 Programme For International Student Assessment (PISA) Results From PISA 2015 (http://www.bps.go.id/linkTableDinamis/view/id/1054) accessed in 19 January 2016
[4] Wijaya A 2012 Pendidikan Matematika Realistik (Yogyakarta: Graha)
[5] Depdiknas 2008 Panduan Pengembangan Bahan Ajar. Jakarta: Direktorat Pembinaan SMA, Dirjen Mandikdasmen (Jakarta: Depdiknas)
[6] Plomp T and Nieveen N (eds) 2007 An Introduction to Educational Design Research (Enschede: Netherlands Institutefor Curriculum Development (SLO))
[7] Ismail RN and Arnawa IM 2019 Pengembangan 4 C’s Dalam Perangkat Pembelajaran Matematika Berbasis Pendekatan Realistic Mathematics EducationPeserta Didik Kelas VIII SMP Master Thesis (Padang: UNP)
[8] Gravemeijer KPG 1994 Developing Realistic Mathematics Education (Utrecht: Freudenthal Institute) ISBN : 90-73346-22-3
[9] Permendiknas 2016 Lampiran Peraturan Menteri Pendidikan Nasional Republik Indonesia Nomor 22 Tahun 2016 tentang Standar Proses Pendidikan Dasar Dan Menengah (Jakarta: BSNP)

[10] Plomp T 2013 Educational Design Research: an Introduction *An Introduction to Educational Design Research* eds Plomp T and Nieveen N (Enschede: SLO Netherlands Institute for Curriculum Development)

[11] Ismail RN and Arnawa IM 2018 Improving Students’ Reasoning and Communication Mathematical Ability by Applying Contextual Approach of The 21st Century at *Advances in Social Science, Education and Humanities Research (ASSEHR)* 285 2nd Int. Conf. Math. Math. Edu. (ICM2E 2018)

[12] Isabel V and Ana B 2017 The Importance of Seeing in Mathematics Communication *J. Euro. Teach. Edu. Net.* 12 49-63

[13] Yunisha R et al 2016 Pengaruh Pendekatan Pendidikan Matematika Realistik Terhadap Kemampuan Komunikasi Matematis Siswa Kelas VII SMP *Jurnal Elemen* 2 136 - 145

[14] Kleden K, Agustina M et al 2015 Analysis Of Enhancement Of Mathematical Communication Competency Upon Students Of Mathematics Education Study Program Through Metacognitive Learning *Int. J. Edu. Res.* 3 ISSN: 2411-5681

[15] Khoiriyah N 2016 Kemampuan Komunikasi Matematis Siswa Kelas VII SMP Negeri 1 Mojolaban *J. Math. Math. Edu.* 6 34-46

[16] Arnawa IM, Wirdaningis S and Anhar A 2017 Pengembangan Perangkat Pembelajaran Matematika dengan Pendekatan Contextual Teaching and Learning untuk Meningkatkan Kemampuan Pemecahan Masalah Peserta Didik Kelas XI JNPM *J. Nas. Pend. Mat.* 1 275-289

[17] Fauzan A and Yerizon Y 2013 Pengaruh Pendekatan RME dan Kemandirian Belajar Terhadap Kemampuan Matematis Siswa *Prosiding SEMIRATA 2013* 1