The effectiveness of learning instruments on the topic of the set using problem-based learning model at Islamic junior high school in Pekanbaru

Sakur, A Murni and R D Anggraini
Universitas Riau, Jl. Kampus Bina Widya, Km. 12.5 Simpang Baru, Riau 28293, Indonesia
E-mail: sakur@lecturer.unri.ac.id

Abstract. This study is a continuation of the research and development of learning instruments on the topic of set. Researchers through Research and Development have produced prototypes of learning instruments, namely: lesson plan and worksheets. The prototype of the learning instruments has been analyzed for validity and practicality. The learning instruments then needed to be tested for its effectiveness through experimental research in two classes, the experiment, and control class. The purpose of the study was to examine the difference of learning outcomes between classes using learning instruments on the topic of the set and the class using the conventional learning model in Year 7 at one of the Islamic Junior High School in Pekanbaru. This research used a pre-experimental research design from a static group comparison. The results showed that the students’ learning outcome using learning instruments of Problem-Based Learning (PBL) model was better than their counterpart. The learning instruments using the problem-based learning model was effective to be used in Islamic Junior High School in Pekanbaru.

1. Introduction

The student-centered learning is important to create a fun and enjoyable learning. To implement student-centered learning, learning instruments, including lesson plan and worksheet employing student-centered approach should be developed [1]. One of the approaches focusing on students is problem-based learning (PBL). Learning is a mental process that occurs within a person, thus causing the change in behavior [2]. The mental activity occurs because of the individual interaction with the environment. Trianto [3] stated that learning, in general, is a process marked by the change in one's self. Changes as a result of the learning process can be indicated in various forms such as changing knowledge, understanding, attitude, and behavior, skills, and abilities, as well as changes in other aspects in the individual learning. Learning is a process of change in a person towards a better and relatively permanent as a result of his/her own experience with the environment. These changes can be knowledge, understanding, attitude and behavior, skills and abilities. The process of change is an individual's interaction with the environment. Oemar Hamalik [4] stated that learning outcomes might be indicated by the behavior of learners, which can be observed and measured in the form of changes in knowledge, attitudes, and skills.

The PBL is learning aiming to develop the ability to think and solve problems. This learning challenges learners to develop critical thinking skills, examine problems, find and actively and creatively apply their existing ability. Implementation of PBL encompasses five steps [5] as outlined in Table 1.
Table 1. Steps of problem-based learning.

| Step/stage                                      | Teacher activity                                                                                                                                 |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| The orientation of the learners on the problem | Presenting phenomena/issues, exposing logistics to learning, motivating learners to engage in defined real-life problem-solving activities |
| Organize learners to learn                      | Help learners understand the problem of starting with the identification of learning tasks to do problem-solving planning                       |
| Guiding individual or collective investigations | Guide or motivate learners to do research (experiment if necessary) and implement problem-solving                                             |
| Develop and present the work                   | Helps learners provide ease in providing the necessary tools and sharing tasks in presenting products or works                                |
| Evaluate the learning process                  | Together with the learners to summarize the contents of the lesson, reflect on the problem-solving process. And evaluation.                 |

The role of teachers in the application of PBL is explaining the problem, facilitating the learners’ investigation and dialogue or discussion and guiding learners. Besides, teachers also provide scaffolding to help learners to solve problems. Scaffolding is an effort to improve the ability of inquiry and the cognitive development of learners by guiding and motivating the learners to find or build their knowledge of what is learned.

The PBL model is learning that allows learners to share ideas and considers the most appropriate answer. This learning also encourages learners to improve their collaborative skills to solve the contextual problem mutually. Learners are expected to present their work in front of the class so that the learning process that followed by all learners are required to achieve the learning objectives. The implementation of this PBL enables learners to be engaged in learning as this learning focuses on the activities of learners in searching, processing and reporting information from various sources. There are several aspects that are analyzed to test the effectiveness of learning instruments with PBL toward the students’ mathematics learning outcome. One of these is the Mathematics Initial Ability (MIA). The students’ MIA is categorized into high, medium, and low, as the other variable in this research.

This problems statement of this research are: (1) Is there a significant difference in mathematics learning outcome between students in the experimental and control class?; (2) Is there a significant difference of mathematics learning outcome of learners with high MIA between the experimental and control class; (3) Is there a significant difference in mathematics learning outcome of learners with medium MIA between the experimental and control class; and (4) Is there a significant difference of mathematics learning outcome of learners with low MIA between the experimental and control class.

This research aims to test the effectiveness of learning instruments on the topic of set. The learning instruments (called prototype II) are tested for the validity and reliability. The specific purpose of this research is to examine the difference of the Year 7 learners’ learning outcome in Islamic Junior High School Pekanbaru. The difference in the learners’ learning outcome can be interpreted to examine the effectiveness of learning instruments.

2. Method

Through research and development, the researcher has generated learning device products invalid prototype and practicality. The prototype products must then be tested for its effectiveness through experimental research. The selected school was divided into the experimental and control class determined by the normality and homogeneity test on the data of the Mathematical Initial Ability (MIA). In the experimental class, learning was conducted by using the learning instruments developed, while the control class was run in the conventional way. This research used a quasi-experimental research method that was performed in the existing environment. The MIA of the Year 7 learners were divided into high, medium, and low groups. The impact researched as a result of the treatment was the mathematics learning outcome as an achievement of basic competence. Population in this research were all students of...
Year 7 Islamic Junior High School Pekanbaru on the academic year 2017/2018, consisting of four classes. The sample classes were two class, one experiment class implementing PBL (28 students) model and control class (31 students) with the conventional learning model.

The research involved two classes with designs presented in Table 2.

### Table 2. Research design.

| Class   | Treatment                  | Post-test |
|---------|----------------------------|-----------|
| Experiment | X₁<sup>a</sup>      | O<sup>c</sup> |
| Controls    | X₂<sup>b</sup>      | O<sup>c</sup> |

<sup>a</sup>: Problem Based learning model
<sup>b</sup>: Conventional learning using a scientific approach
<sup>c</sup>: Posttest

The data collection instruments that were used are test and non-test. The test was a daily test for basic competency about the subject of the set. The non-test instrument was the observation sheet during the learning process and interview guidelines. The test was developed by the researchers that used to measure the mathematics learning outcome of learners. The data of MIA and learning outcome of the learners were tested for normality, homogeneity and mean difference. Analysis data was conducted using the SPSS software version 20.

The data of MIA was derived from the value of daily tests on concerning number. Table 3 shows the result of the normality test with Kolmogorov Smirnov test not normally distributed.

### Table 3. The test results of the normality of MIA data.

| Class | N  | μ     | σ   | Sig. | Description |
|-------|----|-------|-----|------|-------------|
| VII-3 | 28 | 61.96 | 31.250 | 0.000 | Not normal  |
| VII-4 | 31 | 54.19 | 28.899 | 0.000 | Not normal  |

Furthermore, hypothesis testing using nonparametric statistical Mann Whitney tests. The verbal hypothesis formula for Mann Whitney test on posttest score data of experimental class and control class is as follows.

H<sub>0</sub>: The average MIA of grade VII-3 is lower or equal than grade VII-4
H<sub>1</sub>: The average MIA of grade VII-3 is higher than grade VII-4

Mann-Whitney test results are presented in table 4.

### Table 4. Mann-Whitney test data of MIA students.

| Class | N  | μ     | Z   | Sig. (1-tailed) | H<sub>0</sub> |
|-------|----|-------|-----|----------------|-------------|
| VII-3 | 28 | 61.96 | -0.594 | 0.552          | Accepted    |
| VII-4 | 31 | 54.19 |       |                |             |

Table 4 shows that the significance value (sig.) is more than α = 0.05 which means H<sub>0</sub> is accepted, and H<sub>1</sub> is rejected. This means that at 95% confidence level, there is no average difference between grade VII-3 and grade VII-4.

The test of mathematics learning outcome in this research was in the form of a description problem and a test device aiming to measure the achievement of basic ability as stated in the regulation of the ministry of education (Permendikbud) No. 24, Attachment 1 [6]. Interview guides were prepared to interview teachers and some learners. The interview was used to explore teacher and student comments’ related to the learning process using learning instruments developed and conducted to improve the mathematics learning outcomes.

Learners were grouped into three groups of height, medium and low. Grouping criteria were based on the mean (MIA), and standard deviations (SD) referring to the criteria used by Ratnaningsih [7] is; high
group(s-MIA ≥ \bar{x} + SD), the medium group (\bar{x} - SD ≤ s-MIA < \bar{x} + SD), and low group (s-MIA < \bar{x} - SD)

To obtain optimal results, researchers conducted observation activities on the implementation of the learning process, especially in the experimental group. Observation sheets for learners were used to observe the activities of learners in the ongoing learning using the developed student worksheets. Teacher observation sheets are used to observe teacher activities in implementing the learning. Observations were made by observers using the observation sheet.

Tests to determine the effectiveness of actions performed on the experimental class of mathematics learning outcomes obtained by learners were measured by calculating the “effect-size” (d) using Cohen's formula [8] as follows.

\[
d = \frac{\bar{x} - \bar{c}}{S_{\text{pooled}}} \quad \text{and} \quad S_{\text{pooled}} = \sqrt{\frac{\left(n_i - 1\right)s_i^2 + \left(n_c - 1\right)s_c^2}{n_i + n_c}}
\]

The interpretation of the result of the calculation of the value of effect size is presented is; High (d ≥ 0.80), medium (0.50 ≤ d < 0.80), low (0.20 ≤ d < 0.50), and very low (d < 0.20).

3. Result and discussion

The results with Kolmogorov Smirnov and Lavee test shows that the score of the students' posttest of both classes was normally distributed as showed table 5.

| Class | N   | \(\mu\) | \(\sigma\) | Sig. | Description |
|-------|-----|---------|-----------|------|-------------|
| VII-3 | 28  | 92.55   | 10.540    | 0.175| Normal      |
| VII-4 | 31  | 48.18   | 24.968    | 0.191| Normal      |

The hypotheses for testing the homogeneity of posttest data were:

\(H_0\): There is no difference in variance from posttest data of both classes

\(H_1\): There is the difference in variance from posttest data of both classes

The result of the homogeneity test, Lavee-test, is presented in Table 6.

| Class | N   | \(\mu\) | Varian’s | Sig.   | Description |
|-------|-----|---------|----------|--------|-------------|
| VII-3 | 28  | 92.55   | 111.100  | 0.000  | Homogeny    |
| VII-4 | 31  | 48.18   | 623.404  |        |             |

Based on table 6, it can be seen that the significance value (sig.) is less than \(\alpha = 0.05\) which means \(H_0\) is accepted. This means that at 95% confidence level, there is no difference between the experiment and control class. The hypothesis formula for t-test of posttest data of learners of experimental class and control class is:

\(H_0\): the average of posttest of experiment class is lower or equal to the average of the control class

\(H_1\): the average of posttest of the experiment class is higher than the average of the control class

The results of the independent sample t-test of students’ posttest data are presented in Table 7.

| Class | N   | Df | T    | \(t_{0.05(56)}\) | \(H_0\)    |
|-------|-----|----|------|-----------------|------------|
| VII-3 | 28  | 56 | 6.797| 2.003241        | Accepted   |
| VII-4 | 31  | 56 | 6.797| 2.003241        |           |

Table 7 shows that at the 5% significance level the average achievement of experimental class ability is better than the control class average.
The treatment of this research took place for six lessons in both the experimental and control class. At the end of the study, a posttest was administered for both classes to examine the results achieved after the treatment. Implementation of learning in both sample classes with the same subject which is the set. Based on observations and interviews it is stated that the implementation of learning in both sample classes has been verified and convinced according to the planning. Profile of the MIA group of the learners is presented in Table 8.

Table 8. Profile of learners groups.

| Group category | Experiment | Controls |
|----------------|------------|----------|
|                | N | rMIA<sup>a</sup> | rHB<sup>b</sup> | N | rMIA<sup>a</sup> | rHB<sup>b</sup> |
| G-height       | 3 | 100 | 90.8 | 6 | 86.7 | 55.7 |
| G-medium       | 15 | 81 | 88.2 | 20 | 54 | 42.6 |
| G-low          | 10 | 22 | 81.1 | 5 | 16 | 32.8 |

<sup>a</sup>: the average of MIA  
<sup>b</sup>: the average learning outcome

Table 8 shows the average increase in learning outcomes in the experimental class, especially in groups of students in the low and medium category. The average outcome of the controlled class learning in the MIA group was high and medium. The difference in learning result of MIA group high in experimental class decreased 9.2 points, while in control class decreased 31 points. The results of the study were medium, in the experimental class, there was an increasing while in the control class there was a decreasing. The learning result of the low MIA group in the experimental class showed an increase of 59.1 points, while in the controlled class is 16.8 points.

The changing of the average of learning outcome indicates that the learning process is effective. After the hypothesis test in the posttest scores of each class using the Independent Sample T-Test with the help of SPSS, it was found that the average experimental class was better than the average post-control class as supported by the presence of Table 6. So it can be said that there is a significant difference to the learning outcomes between the classes applied Problem-based Learning model and the conventional learning model of Year 7 students at Islamic Junior High School Pekanbaru. Based on table 4 and table 7, can be said that the average achievement of experimental class competencies increases. The average achievement of controlled class competencies decrease.

4. Conclusion
There is a significant difference in the mathematics learning outcomes of learners between the class applying Problem-based Learning model and the class applying the conventional learning model at grade VII at Islamic Junior High School Pekanbaru. There is a difference in the mathematics learning outcomes of learners with high Mathematical initial ability in experimental and controlled classes. There is a difference in the mathematics learning outcomes of learners with medium Mathematical initial ability in experimental and controlled classes. There is a difference in the mathematics learning outcomes of learners with low Mathematical initial ability in experimental and controlled classes. Thus it can be interpreting that the application of learning instruments that designed in prototype II is effective and can enhance the achievement of the learner's ability.

References
[1] Kemendikbud 2016 *Peraturan Pemerintah No. 22 tahun 2016 tentang Standar Proses Pendidikan Dasar dan Menengah* (Jakarta: Kementerian Pendidikan dan Kebudayaan)  
[2] Sanjaya W 2008 *Strategi Pembelajaran Berorientasi Standar Proses Pendidikan* (Jakarta: Kencana Prenada Media)  
[3] Trianto 2007 *Mendesain Model Pembelajaran Inovatif-Regresif* (Jakarta: Kencana Prenada Media Group)  
[4] Hamalik O 2003 *Proses Belajar Mengajar* (Jakarta: Bumi Aksara)
[5] Ibrahim M and Nur M 2002 *Pembelajaran Berasaskan Masalah* (Surabaya: Universiti Press)
[6] Kemendikbud 2006 *Peraturan Pemerintah No. 24 Tahun 2016 Lampiran 15 tentang Kompetensi Dasar dan Struktur Kurikulum SMP/MTs* (Jakarta: Kementerian Pendidikan dan Kebudayaan)
[7] Ratnaningsih N Pengaruh Pembelajaran Kontekstual terhadap Kemampuan Berpikir Kritis dan Kreatif Matematik serta Kemandirian Belajar Siswa Sekolah Menengah Atas [Dissertation] Bandung; Universitas Pendidikan Indonesia; 2007
[8] Cohen J 1992 Quantitative methods in psychology: A power primer *Psychological Bulletin* **112** 155