Using Realistic Mathematics Education approach to learn linear program

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Abstract. This study aims to determine the effectiveness of Realistic Mathematics Education (RME) approach to making the learning of linear program material easier than using the scientific approach. If the linear program learning is easy for students, then it will affect their achievements. This study used quasi-experimental design and involved 41 vocational high school students majoring in accounting at SMK Taman Siswa Banjarnegara. We grouped the students into two groups. The first group got treatment of RME and consisted of 19 students, from now on called the experimental group. Then, the second group, which is called the control group, got a scientific approach and consisted of 22 students. The instrument used in this study was a test. The data were analyzed using one sample t-test to determine the differences in the average achievement between the two groups. The results of the descriptive analysis of learning achievement in the RME class showed an average increase of 49.47 on the pretest instrument to 86.32 in the posttest instrument, while in the control class using the scientific approach showed an average increase of 49.55 on the pretest instrument to 71.82 in the posttest instrument. The t value in the RME approach is 18.614 > 0.05 and in the scientific approach is 0.463 > 0.05. Thus, both approaches are effective regarding mathematics learning achievement.

1. Introduction

Every student certainly wants to learn mathematics easily and fun. Mathematics is a human activity [1]. Based on a survey by TIMSS in 2011 showed the results that the most important findings in mathematics learning are related to student learning achievement with the average achievement of Indonesian mathematical abilities at the lower level of 43% while internationally with a median of 75% [2]. Indonesia was only ranked 41 out of 45 participants. The same is true for the 2017 Computer-Based National Examination results for vocational schools in Banjarnegara that get the second-lowest ranking in the province of Central Java, especially math scores so that it requires handling especially in classroom learning.

The Realistic Mathematics Education (RME) approach is learning that views mathematics as a human activity related to reality [3]. Using RME approach in mathematics learning is done through stages such as understanding the context problem, using ‘model of’ and ‘model for’ solving mathematical problems, and using non-routine problems, so that we could improve the students’ mathematics learning achievement. Research also concludes that the RME approach is effective against mathematics learning achievement [4].
Research on an RME approach has been partially carried out by several parties in improving mathematics learning achievement. However, this study is different from the research that has been done before because the application is carried out on students of vocational high school majoring in accounting. Based on the facts that occur in the field because the learning achievement is still low and there is support from previous research, the realistic approach will be applied at the SMK Tamansiswa Banjarnegara, a private vocational high school. The present research aims to test the effectiveness of the RME approach in improving the mathematics learning achievement of 11th-grade students.

RME is learning in mathematics education that involves students to actively and interestingly developing their understanding by sitting on problems in the context [1]. Moreover, Van den Heuvel-Panhuizen states that RME is a learning approach to mathematics that first presents realistic situations in the learning process as a source of developing concepts [5]. There are three basic things in RME, namely guide reinvention, didactical phenomenology, and self-developed models [6]. In the principle of model development, the model has two stages, namely the ‘model of’ and the ‘model for’. Model of means a contextual and specific model of the given problem situation, while the model for is a model that is the basis for going to mathematical thinking at the formal level.

There are five specific characteristics incorporated in RME, namely the use of context, bridging by vertical instruments, student contribution, interactivity, and intertwining [7, 8]. To conduct learning by applying RME, teachers play some roles, namely: (1) Teachers are only as facilitators of learning; (2) Teachers must be able to build interactive teaching; (3) Teachers must provide opportunities for students to contribute to their learning process actively and actively assist students in interpreting real problems; (4) The teacher is not embedded in the material contained in the curriculum but is active in linking the curriculum with the real world both physically and socially [9].

Based on the survey results by TIMSS in 2011, the results showed that the achievement of mathematics learning in Indonesian students was at the lower level of 43% while in the international median the largest was 75% [2] as well as the acquisition of the 2017 Computer-Based National Examination at SMK in Banjarnegara. This research is different from the research that has been done before because, in the application, it is carried out on students at the vocational high school level majoring in accounting which lead to a different context. The topic discussed in this learning was linear program which is aligned with the daily life situations.

2. Method
The type of research used is quasi-experimental research using classes at school. This type of research was chosen to compare the effectiveness of applying realistic mathematical approaches. Wherein the control class used applies the scientific approach. In one school it is divided into three classes for accounting majors at grade XI, so it can take two classes to do treatment. The research design [10] used is illustrated in Figure 1.

![Figure 1. The design of quasi-experiment](image-url)

This research in Figure 1 was conducted in class XI of SMK Tamansiswa majoring in accounting in Banjarnegara Regency, Central Java Province, where this school had used the 2013 curriculum. In the school, there were three classes in the accounting department. The selection of Experiment 1 and Experiment 2 was made randomly. In Experiment 1, there were 19 students joined while in
Experiment 2, there were 22 students joined. The number of students was adjusted to the number of students in each class. The determination of Experiment 1 treatment is the RME approach and Experiment 2 is the scientific approach, is also determined randomly.

The instrument used is a test of mathematics learning achievement of students in linear program material. The question of learning achievement test is a multiple choice of ten items. This instrument includes questions consisting of three indicators, namely two questions discussing mathematical models, three questions for maximum numbers and three questions explaining minimum values.

After testing the instrument and the researcher is ready to take the instrument data, the researcher first takes the pretest data then analyzes it descriptively. After the pretest, researchers conducted mathematical learning by applying the RME approach in class XI Accounting 1 as the Experiment 1 and class XI Accounting 2 as the Experiment 2.

As for the treatment of the first meeting material, the two classes were related to the two-variable linear inequality model, meeting the second is related to optimization with the vertex point test method and the third meeting related to optimization with the inquired line method. This learning was done in groups with the help of worksheet. Data analysis techniques used are descriptive analysis and inferential analysis. The descriptive analysis aims to describe the results of the learning process obtained after being given treatment on learning achievement. The data presented are average, standard deviation, maximum and minimum values while inferential analysis aims to describe the results using the t-test.

Mathematics learning using realistic mathematical approaches concluded effectively regarding student learning achievement based on the minimum completeness criteria that are 70. The decision criterion rejects \( H_0 \) if the significance value is less than 0.05 and accepts \( H_0 \) if the significance value is more than 0.05. Test statistics are used to compare the effectiveness of two learning approach groups with one dependent variable, namely the independent t-test has a decision criterion to reject the null hypothesis \( (H_0) \) if it meets the significance value is less than 0.05 and accepts \( H_0 \) if the significance value is more than 0.05.

3. Results and Discussion

3.1 How were the results of learning mathematics after treatment?

The Table 1 is a description of the data of students’ mathematics learning achievement tests on linear program material in the first experimental class and second experimental class.

| Description       | Output of experiment |
|-------------------|----------------------|
|                   | Pretest of Experiment 1 | Pretest of Experiment 2 | Posttest of Experiment 1 | Posttest of Experiment 2 |
| Number of student | 19                  | 22                  | 19                  | 22                  |
| Score             | 940                 | 1090                | 1640                | 1580                |
| Mean              | 49.47               | 49.55               | 86.32               | 71.82               |
| Deviation Standard| 12,681              | 13,62               | 8,307               | 19,429              |
| Max Score         | 70                  | 70                  | 100                 | 90                  |
| Min Score         | 20                  | 20                  | 70                  | 30                  |

In Table 1, it corresponds to the descriptive purpose of showing the results of mathematics learning achievement from before and after being given treatment. The results of the pretest in experiment class 2 showed a higher score and average than the Experiment 1, but after treatment and posttest, data retrieval obtained higher results in Experiment 1. The maximum value was found in Experiment 1.

Hypothesis testing using the one sample t-test was carried out on the value of learning achievement in mathematics to see the effectiveness of the two classes. The results of statistical tests can be seen in Table 2.
Table 2. One-sample t-test

| Test Value = 70 | t   | Df   | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference |
|----------------|-----|------|-----------------|-----------------|------------------------------------------|
|                |     |      |                 |                 | Lower | Upper                     |
| Post-test      |     |      |                 |                 |       |                          |
| Experiment 1   | 18.614 | 18 | 0.000 | 16.416 | 12.41 | 20.42                  |
| Post-test      | 0.463 | 21 | 0.648 | 1.918  | -6.70 | 10.53                   |
| Experiment 2   |     |      |                 |                 |       |                          |

In Table 2, the Sig value in the Experiment 2 is greater than the experimental Sig value. Thus, the Experiment 1 is effective and the Experiment 2 is significantly effective. How to retrieve data first to retrieve data using instruments to find out whether the instrument is suitable for use in research. The ones that are analyzed are the level of validity, reliability, homogeneity and normality data. The test results, ten items of valid instruments, the reliability coefficient of 0.679 data is reliable, the normality data of 0.113 data that is meant to be normal and the value of homogeneity of 0.605 data in question is homogeneous. Based on the table, it was found that the value of t in mathematics learning with a realistic mathematical approach was $18.614 > 0.05$ and the scientific approach was $0.463 > 0.05$ so that both approaches were effective regarding mathematics learning achievement.

Subsequent hypothesis testing using the independent sample t-test is used to compare the effectiveness of the two learning approach groups used. Statistical test results can be seen in Table 3.

Table 3. Independent samples t-test

| Levene’s Test | t-test for Equality of Means | 95% Confidence Interval of the Difference |
|---------------|-----------------------------|------------------------------------------|
|               | F   | Sig. | T   | Df   | Sig. (2-tailed) | Mean Diff. | Std. Error Diff. | Lower | Upper |
| Score         | Equal var-         | 7.549 | 0.09 | 3.019 | 39 | 0.063 | 14.498 | 4.802 | 4.784 | 24.211 |
|               | assumed           |     |      |      |               |             |                  |       |       |
| Score         | Equal var-         | 3.180 | 0.063 | 14.498 | 4.560 | 5.176 | 23.819 |
|               | not assumed       |     |      |      |               |             |                  |       |       |

Based on Table 3, it can be seen that F arithmetic Lavene test is 7.549 and the significance value of Lavene test (probability) is $0.09 > 0.05$ so that both classes have equal variances assumed. Thus the analysis of different t-test uses the assumption of equal variances assumed where the sig (2-tailed) value obtained is $0.063 > 0.05$ so that $H_0$ is accepted.

3.2 How did the stages of learning with an RME approach run?

The effectiveness of learning by applying RME approaches is not superior to learning mathematics by applying scientific approaches, but still has advantages. Realistic mathematical approaches have good steps to be applied to mathematics learning in the classroom. The first stage is understanding the contextual problem, which is understanding the issues related to matters related to sales. From the contextual problem, students read in detail and carefully to get an understanding of their respective styles and abilities.

Figure 2 is the second stage performs horizontal mathematization. Freudenthal suggested that horizontal mathematization leads from the world of life to the world of symbols [6]. At this stage,
students make a solution with their abilities by leaving the existing procedural rules so that what is in students' minds can be written down but still directed. At Meeting 1, students are given three problems wherein horizontal mathematical students gradually create a mathematical model by the problem whereas, at meetings 2 and 3, students are given problems to solve the expected problems in the vertical mathematical process.

**Figure 2.** Horizontal mathematization

Figure 3 is the third stage performs vertical mathematical. The vertical mathematization is arranging certain procedures that can be used to solve contextual problems [6]. This mathematization leads to the conclusion stages obtained from the horizontal mathematical stages.

**Figure 3.** Vertical mathematization

The fourth stage communicates interactively. Students explain and give reasons for the answers they give, understand their answers, agree to their answers, express disapproval, find alternative solutions, and reflect on each step taken or against the results learning [11].

The fifth stage reflects. Students are assisted by the teacher to reflect on each step taken previously or to the results of the lesson so that they can conclude the learning objectives achieved. This step will further strengthen the concept that students have obtained in the previous step so that it is possible to improve mathematics learning achievement also to improve the ability to solve more complicated problems.
3.3 How did the stages of learning with a scientific approach run?

The first stage observation or observation is to consider or perceive some aspects that exist then recognize a significant problem situation [11]; then observations are determined or modelled. Introduction to the problem is the first step in solving problems that occur with a lost or invisible situation that must be a concern. If a problem can be identified, the observation is achieved to get a solution. Accurate observational information can be obtained from the availability of information in the worksheet.

Figure 4 is the second stage, asking is one of the entry points in gaining knowledge [12]. Some of the benefits of asking are arousing students’ curiosity, interest and attention to the topic of learning. Questions that students have asked are two things, namely yes or no answer and questions in the form of concepts. Questions in the form of concepts that have been submitted either in the experimental class or in the control class are described in Figure 4.

![Figure 4. Asking and collecting information](image)

The third stage of gathering information, leads to further action from asking [12]. This activity is carried out by exploring and collecting information from various sources.

The fourth stage is reasoning, relates one fact or several other facts so that it can conclude the relationship to form a result of a series of concepts in the form of concepts [12]. Furthermore, reasoning activities lead to problem-solving as additional information.

The fifth stage communicates students are directed to present what has been discussed in their group. The communicating stage can provide further clarity because the teacher will provide clarification about answers that must be corrected or correct and provide opportunities for presentation on the correct answers [12].

4. Conclusion

Based on the explanation above, the results of this study indicate that a realistic approach is effective in improving mathematics learning achievement in linear program material. The results of the descriptive analysis of learning achievement in the RME class showed an average increase of 49.47 on the pretest instrument to 86.32 in the posttest instrument, while in the control class using the scientific approach showed an average increase of 49.55 on the pretest instrument to 71.82 in the posttest instrument. The t value in the RME approach is 18.614 > 0.05 and in the scientific approach is 0.463 > 0.05. Thus, both approaches are effective regarding mathematics learning achievement. The effectiveness of the RME approach to learning achievement increases but is not significant.
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