Learning design of reciprocal proportionality using airplanes context

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Abstract. The aim of the study was to produce a learning trajectory of reciprocal proportionality using airplanes context. In the process of learning mathematics in school, the teacher be the center of learning make students become passive. This causes learning to be boring and difficult to understand subject matter. The research method uses a research design with three stages, namely preliminary, design of experiment (pilot experiment & teaching experiment) and retrospective analysis. The participants of the research are 25 students in junior high school number 12 Palembang. The results show a series of track student activity initially linking capabilities with new information that it receives. Retrospective analyses of teaching experiment showed that using airplanes take off as a context; the method can support students learning of reciprocal proportionality.

1. Introduction

In the 2013 curriculum, mathematics subjects are given to students at the junior high school level. The goal is that students have strong mathematical mastery from an early age so that they can survive in an increasingly competitive life. But in reality, not all students like math because some people think of mathematics as a collection of rules that must be understood, mathematical calculations, mysterious algebraic equations, and geometric evidence [1]. This false assumption is due to traditional learning patterns that are still a learning pattern in some schools. Teachers teach mathematics with the practice of mathematical symbols, emphasis on information provided, and the application of mathematical algorithms [2]. The drill approach is often used by teachers who are actually not effective. During this time the teacher only carries out procedural learning, only provides formula formulas and then does the exercise questions, without giving students the opportunity to actively find concepts [3]. During this learning process is still teacher-centered so students are passive [4].

Comparative learning does not escape traditional methods. Students only receive information provided by the teacher, so that active participation in learning is less visible. This is what causes learning to focus only on memorizing concepts, so mastery of students' concepts is low, especially the ability to solve story problems related to everyday life. In order for learning to be easy and beneficial for students, it should be preceded by the introduction of problems from the student environment (contextual problems). By asking contextual problems students are gradually guided to master mathematical concepts. Various efforts to overcome problems in mathematics learning are carried out,
including teachers can plan to learn according to the character of the material by utilizing the learning context that can be obtained easily and cheaply and close to the life of students.

The use of RME in learning has been going on since 2001 and was adapted from the theory of teaching and learning Realistic Mathematics Education (RME) in the Netherlands [5,6]. RME has been widely used in design research, using the context of typical Palembang food [7]. Context becomes the starting point in mathematics learning) and the realistic approach students have the opportunity to use context into mathematical ideas using models such as candy, plastic pipes, public vehicles, and airplane images [8,9]. Realistic mathematical approaches were chosen because this approach oriented on mathematical day-to-day experience (mathematize of everyday experience) and apply mathematics in everyday life and must be given that in mathematics learning students must be given the opportunity to find (to reinvent) through guidance [10,11]. This means that learning is done through real experience and that is close to the students so that it is more meaningful for students. Then the RME in this study is expected to be more innovative learning and learning to be more meaningful for students as well as improving students' understanding of reciprocal proportionality.

The comparison is one of the mathematical materials that has been studied at the elementary school level. Comparative materials for elementary school (SD) levels are still incorporated in fraction material, while those for junior high school (SMP) are taught in class VII in the even semester with different levels in comparison of material in elementary school (SD). For SMP, the comparison material consists of a comparison of values and a comparison of the value of reversals. In this study, the material taken is the ratio of reciprocal proportionality. Comparison of class VII SMP which is one of the basic competencies is to use comparisons for problem-solving [12]. The context that can be used in learning comparative material reverses the value by using the ratio table. The comparison table raises comparisons that show proportionality situations [13]. The context of aircraft taking off is used to determine the ratio, determine, find relationships that occur between two ratios, so they understand the concept of reciprocal proportionality using the duration of time described above. Based on the background described above, this study aims to produce student learning trajectories in reciprocal proportionality learning using the context of aircraft taking off with the RME approach in junior high school.

2. Methods
The method used in the research is the method that has been done by previous researchers, namely the type of validation research design that aims to prove the theory of learning and develop a localinstructionaltheory (LIT) in collaboration with researchers and teachers to improve the quality of learning. [14-16]. Some experts define tree stages in design research, namely: (a) preparing for the experiment, (b) the design experiment and (c) retrospective analysis [17-19]. The learning design in the form of learning trajectory of students who designed learning activities through iceberg comparison turned values using the context of airplanes take off for class VII junior high school. Learning in this study is designed to produce learning trajectories in comparative learning reciprocal proportionality [20,21]. Several relevant studies among who conducted research from the concept of comparison with a strategy of comparing duration by using ratio tables. The advantage of the ratio table is that all numbers have their own place and that the measurement unit must remain the same. The comparison is the difference between two or more things by following certain patterns of similarity. The completion of comparisons can be done by comparing ratios and using ratio tables [1].

3. Results and Discussion
In this study, interviews were conducted with students who were the subject of research to find out the students' initial abilities. The results of the interviews show that students have learned the comparison material, but for reciprocal proportionality, they have not learned. In addition, an initial test is also given to determine the students' initial abilities. Students are given a written test of five initial test questions, and in completing this initial test the students work individually. Initial test results show that 8 out of 10 students are able to represent and identify what is questioned and make a comparative
value of the problem. Some students are also able to complete a comparison operation not only worth but also a reciprocal proportionality. As for the problem of problem-solving number 4 and 10 children are very confused with the story problem that is so long and needs proper analysis to solve the problem. So that for the problem the student can only identify what is known about the problem and cannot solve the question of the problem. After observing and watching videos, students were asked to pay attention to the video and spell out the questions contained in the (student activity sheet) SAS 1. The sketch pattern of the images in the given video was played with students in front of the class, and then the students were asked to draw the whole picture of the movement of airplanes take off.

Based on an analysis of the learning process, student attitudes, and interactions between students, viewed from videos and photos during the pilot experiment, seeing from the students' written results in the form of student activity sheet and test questions, the researchers revised hypothetical learning trajectory (HTL). The HTL revision also takes into account observers' observations, discussions with the model teacher, and requests for advisors' advice. The revision was carried out with the aim to get more accurate data in accordance with the research objectives. After repairing the HTL in the pilot experiment, then the teaching experiment is held. The results of the teaching experiment will be described as follows: Learning activities in the comparison material turned around the value contained in the repaired HTL based on the results obtained in the pilot experiment stage consisting of 3 activities, namely exploring the video of the plane that was taking off, finding the comparison concept of value clicking, and solving problems related to the ratio of reciprocal proportionality. The explanation of each activity in HTL in the teaching experiment is as follows.

3.1. First Activity: Exploring the Concept of Airplanes Take Off
In the first activity, students are asked to see the video displayed and students are required to pay serious attention to the picture on the video. The students' thoughts were provoked, they analyzed that the images on the video were airplanes that took off which, if observed, the size of the aircraft was getting smaller and disappearing covered in clouds. Students are asked to draw the video illustration, one of the proofs of the answers attached to figure 1.

![Figure 1. Students draw airplanes take off.](image_url)

From the observations of students drawing various forms of images, some taking pictures of the plane as a whole, but there are also those who do not make the steps according to what they watch but make very good steps according to the flow of the plane process one by one until flying. After drawing illustrations of airplanes take off, students are asked to estimate the size of the aircraft according to the phenomenon they are seeing. Students can estimate the size of the aircraft easier if given a measuring device duration when airplanes take off. The test results conclude that students understand that there is a visual relationship between the sizes of the aircraft which decreases with the length of time the airplanes take off.
3.2. Retrospective analysis of the first activity
The activity of drawing sketches of airplanes take off and the time relationship with the plane drawing takes off aims to give students an understanding of the concept of comparison. The sketch of the plane's picture shows the shape of the plane which gets smaller and smaller.

Students' understanding of the concept of measuring the shape of a plane is needed when solving problems and filling in question and drawing of the plane. The results of the study indicate that the strategies used by students vary. It appears that students do various portrayals of this thing seen in their different ways of drawing. But from the quotation of the dialogue with Ardi (sample student), he was confused about how to make a sketch in the form of an airplane or the shape of arrows showing the plane was taking off. This finding is in accordance with the conjectures predicted by researchers.

In addition, from the results of the interview it is known that students when sitting in class VI elementary school when they first learn comparisons, comparisons are presented in the direct form formula a/b. The researcher explores the students' knowledge by asking students to show comparisons in the form of table ratios, then students fill the table of speed and time relationships. This concept is one of the strategies of the comparison concept is to compare the duration by using the ratio table [1]. But this understanding is not enough because it turns out that students still have difficulties when filling out the column of table, need guidance from researchers. In the opinion of researchers, this is because students tend to be afraid of making mistakes or not too confident by filling in the column of the table. Another obstacle is when students determine the time that is not available in the column of table, while what is asked is the shape of the picture, how many children are still confused and need an explanation to be in accordance with the 13th dialog. The airplane takes off to reach the final process of learning activity 1. Overall this activity helps students explore the planes that are take off and find the concept of comparison.

3.3. Second activity: Find the concept of comparison with the opposite value
On the second activity, students carry out several activities ranging from solving problems in the form of tables to drawing conclusions. For the initial context of the problem given, in asking the trip using an airplane is if the airplane's speed is determined by the pilot, then how much travel time the destination is.
3.4. Retrospective Analysis Activity 2

This learning aims so that students can find the concept of reciprocal proportionality. In addition, the goal is also for students to be able to state problems or conditions and comparisons with opposing values. In solving the problem of speed and time of aircraft where this problem is the context presented so students can find the concept of comparison with the opposite value, students multiply according to the formula of distance velocity multiplied by time and there is also dividing distance with an estimated time of up to 5 hours and so on will produce a distance of 1200 km. This is consistent with the alleged research. From the quotation it appears that students understand and are able to predict hourly hours one by one so that it will produce a distance of 1200 km, while there are other groups related to physics learning using distance formulas, this corresponds to the function of the ratio table that all numbers have a place itself and that the unit of measurement must remain the same [1]. The assessment of researchers is more for students who multiply the results listed instead of dividing one by one, so students can solve problems that exist in the SAS.

Furthermore, in drawing conclusions after students do the learning to fill the table students can easily draw conclusions, because the process can easily state a relationship between speed and time, although this is with the guidance of researchers so that students are facilitated from the researcher.
Then after that, the student is given 3 problems which he in solving it is also asked to determine which is the ratio of the value and the reverse value then make a conclusion again what is meant in the comparison of the value and turn around the value after working on the problem.

3.5. Third activity: Work on problem-solving problems

In the third act, in the teaching experiment students were given a comparative value problem and changed the value into the context of the pie slice, average speed, rectangle, worker time and food concentrate. The number of questions previously designed for the initial design for SAS 3 was 3 items, but after discussing with colleagues, taking into account the time be added to 5 questions. Five problems including comparative story questions change theme values between workers and workdays in conducting school renovations for problem 1, for question 2 at average speed, for question no. 3 length and width in a rectangle, while number 4 about what time is needed in the completion of the project, and the number 5 is the end of the food concentrate. The findings in the field indicate that students tend to experience problems, this can be seen from the lack of students’ ability to interpret problems (story problems) given, but provide guidance to students so students are directed to work on the third act.

![Figure 5. Determine the sharing ratio.](image1)

![Figure 6. Determine the velocity.](image2)

After working on the second question students seem to have difficulty, but once they can answer and have different answers because they have different concepts than what they know. As a teacher guide them to find answers. Next, they worked on the third question. Students are asked to do a third problem solving where students can find the length and width of a rectangle with a known fixed size area. So that students can determine the other width.

![Figure 7. Determine the width or length in the fixed size area.](image3)

Students can answer even though they have various answers that can do comparisons but often divide. Students are asked to solve questions 4 and 5, where the time students spend is accelerated.
3.6 Final Test Retrospective Analysis

Based on the results of the final test, in the number one problem in the form of an ordinary comparison question that is comparing male and female students in the class all students are able to answer the questions correctly all, students are able to compare using the a/b ratio formula. And also students are able to examine the form of the routine/ordinary questions. For problem number two, students are asked to investigate how much work is needed in a project. From the completion of the students, it was found that only 23 students could answer the question. The twenty-three people were able to use the concept of reciprocal proportionality, while the wrong one was able to use a comparison but did not complete the next step so that it was wrong or not completely resolved.

Furthermore, for question number three, students are asked the same form of problem with number 2, namely the food provided is enough for how many days, all students are able to solve it, consisting of 22 correct students and three who are still unable to complete. Then in problem number four, students are asked for development that needs additional workers, the results obtained the state that 20 students are able to solve the problem correctly. Whereas in the last question which is problem number five, there are only 15 students who are able to finish understanding the problem well. In this problem, students were asked to determine the time in reading the storybook. Students who answered wrongly because they did not understand the problem well so there was confusion in solving the problem.

Test results show that not all students or only some are able to solve the problem properly. However, here it is seen that the development of students in learning using the RME approach with video of airplanes takeoff. This is evident in the completion of students in writing down the reasons for the answers without any guidance from the teacher. Thus, learning using the RME approach has provided new experiences for students. Students no longer only receive material from the teacher and only memorize the reciprocal proportionality, but with the help of the right context, the students themselves who actively build their knowledge about reciprocal proportionality.

The concept of questions made as experimentation instrumentation is based on the results of previous studies that are aligned with the learning design of reciprocal proportionality airplanes takeoff as a context as novelty research or state of the art. For example the use of table ratios gives positive implications for this study in accordance with conclusions obtained by previous researchers [1]. The research entitled "Improving Students 'Critical and Creative Thinking through Realistic Mathematics Education using Geometer' s Sketchpad" concluded that by using geometry's sketchpad students become critical and creative thinking so that student learning outcomes increase [22]. If using geometry's sketchpad is compared to this research, learning design of reciprocal proportionality airplanes as a context then uses video to stimulate and trigger students' desire to learn reciprocal proportionality in line with the basic goals of RME [6]. It must be admitted that the results of the study found that not all students can understand the concept of learning design so that it can be justified based on research conducted by Arsyasthamby and Zubainur who concluded that not all activities of students who use RME have a positive impact on all students due to the need for full support not only from teachers and students but from all academics [23].
4. Conclusion
Based on a series of tests on conceptual understanding of class VII students through the RME approach, improving student learning skills is based on the flow of tiered learning processes in the first activity followed by the second and third activities. Students' reasoning is better because the analogy abilities of students have been formatted based on learning by visualizing in the first activity and comparing values in the second act so that when answering the third activity, students are easier because students can imagine the analogy of illustrations given and able to calculate the value. The test results show that not all students or only some are able to solve the problem properly. However, here it is seen that the development of students in learning using the RME approach with video of airplanes take off. Although it must be admitted that from the student population tested the learning outcomes of some students have not received a significant increase, this certainly should be a reference for renewal in further research.

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