On teaching learning for proportion using musi tour context

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Abstract. This study aims to produce a learning trajectory that assist student to understand in the study of proportion. The learning approach used Pendidikan Matematika Realistik Indonesia (PMRI). This research used design research that are three phases, preparing for the experiment, the design experiment, and the retrospective analysis. Musi tour context used in the series of learning activities to developing Hypothetical Learning Trajectory (HLT). Then, HLT has been designed compared with actual learning during the teaching experiment. Theoretical development implemented through an interactive process on three phases of design research that aims to giving contribution about Local Instruction Theory (LIT) for assist student studying proportion. Interviews, video recordings, photograph and giving pretest and posttest are undertaken to collect the data. The result of the retrospective analysis is Musi tour context as a learning model can assist student understand in the study of proportion.

1. Introduction

Proportion is one of the main subjects in mathematics learning for junior high school level. At this level, student learn about direct and reciprocal proportionally. The purpose of studying this proportion is so that students are skilled at using the concept of proportion in daily life. However, in fact, students often have difficulty in solving problems related to proportion. Some research of the earlier in Palembang Indonesia, as research conducted by Rahmawati [1], Ningsih [2], and Muttaqin [3] also shows there are still student difficulties in understanding the concept of proportion. According to Sumarto, in teaching the concept of proportion, the teacher gives the formula that is by using algebraic notation and cross product [4]. Meanwhile, in exposing students to the common multiplication and division problems, it has not been effective in helping students to develop a deeper understanding of reasoning about proportion [5].

One of the ways to teach proportion material can be done by using exploration activities [6, 7]. According to Zulkardi [8], context can be used as a starting point in learning. By conducting exploration activities using a context, mathematical ideas appear [1, 9]. The maximum result is also obtained by some previous studies in proportion learning using the context, those are Rahmawati’s research [1], plot paper is used as a context and Muttaqin’s research [3] also used debit of river Komering, map of East OKU, and rice field as a context in proportion learning. These two studies show that context can be used as a starting point for student in proportion learning and it was very good to be applied in proportion material. However the research is only limited to direct proportion learning while the understanding of the concept of reciprocal proportion is also needed by students.

The context used in this research was the context of Musi Tour. Musi Tour is one of water tours in Palembang, Indonesia. Several tourist attractions along the Musi river can be visited while travelling with Musi Tour. This context is very close to the daily life of students and can encourage students to find mathematical concepts. In the context of this Musi Tour, there are situational problems and
activities that represent direct and reciprocal proportion. Furthermore, through that context is expected to support students’ ability to understand the concept of direct and reciprocal proportion.

The purpose of this study was to produce the learning trajectory which can help students in understanding the direct and inverse proportion using the context of Musi Tour in seventh grade.

2. Method
This research used design research which produces a learning trajectory in learning proportional using Musi Tour context. Design research aims to develop a local instructional theory which is based on the existing theory (theory-driven) and empirical experiment (empirically based) through cooperation between the researcher and the teacher to improve the relevancy of this research with educational policy and practice [10]. Result of answers and opinions of students were analysed using descriptive qualitative method to see how students work to answer the test using context in proportion learning. The subjects were 32 students of the seventh grade of SMP Nurul Qomar in Palembang, Indonesia.

This research used design research that are three phases, preparing for the experiment, the design experiment, and the retrospective analysis. Interviews, video recordings, photograph and giving pretest and posttest are undertaken to collect the data.

3. Result and Discussion
The first step, we designed a proportion problem using the context of the Musi Tour and make a Hypothetical Learning Trajectory (HLT) that contains some of student’s thinking in problem solving. The context used in this research was Musi Tour. This context is used as a starting point in proportion learning. Student are given problems related to the context of the Musi Tour. The aim is to find out whether the students can know and determine that the proportion of two quantities consisted of two quantities of the same unit and two quantities of different unit from context, to write the proportion in a table, to make an equation from the proportion of each column in a table, to make a graph of the data obtained in the table, to determine and show the comparison of the value with a proportion turned around value and to get the results of the proportion.

Then the context design that has been designed is validated through expert review. Some improvements and additions to the design were carried out according to S.’s suggestion then we made observations to school, discussed with the teacher, and randomly selected research subjects. Proportion problems that have been designed are also given to students, after a series of processes at the research design stage are carried out.

This research has been tested in one to one and small groups to see the practicality of the design that has been designed. In one-to-one, 3 students with high, medium and low ability are selected to work on the corporation problem individually and in small groups, 2 groups consisting of 3 students each work together in problems solving.

3.1. The first activity was understanding and determining the both proportion through the context of the Musi tour.
The first subject was the introduction of the context of the Musi Tour by asking students to tell their experiences on a trip to visit the tourism places along the Musi River. Furthermore, on the second subject of the activity conducted, the students can know that the proportion of two quantities consisted of two quantities of the same unit and two quantities of different unit. In this case, the problem began by comparing the number of boats that have different passenger capacity on a trip to Kemaro Island, and the activity of comparing the fare of some boats that have the same travel route as an activity comparing two of the same quantities. Furthermore, students compared the travel time with the distance of a boat as an activity of comparing the two different quantities. To clarify students’ answers, the following transcripts are listed with the students.

  Student : Is the above problem an activity that compares two of the same quantities? Explain it!
  Teacher : The answer is yes or no?
  Student : Yes (exclaim)
Teacher : What's the reason?
Student : They both compare the number of members
Teacher : What was the first one to compare?
Student : Quantities
Teacher : Quantities? What kind of quantities has been known?
Student : Rates
Teacher : Is there the same purpose of the boat?
Student : Yes
Teacher : So, can we compare it?
Student : Yes we can
Teacher : Okay, so is it the same or different quantities for comparing that activity?
Student : It is the same quantity
Teacher : Same, what is compared?
Student : Km per hour
Teacher : Do that km and hour have the same size?
Student : No, they don’t.
Teacher : Yes, it's same or different?
Student : It’s different

From the transcript above, it can be concluded that students have understood and can determine the comparison of two equal quantities and the comparison of two different quantities through the given context.

3.2. The second activity, the students knew and understood the direct proportion and solve the problem of direct proportion by the aid of Ratio table.

The objective of this activity was that students can understand the direct proportion and solve the problems provided by the aid of Ratio table.

![Figure 1](image.png)

**Figure 1.** Students’ making a model and the conclusions that students got from this activity.

Figure 1 shows students’ activity which is making a proportion boat as a model of learning and the conclusions that students got from this activity. Students linked the problem related to the context of the Musi Tour and solved the problem using a model created by them. Students made the off model, that is making and designing their own boat proportion. From the activities they did, the students understood that the more passengers who participated in the tour of school, the more boats were needed while the fewer passengers who participated, the fewer boats were needed as direct proportion. Students used their own proportion boat assistance to help them in understanding the changes that occurred due to the addition / subtraction of passengers and boats. Students could create for models by creating and deciding for themselves about the tables of the number of passengers and the number of boats of activity they have done. Students made the connections that occurred between the number...
of passengers and boats and then determined the proportion equation and made a graph of the direct proportion. The following transcripts are listed with the students.

\begin{center}
\begin{tabular}{ll}
Teacher & : how many boats they have? \\
Student & : 3 \\
Teacher & : 3 boats? \\
Student & : yes \\
Teacher & : Well, What about 64? \\
Student & : (students are counting) \\
Teacher & : So? How many boats?? \\
Student & : 4 boats \\
Teacher & : how many passengers? \\
Student & : 80 passengers \\
Teacher & : So, how is the conclusion? \\
Student & : the more boats, the more passengers they have
\end{tabular}
\end{center}

From that transcript, it can be concluded that the given context and questions at each stage, the students were able to understand the direct proportion, even though they have not used the correct language. However, when they were asked, they were able to explain their intentions and conclusions.

Then, on the problem of learning activity 2, the students solved the problem of direct proportion, this question’s form was the story and the problem related to the Musi tour. Here is the students’ answer on learning activity 2.

\begin{center}
\textbf{Figure 2.} Students’ answer on learning activity 2.
\end{center}

\begin{center}
\includegraphics[width=0.5\textwidth]{image.png}
\end{center}

Figure 2 showed that students could solve direct proportion problem by using Ratio table and used the proportion equation to find the final result of the given problem. The use of ratio helped the students to see the changes in the existed numbers and helped the students in understanding direct proportion.

3.3. The third activity, the students knew and understood the reciprocal proportion and solved the problem of reciprocal proportion by the aid of Ratio table.

The objective of this activity was that students could understand the reciprocal proportion and solved the given problem by the aid of Ratio table. Students linked the problem related to the context of the Musi Tour and solved the problem using a model created by them. Students made the off model, that is the sketch of Pagoda picture and made illustrations and determined the number of passengers on each trip. From the activity they did, the students understood that the more passengers on each trip, the cheaper cost that must be paid by each passenger while the fewer passengers on each trip, the more expensive cost that must be paid by each passenger. Students could create for model by creating and designing their own tables of the number of passengers from the cost of each passenger on each trip. Students made the connections that occurred between the number of passengers and the cost of each passenger of the activity they have done. The students then determined the proportion equation and made the graph of the reciprocal proportion. Here is the picture of sketches and illustrations made by
students as a model of learning can be seen in Figure 3 and the conclusions that the students got from this activity can be seen in Figure 4.

![Figure 3. Picture of sketches and illustrations made by students.](image)

![Figure 4. Conclusions that the students got from this activity.](image)

The following transcripts are listed with the students.

**Student**: Because the photo shot closer

**Teacher**: if it is not closer? How is the picture?

**Student**: It's big

**Teacher**: How if further?

**Student**: It's smaller

10, the rental costs of boats are 800

**Teacher**: Why is the answer 10?

**Student**: Because it's multiplied by 80

**Teacher**: Well, what about 20?

**Student**: 640

**Teacher**: 640

**Student**: (students are writing)

25, 25, 5 more

**Teacher**: so is it 800?

**Student**: Yes, it’s 800

**Teacher**: okay, what is the conclusion of the inverse proportion?

**Student**: the more passengers have, the cheaper cost of each passenger, the fewer passengers have, the more expensive cost for each passenger
From that transcript, it can be concluded that the given context and questions in each stage, the students were able to understand the reciprocal proportion, even though they have not used the correct language. However, when they were asked, they were able to explain their intentions and conclusions. Then, on the problem of learning activity 3, the students solved the problem of reciprocal proportion, the question’s form was the story and problem related to the Musi tour. Here is the students’ answer on learning activity 3.

Figure 5. The students’ answer on learning activity 3.

Figure 5 showed that students could solve reciprocal proportion problem by using the Ratio table and used the proportion equation to find the final result of the given problem. The use of ratio helped students to see the changes from the existed numbers and helped the students in understanding the reciprocal proportion.

The first, second and third activities can be concluded that those could help students to understand the concept of direct and reciprocal proportion. This is in accordance with the opinion of Cramer & Post, which state that one of the ways to teach proportion material can be done by exploration activities [6]. Proportion material exploration activities may include situations involving measurement, price, geometry, or other visual contexts or varying rates [7]. By conducting the exploration activities using a broad context, mathematical ideas appear [1, 9]. From the three activities described above, it can be seen that the context of this Musi tour has a good role in helping students in understanding the direct and reciprocal proportion. The context provided also affected students in recognizing and distinguishing situations related to direct and reciprocal proportion. In the context of the Musi tour, there are activities that represent direct and reciprocal proportion.

This study used Ratio table which was implemented through students’ activities using their own “proportion boat” to understand the changes that occurred due to the addition / subtraction of passengers and boats and students’ activities to illustrate the number of passengers on each trip of a ship for them in understanding the changes that occurred due to the addition / subtraction the cost that must be paid by each passenger. Furthermore, from the result of these activities, students created and defined their own tables of the activities they have done on the activities which was provided. This is in accordance with the opinion of Wijers which states that teaching proportion can use Ratio table [11]. Ratio Table is reported as a tool commonly used in the preliminary stage of proportion reasoning [12] In line with this, Sumarto also states that this table is a good tool for calculating and helping students in understanding the main point of the material [4]. Ratio table and context can help students in developing proportion reasoning as well as a proportion problem-solving strategy. Through the use of Ratio table in the students’ activities which are given helped the students in understanding direct and reciprocal proportion. The use of the ratio table helped the students to see the changes from the existed numbers and helped the students in understanding direct and reciprocal proportion.

Based on the results of retrospective analysis on a series of activities at the teaching experiment, the learning is in accordance with the HLT designed. It can be concluded that students have understood the concept of direct and reciprocal proportion from the use of the Musi tour context.

This study also reflected three PMRI principles in the learning process as revealed by Zulkardi & Putri [13], those are the first principle is Guided reinvention and didactical phenomenology. Students
can rediscover mathematical concepts especially on direct and reciprocal proportion learning through teacher’s guidance by using the context of Musi Tour.

The second principle is progressive mathematical. In this case, the phenomena which are occurred in the daily life of society are used in the learning of direct and inverse proportion material. Therefore, Musi Tour context was used in this study which involved all elements of a trip from the number of boats, boat fares, the number of passengers, distance and travel time in a trip along the Musi Tour in this study.

The third principle is self-developed models. The self-developed model used in the direct proportion learning was by using proportion boat while the reciprocal proportion is by creating sketches and illustrations made by students from a Musi Tour trip and by the aid of a Ratio table to make it easier for students in understanding the both proportion

4. Conclusion
The result of learning trajectory is the trajectories that helped students from the learning process which was passed start from the students explored their knowledge to understand and determine the both proportion from the context of Musi tour, students were able to model and understand the direct proportion and solve the problem by the aid of Ratio table, and students were able to model and understand the concept of inverse proportion and solve the problem by the aid of Ratio table. From the three activities obtained also can be seen that the context of Musi tour has a good role in helping students to understand the direct and inverse proportion. The context provided also affected students in recognizing and distinguishing situations related to the direct and inverse proportion. In the context of Musi tour, there are activities that represent direct and inverse proportion.

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6. References
[1] Rahmawati 2015 Desain Pembelajaran Perbandingan dengan Menggunakan Kertas Berpetak di Kelas VI Magister Thesis (Universitas Sriwijaya)
[2] Ningsih., R., P. 2016 Desain Pembelajaran Perbandingan Senilai Berbasis Pendekatan Matematika Realistik Indonesia (PMRI) di Kelas VII Sekolah Menengah Pertama Magister Thesis (Universitas Sriwijaya)
[3] Muttaqin H, Putri R I I and Somakim 2017 Journal Mathematics Education 8 211
[4] Sumarto, N. 2013 Design Research on Mathematics Education: Ratio Table In Developing The Students’ Proportional Reasoning Magister Thesis (Universitas Sriwijaya)
[5] Norton, S. J. 2005 Proceedings of the 29th Conference of the International Group for the Psychology of Mathematics Education 4 17
[6] Cramer K, Post T and Currier S. 1993 Learning and Teaching Ratio and Proportion: Research Implications In: Owens D (Ed) Research Ideas For The Classroom 159-178 (NY: Macmillan Publishing Company)
[7] Walle J A V D 2008 Matematika Sekolah Dasar dan Menengah: Pengembangan Pengajaran (Jakarta: Erlangga)
[8] Zulkardi 2002 Developing a Learning Environment on Realistic Mathematics Education for Indonesia Students Teacher Doctoral Dissertation (University of Twente)
[9] Andinasari 2016 Prosiding Seminar Pendidikan Nasional 1 92
[10] Gravemeijer K and Erede V D 2009 The Elementary School Journal 109 510
[11] Wijers 2015 Teacher Knowledge Needed to Teach Ratio and Proportional In Secondary School Mathematics Using ratio Table online: http://www.fisme.science.uu.nl
[12] Steinthorsdottir O B and Sriraman B 2009 Mathematics Education Research Journal 21 6
[13] Zulkardi and Putri R I I 2006 Mendesain Sendiri Soal Kontekstual Matematika Prosiding KNM13 pp 1-7 (Universitas Negeri Semarang)