Learning direct proportion by using the context of *timpan* recipes

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Abstract. Successful learning is not only based on students' final grades but also on the learning process itself. The process is crucial to assess students' understanding of mathematics concepts. This study aims to describe the learning activities of direct proportion using the realistic mathematics education (RME) approach implemented in the hypothetical learning trajectory (HLT) trial. The HLT was developed in the context of *timpan* recipes which is appropriate to the characteristics of students in Aceh. This study used design research method that involves two stages, preparation and learning trial. This HLT trial involved 20 seventh graders in a junior high school in Banda Aceh, Indonesia. Data were obtained through the observation sheet, field notes, and interview. The results showed that the students were actively involved during the HLT trial, thoughtfully analyzed the problems, positively responded to the learning, appropriately chose and used procedures or operations in solving the issues related to direct proportion. Also, the class performed effective interaction among students and the teacher.

1. Introduction
The learning trajectory was designed by teachers to help students to learn meaningfully through stages of activities involving students' previous experiences and existing knowledge [1]. All learning materials require a learning trajectory to lead students through the stages of learning from a real situation to the abstract form of mathematics. One of the topics studied by junior high school students is direct proportion. This topic is important as these concepts are applied to various daily life problems. Students' understanding of direct proportion is also required for learning other disciplines as well as being applied in the workplace.

Learning becomes meaningful if the teacher uses an appropriate learning approach to provide students with real experience and meaningful mathematics knowledge [2]. The realistic mathematics education (RME) is one of the approaches providing students the opportunity to construct concepts and formulas in mathematics [3]. Students need to be given sufficient opportunities to build their own knowledge and understanding through a set of specific activities using a context as a source of learning [4]. It is because mathematics learning focuses on not only the outcome but also the way to obtain the solution [5]. Based on the first characteristics of RME, the use of context, students carefully pay attention to the problems given by the teacher's explanation. The context used can also help the emergence of the fifth characteristic, the intertwinement with other mathematics topics or other aspects beyond mathematics, such as culture. Besides, the context used is not only in the form of real-world problems but also problems that can be imagined in the students' mind [6]. The choice of context greatly influences the students' responses to the learning process because the context is the key
for students to understand the topic taught meaningfully. The teacher's chosen context needs to be closely related to the students' experience.

The context of the *timpan* recipe as a typical cake of Acehnese encountered by students in their daily life can be utilized to help students to understand mathematics especially the direct proportion topic. Although the context of food recipes has been widely used in teaching proportion, the context used is reserved for students living in Aceh. Therefore, the researchers used this *timpan* recipe context for the students in Aceh. The students will find this direct proportion concept as a ratio of two measurements and represent it in graphs and equations. This study aims to describe the learning activities of direct proportion using realistic mathematics education (RME) approach implemented in the hypothetical learning trajectory (HLT) trial. A research question "what are the students' activities occurred during the HLT trial of direct proportion using the context of the *timpan* recipe?" will be answered through this study.

2. Method

This paper describes the learning activities of direct proportion with RME approach using the context of the *timpan* recipe. The learning obtained is the result of the development of HLT trial of direct proportion appropriate to the characteristics of students in Aceh. Local instruction theory (LIT) has been developed through design research steps: preparatory steps, learning trials, and retrospective analysis [7]. At the preparation stage, a needs assessment has been made with the decision that HLT has not been formed and needs to be developed. At this stage, HLT of direct proportion has also been developed using the RME approach with the *timpan* recipe context. Then, a trial of learning with HLT was conducted at the second stage. This paper focuses on the results of the HLT trial of learning activities analyzed in the classroom.

The HLT trial of direct proportion with the context of the *timpan* recipe involved 20 Year 7 students in a junior high school in Banda Aceh, Indonesia. Data were obtained through the observation sheet, field notes, and interview. The data was then analyzed based on the observation and the field note on the student activities during the learning process. The data was analyzed and re-confirmed to the students through the interview.

3. Result and discussion

The data in this article was the results of a lesson trial. The learning objective is that the students are expected to find the direct proportion concept by using graph and equation. Students' learning activities can be observed through students' activity in observing the problems given during the learning, students' responses to the problems, students' strategies in solving the problems, and the interaction between students and the teacher.

Learning activity began with selecting flavor variants of *timpan* based on individual preference. The students worked on the given problem and chose one of the three flavors of *timpan*, namely pumpkin, jackfruit, and banana *timpan*. This activity relates to the students' experiences that have made or eaten their favorite flavor of *timpan*. Their experiences can help students solve the problems by choosing *timpan* flavor as a benchmark. Activity and student answers’ of the selection of *timpan* flavor can be seen in Figure 1.
Figure 1. The results of student answers in choosing a timpan recipe based on their preferences.

Based on Figure 1, the selection of the recipes varied. Two groups chose the pumpkin timpan, two groups chose the jackfruit timpan, and one group chose the banana timpan. The group choosing the banana timpan questioned about the units of the banana used in the timpan recipe as in the following excerpt.

Teacher : Which timpan flavor do you choose?
Students : We choose the banana one.
Teacher : Good, any problem with this recipe?
Students : Yes, there is. How many grams are 10 bananas?
Teacher : Okay, 10 bananas are less than ½ kilograms
Student : ½ kg means 500 grams, isn’t it?
Teacher : Yes, correct.

Based on the excerpt above, students sought additional information to match the units of each ingredient to their chosen recipe by linking the students' prior knowledge of the units and quantities they had studied in primary school.

Figure 2. The results of the students' answers to determine the A, C, D, and E recipes.

It should be 250 x 5 = 1.250 grams, but the students wrote 750 grams.
The second activity was to determine the composition of the ingredients in other recipes with the same flavor if some compositions of the ingredients in a recipe are known. The students used the recipes of *timpan* (i.e., pumpkin, jackfruit, and banana *timpan*) they chose as a benchmark in determining the composition of other ingredients by completing recipe B. After completing the composition in column B, the students were asked to find the composition in the column A, C, D, and E as presented in Figure 2.

In this activity, the students determined the composition of the ingredients in other recipes using the recipe A as a benchmark. The students knew that the composition of the ingredients in the recipe B was two parts of that of the ingredients in the recipe A. They used the recipe A to determine the recipe C, D, and E. The students used multiplication and division rules in determining the composition in the recipes. One out of five groups made mistakes in calculating multiplication. Students wrote 750 grams and 750 ml for the composition of glutinous flour and coconut milk on the recipe C, respectively. Whereas, the students had already known that the composition in the recipe C was one-fifth of that in the recipe A (i.e., A : C = 1 : 5). The composition in the recipe A should be multiplied by 5 so that the answer would be 250 x 5 = 1.250 grams of flour and 1.250 ml of coconut milk. Based on the interview results, the students admitted that they made a mistake in multiplying 25x5. They did not do the calculation on the paper, but instead, they spontaneously mentioned that 25x5 was 75.

The next step was to determine the ratio of the results of the composition of the five recipes that have been previously obtained. Figure 3 presents one of the students' answers.

![Figure 3. The results of students’ answers in determining the ratio](image)

In this activity, the students determined the ratio based on one component in a *timpan* recipe. For example, by looking at the comparison of the number of *timpan*, the students then split each component of the ingredients with the smallest number. These students' strategies were also applied to other components. Thus, the students got the recipe B is twice of the recipe A, the recipe C is five times of the recipe A, the recipe D is 7 times of the recipe A, and the recipe E is ten times of the recipe A. In another word, the ratio of the recipe A, B, C, D, and E is 1:2:5:7:10.

In the final stage of this learning, the students represented the ratio of the *timpan* recipe composition in graphs and equations. The students worked in their groups to find out the direct proportion concepts and wrote the results on the activity sheets as presented in Figure 4.
Figure 4. Students’ answer to the representation of ratios in graphs and equations.

In the graph presented in Figure 4, the students randomly selected two different components as coordinates and chose ratio as scales. Although no one chose the original measurement as a scale, the teacher kept reminding the students that the original measurement of a timpan recipe could be used as a scale in drawing a graph. In general, the curve of direct proportion graph obtained by students was a linear graph, and the students were managed to write the equation of direct proportion correctly.

Based on the four activities previously discussed, it is indicated that the teaching and learning process went well. The students presented a direct proportion concept in graphs and equations using the timpan recipe context. This is aligned with other research findings that the use of context in mathematics learning leads to more meaningful learning for students. The context presents abstract concepts of mathematics in representations that can be easily understood by the students. Therefore, the student learning activities using the realistic mathematics education (RME) approach are improved [8] and [1].

4. Conclusion
The results show that the students were actively involved during the direct proportion learning using the context of the timpan recipe. This finding is indicated by the students' activities, students' positive responses to the learning, the utilization and the selection of certain procedures or specific operations appropriately in direct proportion problem-solving. Besides, there was an effective interaction between the students and the teacher. Also, the context of this timpan recipe can be used as a starting point in teaching direct proportion. For further research, it is recommended to select other cultural contexts closed to students' life as the key element in learning mathematics.

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