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Learning of Sets using Indonesian Realistic Mathematics Education

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Abstract. The set is essential for students to learn and master because it influences other mathematical materials and applications in daily life. However, many students still have difficulties studying the set, such as understanding the material. Therefore, it is necessary to design learning with the right approach and context. Design research from Gravemeijer & Cobb is used with three main stages: preliminary design, experimental design (pilot experiments and teaching experiments), and retrospective analysis. The subjects in this study were 7th-grade students in one of the Junior High Schools in Semarang. This study produces a learning trajectory using the Sedekah Laut context for set material based on Indonesia Realistic Mathematics Education. The resulting learning trajectory consists of a series of 4 activities: contextual video observations to find the concept of sets, not sets, empty sets, universal sets, and Venn diagrams, explain the properties of the set, define sets operations, and solve problems related to sets. This article explained in detail the learning trajectory of the set with the context of the sedekah laut tradition at the pilot experiment stage. This study shows that using local wisdom-based context can help students understand sets and can be an inspiration to introduce mathematical concepts with other local wisdom.

INTRODUCTION

The set is one of mathematics material that forms the basis for the development of mathematics such as algebra and geometry and has links in daily life [1]. In addition, the set is also used in solving problems in life [2]. Although set material is essential to master, the set is still a challenging material for students [1].

Students' difficulty in set material is applying sets' concepts for solving contextual problems [1]. Other difficulties experienced by students include difficulty understanding the questions, then transforming the questions given, and finally solving the questions [21]. Moreover, the students' difficulty in learning set is interpreting the notation and symbols used in set operations [3]. The same thing was conveyed by Asnidar [4], who revealed that students still have difficulty understanding symbols and set operations. This is reinforced by Sabil [5], who said that students had not understood the set and its operations. The results of the study from Harahap [6], the difficulties in learning set material such as difficulties in the understanding intersection and union problems, drawing Venn diagrams, understanding contextual problems, and converting cotextual questions into formal mathematical form.

There are several causes of sets of learning difficulties, such as students cannot master the prerequisite material [7]. Sabil [5] stated that the lack of understanding of sets and operations also causes learning difficulties. In addition, because students can not reason and understand questions, lack of practice in working on questions, inaccuracy in operations, and lack students' ability to interpret solutions into real contexts [22]. Harahap [6] added that two factors

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cause difficulties, such as internal and external factors for students. Internal factors such as interest and motivation to learn while external factors include the use of teaching aids that are monotonous.

It is necessary to design meaningful learning using appropriate approaches, contexts, and methods for set learning to generate motivation and understanding of concepts to help students overcome the learning difficulties. One suitable approach is the Indonesian Realistic Mathematics Education (IRME) [8].

IRME is an approach oriented towards the mathematization of experience and is applied in daily life and provides opportunities for students to be active in constructing their knowledge [9]. IRME has been going on since 2001, emphasizing the usefulness of concepts [23] that can increase motivation, problem-solving abilities [10], increase motivation and learning outcomes [11], and make it easier for students to understand concepts [12].

Learning with IRME starts from the context used as a starting point and learning resource [13]. The context used is not only with concrete objects but can be imagined by students [14]. Learning with this approach begins by providing situations or problems that students can imagine. Later, with guidance from the teacher, students can solve problems through formal mathematization [9]. Many contexts are used in learning mathematics, such as the context of community traditions and habits [15];[16]. In this study, researchers used the context of the Sedekah Laut tradition to introduce set material to students. In addition to this tradition, it can be represented in the set material and introduce local wisdom to students.

Based on the background described above, the author researched Sets Learning Using the Context of the Sedekah Laut tradition to produce a learning trajectory that facilitates students in understanding the material and creating meaningful learning.

RESEARCH METHODS

The method used in this study is design research which is used to develop theories in learning mathematics. The theory in question is the Local Instruction Theory (LIT) for set material applied in learning [24]. Design research has three main stages [25], namely 1) the preparation stage, at this stage the researcher conducts a literature review and designs a Hypothetical Learning Trajectory (HLT), 2) the design experiment stage (pilot experiment and teaching experiment), and 3) retrospective analysis, comparing the hypothetical learning trajectory with the actual learning trajectory. In this article, only the pilot experiment results are presented to provide a detailed description of HLT testing in small groups.

The subjects involved in the study were 7th- grade students in one of Junior High School in Semarang with six main subjects in the pilot experiment stage with different abilities (high, medium, and low abilities). Determination of student abilities is based on recommendations from teachers and based on student learning outcomes. There are several activities of collecting data, such as video recordings of the learning process, interviews, and also collecting student work.

RESULTS AND DISCUSSION

The result of this study is a learning trajectory with the context of the Sedekah Laut tradition for Sets in 7th- grade. This learning trajectory is a series of Sets learning processes consisting of four activities adapted to IRME characteristics to facilitate students' understanding of the set's material. Four activities in the learning trajectory such as video observations to find the concept of sets, not-sets, empty sets, universal sets, and Venn diagrams; explain the set properties; define operations of sets, and solve problems related to sets. Students' understanding and activities in the learning trajectory of the Sets material using the context of the Sedekah Laut Tradition can be seen in the results of student work and interviews. The following is a detailed explanation regarding the results of this study:

Observing the Video Context to Understand Concepts of Sets, Non-sets, Empty Sets, Universal Sets, and Venn Diagram

In this activity, students are asked to explore the video context of the *Sedekah Laut* tradition displayed to understand the set material. Activity 1 begins by dividing students into three groups consisting of 2 high-ability students, 2 moderate-ability students, and 2 low-ability students. Then, the teacher gives a student activity sheet containing instructions and activities that students will carry out in understanding the set material. In activity 1,

students can get information from context through observation to understand concepts and define sets, non-sets, universal sets, empty sets, and Venn diagrams. Student work in activity 1 can be shown in the figure 1.

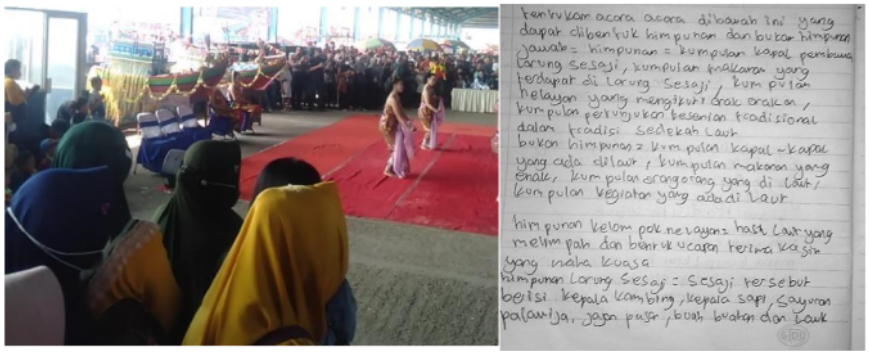


FIGURE 1. Student answer on activity 1 by observing *Sedekah Laut* tradition

In activity 1 students are asked to identify groups that can be found in the *Sedekah Laut* tradition. After students find groups in the *Sedekah Laut* tradition, students are asked to name the elements of each group found and identify whether these elements have clear criteria or not. Next, students are asked to define sets and understand the differences between sets and non-sets. Figure 1 shows that students can understand the differences between sets and non-sets well by determining which sets are included and which are not. In addition, students can also define sets based on what has been explored in the context.

After understanding the set and non-set, students are given a situation from the context of the Sedekah Laut tradition. From the given situation, students are asked to correctly determine all the sets and elements of the set, which will lead to an understanding of the universal set. After that, students are asked to identify whether there is a set that has no elements. In this case, students are directed to understand the empty set. Students' understanding of the empty set and the universe can be explained in the figure 2.

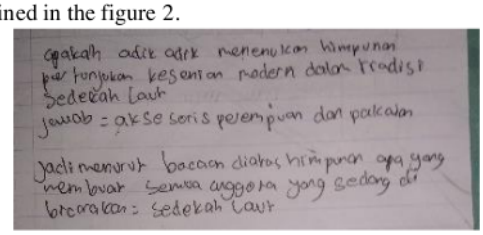


FIGURE 2. Student answer on activity 1

Based on students' answers, students are still less thorough in doing activities because students still mention elements of the empty set. In comparison, the empty set is a set that has no elements. After it was confirmed that the students were not careful in reading the questions and through the guidance of the teacher exploring the context situation again, the students understood the empty set well. Figure 2 also shows that students have understood and answered correctly regarding the universal set.

In activity 1, students are also given the facility to understand the Venn diagram. The activity sheet provides instructions for drawing the Venn diagram correctly. Previously, students were asked first to determine the set and elements represented through a Venn diagram. With instructions from the activity sheet and directions from the teacher, students can draw Venn diagrams.

Explaining the Set Properties

Activity 2 begins by providing a situation in the Sedekah Laut tradition, and students are asked to determine the sets of Larung Sesaji and elements of those sets from the given situation. After that, the activity sheet provides questions about whether the elements of Larung Sesaji A are elements of the other set of Larung Sesaji. In this case, it can lead students to understand subsets. From the given situation, students are also asked to draw a Venn diagram as a representation of the sets and can provide students with a better understanding of subsets. And at the end, students

are asked to define subsets. In addition, after understanding subsets, students are also given the facility to understand the complement and difference of two sets. The activity sheet provides instructions for students to construct their knowledge, such as asking the question, "mention a member of set A that is not a member of set B." In this case, students can understand complement and difference by rereading the context situation and looking at the Venn diagram that has been made previously. The following is the student's work on activity 2.

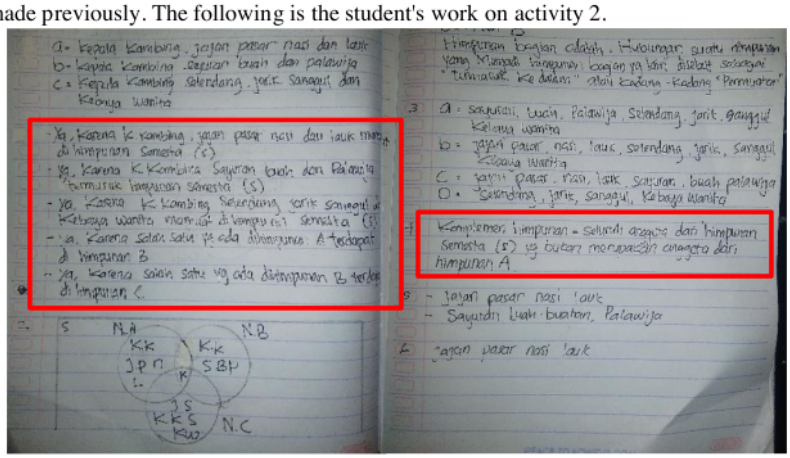


FIGURE 3. Student answer on activity 2

Figure 3 shows that students can determine elements of each set of Larung Sesaji according to the given context situation. Students are also able to identify whether all elements of one set are elements of another set. This is a step for understanding the subsets for students. The student work above also shows that students can draw Venn diagrams well, including correctly placing each set's elements. But, something needs to be fixed, students should put the goat's head into the Venn diagram, which includes 3 sets because the goat's head is part of the 3 sets of Larung Sesaji. Through teacher guidance, students can fix their work for the better. By doing the given activity, students can define subsets well.

Moreover, based on figure 3, students can already understand the complement of sets. The difference between the two sets is indicated by students' ability to determine which elements of 1 set are not elements of the other set according to the instructions on the activity sheet. In addition, students are also able to define the complement of the set nicely.

Defining Operations of Sets

In activity 3, students are given a set of Larung Sesaji A and Larung Sesaji B and a universal set. And then, students are asked to determine the elements of each set and draw a ven diagram. After that, students are asked to determine the Larung Sesaji A set elements, which are the same as the elements of the Larung Sesaji B set. And also determine all the elements of the set A and B within the bounds of the universal set. Activity 3 leads students to understand the intersection and union of sets. Student work in activity 3 can be shown in the figure 4.

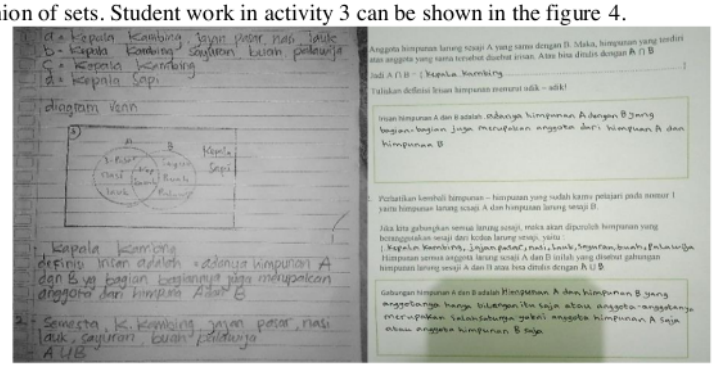
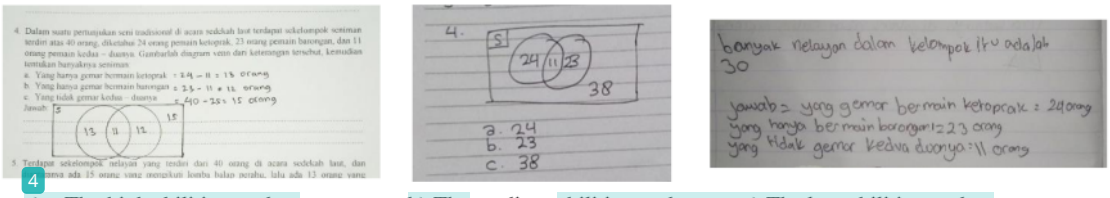


FIGURE 4. Student answer on activity 3

Figure 4 shows that students understand the intersection and union of sets well. Students can determine A∩B correctly (elements of set A are the same as elements of set B) and also can determine AUB correctly (elements of the combination of two sets of Larung Sesaji). And at the end, students can define intersection and union. But still, with the sentences that are still confusing, but after being confirmed by the teacher, students can explain adequately and correctly.

Solving Problems Related to Sets

Students are asked to do activity 4, which is solving contextual problems related to sets. In this activity, students apply the knowledge gained in the previous activities. Students are allowed to discuss with their respective groups to complete activity 4. Figure 5 below is the result of student work in activity 4.



a) The high abilities student b) The medium abilities student c) The low abilities student

FIGURE 5. Student answer on activity 4

Based on the students' answers in the figure above, the students with high abilities (figure 5a) have the idea to solve the problems given in activity 4 correctly. However, students are less careful in answering the questions so that the final results are less precise and do not write down the conclusions of what answers are asked in the questions. The students with medium abilities (figure 5b) have not been able to solve the given problem correctly, but they have an idea to solve the problem using a Venn diagram. They do not understand the questions well. Therefore, they only write down what is already in the activity sheet on the Venn diagram and do not write down the conclusions of what answers are asked. Students with low abilities (figure 5c) have not been able to find ideas to solve the problems given. So that students can only rewrite what is already in the activity sheet without giving other answers and not writing conclusions. But, after receiving guidance from researchers, students can solve contextual problems given correctly.

Based on the results described above, Sets learning using the Sedekah Laut Tradition context based on Indonesian Realistic Mathematics Education can facilitates students in recognizing mathematics and understanding concepts. IRME uses context as a starting point that can support students' understanding from informal knowledge to formal knowledge. This is in line with Yanti [17] who argued that IRME can be used as a starting point in learning, students are involved in solving daily problems with the various strategies they have. Farida [18] also revealed that appropriate context develops students' mathematical thinking and understanding. Furthermore, in this study, students were given the situation of sedekah laut tradition through videos and pictures on activity sheet to provide a real situation so that students are able to imagine to understand the set. The same thing was conveyed by Risdianti [19] that the use of context can stimulate students to grow students' understanding, where students go through all stages in the learning trajectory in order to understand the concept.

This learning trajectory is adapted to the five characteristics of IRME [20], including (a) the use of context this study uses the context of the Sedekah Laut tradition as a starting point and learning resource for sets material, (b) the use of models and symbols for progressive mathematics, Wijaya [8] conveyed that there are four levels of modeling namely: 1) situational level, where students are asked to observe a context video, 2) referential level, students can identify sets from the context to identify sets, non-sets, universal sets, and empty sets, 3) general level, students write down the information obtained from the context in a formal mathematical form to list the elements of the set, and also determine the operations and properties of the set, 4) formal level, students can develop informal knowledge to formal concepts. (c) student contributions, students are given the freedom to discuss, ask questions, express opinions during the problem-solving process in this study. (d) interactivity, during learning, interactions are formed between students, students with teachers, and students with learning instruments; (e) the intertwining which ensures more meaningful mathematics because it can be applied to other learning topics.

CONCLUSION

This research resulted in a learning trajectory of set material to facilitate students in understanding concepts consisting of 4 activities, namely: video observations to find the concept of sets, not sets, empty sets, universal sets, and Venn diagrams; explain the set properties; define operations of sets, and solve problems related to sets.

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