Instructional Design for Teaching Sets Using RME Approach at Junior High School

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Abstract: An instructional design ideally should fulfill characteristics such as student-oriented, goal-oriented and take into consideration students’ learning development. Existing studies showed that many instructional designs did not fulfill these characteristics. This study employed design research to develop Hypothetical Learning Trajectory (HLT) based RME approach for Grade 7 students in Padang. Initial observations, interview with teachers and students at Junior High School in Padang was carried out to gain insight into teachers’ current instructional practice. To date, the study has completed a preliminary design of an instructional sequence, teachers’ book and students’ book on the Sets. This paper presents researchers’ account on the development of preliminary analysis of the teachers’ needs and students’ needs and development of the mathematics curriculum in Junior High school. The HLT derived through this analysis is presented.

Keywords: Instructional Design; HLT; RME; Teaching Sets.

1. Introduction

An instructional design ideally should fulfill some characteristics, such as students-oriented, goal-oriented, and focus on development of students’ progress [1]. An instructional design on sets that has been applied by teachers at junior high school has not fulfilled all the characteristics of a design. Based on observation, interview to the teachers and students at junior high schools in Padang city, it describes that the teachers have tried to involve students actively through group work. The students would like to discuss, but not achieve the optimal intercation in solving the problems related to finding and comprehending concepts in sets. The learning process is seldom started by problems related to students’ background knowledge. The process of learning that has been planned by teacher has not facilitated the students to be more active in proposing ideas for solving problems, has not facilitated students to have a meaningful learning, and has not comprehended students’ level of thinking in learning sets. The teacher argued that the students have comprehended the material through the design they planned. Based on interview with several students of junior high school, learning process of mathematics is done through explaining the materials by the teacher, giving example and exercises. The teacher rarely relates the materials to students’ real life.

The students’ learning process and their level of thinking should give the teacher a working framework in order to develop such knowledge about students’ thinking and learning. An instructional design which is based on students learning trajectory is known by Hypotetical Learning Trajectory (HLT). HLT is a kind of process that consists of learning goal, learning activity and hyphotesis of learning process to predict how
students think and comprehend during the context of learning activity [2]. Some researchers, Baker (2003), Bardsley, Hadi (2006) show that Hypotetical learning trajectory (HLT) can improve students’ comprehension [3-5]. The other researches show that HLT does not only improve students’ comprehension but also improve students’ math thinking ability as the research done by Graveimeijer (2004). He proves that HLT by using RME helps the teachers in developing a good local instructional theory for a topic lesson and also help students in developing their thinking ability such as analysis and the other math thinking ability [6].

One of the approaches that can be used in designing HLT is through realistic mathematics education (RME). RME is one of approaches in mathematics learning process that contains constructive, interactive and reflective components. In RME, mathematics is seen as human activities [7]. Mathematics is not transferred to the students as a product, but the students should construct it by themselves through contextual problem solving that is interactive, whether it is formal or informal, so that the students can find it by themselves, without a teacher who knows the right answer.

There are several steps followed in designing HLT RME-based, such as by preliminary research that contains need analysis, review of literature, deciding learning goal, deciding students’ learning activities, hypothesis learning process. Next, it includes planning and designing prototype HLT, doing formative evaluation and retrospective analysis. The last step is doing summative evaluation. This research is limited in preliminary research and developing prototype of instructional design that can be a solution in Set materials at junior high school in Padang city.

2. Literature Review

An instructional design in terms of HLT consists of three components; learning goal, task of learning activity and hypothesis of how the students learn and think [2]. Setting the learning activities are based on RME. Those activities give a chance for the students to reinvent mathematics through teacher’s guide [8]. The activity RME-based concerns on RME characteristics, they are: 1) the use of contexts, 2) the use of models, 3) the use of students own production and constructions, 4) the interactive character of teaching process, and 5) the interviewments of various learning strands [16].

In designing and developing HLT RME-based in this research, review of previous researches is needed. The researches related to the development of instructional design in form of HLT RME-based have done previously by many researchers, such as a research done by Webb (2011) [9]. In this research, Webb designed HLT RME-based to introduce the concept of logarithm. Web used contextual problem in form of height of poni and the growth of E.Coli bacteria. This contextual problem gives a possibility for the students to do informal mathematism process, that later will improve into formal mathematism process by giving problem in math. These informal and formal mathematism processes help the students to comprehending the concept of logarithm. The use of RME in Cobb’ research proves that learning RME-based builds students-centered learning.

The other research is conducted by Hidayat and Iksan (2015) [10]. This research was aimed to see the effect of RME toward the comprehension of students’ linear program concept. It was a kind of quasi experimental non equivalent, pretest and post test control group design. This research had control class and experiment class. The result of this research shows that the use of RME by using contextual problems help the students to have a better comprehension of linear program concept.

The research related to designing HLT is also conducted by Prahmana and Kusumah (2016) [11]. This research developed HLT in the research of math education by using research based learning. In developing HLT, the researcher used Graveimeijer’s and Cobb’s model. HLT consists of three components; (1) the purpose of mathematics teaching for students, (2) learning activities, device or media used in the learning process, and (3) conjecture of understanding the process of learning how to learn and strategies students that arise and thrive when learning activities are done in Class [16]. The aim of this research is to improve research ability and academic writing for pre-service teacher of math. The other researches that related to HLT and RME have also been conducted [12-14].
Based on those researches above, the research in this paper focuses on the development of instructional design in terms of learning process RME-based in sets materials for students at grade VII of junior high school. In planning the process of the research, it was also used the model proposed by Graveimeijer and Cobb. HLT also consists of three components proposed by Graveimeijer. By designing the learning process RME-based, it can build students-centered learning, develop students’ ability in problem solving, and help the students to use the concept they have in inventing new concept. Thus, the instructional design RME-based will revise and develop students’ ability.

3. Material and Methodology

This research is a kind of development research by using Plomp model [15] and Graveimeijer and Cobb model [16]. To develop learning process, the model proposed by Graveimeijer and Cobb has three phase: preparing for the experiment, conducting the experiment and analysis retrospective. To develop the product of the instructional design, Plomp model is used. This model consists of three phases; preliminary research, prototyping stage and assessment stage. This paper focuses on preliminary research that consists of need analysis, curriculum analysis, students analysis, concept and review of literature analysis. The result of preliminary research will be continued by prototyping stage. The prototype that has been created will be evaluated through formative evaluation. In this paper, the formative evaluation is limited on self evaluation only.

Preliminary research consists of need analysis, curriculum analysis, students analysis, concept and review of literature analysis. The technique of data collection are interview, document analysis and check list. The instruments used are interview guidelines with teachers, interview guidelines with students, and check list for pre-investigation. The result of preliminary research will be developed and self evaluation will be conducted by using self evaluation sheets.

4. Result and Discussion

4.1. The Result of Preliminary Research

In this stage, identification or analysis needed for the development of set materials design RME-based and analyze the limitation of learning material that will be developed. The purpose of this stage is to decide and define the requirements needed in developing instructional design.

4.1.1 The Result of Requirements Analysis

Based on the result of interview with teachers at MTsN Kuranji Padang related to problems faced by students in learning sets so far, the teachers have not designed an instruction that can help students to invent the concept. The teacher explained the materials based on the lesson plan and used the text book. The teachers told that most students did not like math, they assumed that math is difficult, boring and lazy to do any exercises on the text book. The teachers also told that teacher’s inability in designing the instruction is caused by lack of ability related to it. The teachers commonly only used the textbooks as a guideline in teaching. The result of the analysis of instructional design so far has not improved students’ thinking ability.

4.1.2. The Result of Curriculum Analysis

Curriculum analysis is aimed to know the materials about sets that is stated in curriculum, whether those materials are appropriate to achieve the learning goals, whether those materials have been arranged well. The result of curriculum analysis is used as a basis to formulate indicators of learning achievement in developing instructional design of sets materials RME-based for students at grade VII of junior high school. The sets materials contains lot of real life problems faced by the students. Thus, instructional design about sets is needed for guiding the students to comprehend the concept well, which is related to students’ real life.

This curriculum analysis also combines several indicators, in order to avoid any repetition or dividing materials, such as inventing sets concept to kinds of sets. By inventing the sets concept, the students can directly decide the kinds of sets. Venn diagram in the old indicator is included into sets materials. In this
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design, it is included in inventing sets concept because venn diagram is a concept that should be included in sets materials.

4.1.3. The Result of Students Analysis

Students analysis is done in order to know the students characteristics of grade VII during learning process. The students’ learning tendency and their skills, their characteristics at scientific level, ability at high order thinking, and their high curiosity and also their social encourage the researcher to develop instructional design that can stimulate and facilitate students’ habit and accomodate their characteristics to be better.

4.2. The Result of Prototyping Phase

Based on preliminary research, instructional design of sets materials RME-based is designed for students at grade VII of Junior High School.

4.2.1 The Design of Hypothetical Learning Trajectory (HLT)

Hypothetical learning trajectory (HLT) consists of three parts; one of them is the purpose of HLT that consists of three components, they are learning goal for meaningful learning, a collection of task for achieving the goal, and hypothesis of how students learn and think [2]. The learning goal is the students’ target after they accomplish math concept that has been decided, and then students’ activity is designed including the prediction of students’ answer, from the simple up to the more complex ones. This activity is expected to help the students in developing their math ability horizontally into vertical math. The Figure 1 is the rasonale of HLT designed.

![Figure 1. The Design of HLT](image-url)

Based on Figure 1, there are four HLT that are designed, they are inventing sets concept, the activity is to collect the data of students at grade VII of junior high school in order to classify object based on such characteristics. The second activity is classify the students based on their own characteristics. It is aimed to build a problem that can stimulate the students to invent the different amongs sets and non-sets, blank sets and universal sets, because these problems give a chance for the students to classify the good and bad students. From the first and second activity, the students get the description in grouping the object, stating the reason in grouping the object and stating the group member and non member. After that, the students are asked to solve the problem in which how to add the groups into the general activity of sets concept. At this stage, the students have been familiar to group the object and state it into math.

Second, presenting the sets, the first activity is collect the data of stationary that usually used by the students in order to stimulate the students to present the sets by writing the members of sets creator. The second activity, the students are given contextual problem in deciding the animal group based on their characteristics. Those animal groups can be seen as a set that has animals as the members with their own characteristics. For the third activity, the students are given problems related to students’ numbers group that they have commonly learned. Grouping numbers can be seen as a set. All the activities above lead the...
students to present the set in their real life. Through this activity, the students in the group interact to create a pattern in presenting the sets based on the first presentation up to the last one.

Third, sets relation, the activity is related to contextual problems about representation of the class to follow the best students competition. The students are asked to make the possible formation of students who can represent the class. The formation can also be seen as a set. The second activity is given a challenge for the students to choose a decision. The decision taken is based on their knowledge of set. The problem is designed to help the students invent the concept of the same set and equivalent set. Based on the first and second activity, the student are expected to understand sets relation, they are partial set, equal set, disjoint sets and power of set and equivalent set. The teacher facilitates the students during the class discussion to take a decision and strengthen the conclusion by giving such explanation of set relation.

Fourth, set operation, the activity is giving problem related to fruits. The problem stimulates the students to invent the concept of two sets operations by comparing the members of the sets that are operated. The second activity is inventing the characteristics of set operation through problems related to extracurricula activity. The problem stimulates the students to invent the principle of inclusion exclusion.
of two sets operation by comparing the members of each of the groups operated and also the other characteristics that links to each of the set operation.

4.2.2. The design of teacher’s book and students’ book

The teacher’s book designed in this RME learning has some components. It includes HLT rationale, students activity, time allocation, about math, homework media, plans of students’ evaluation, lesson plan (comment of the activity and solving of the activity) and the conclusion. In other side, the students’ book have some components; learning goal, students’ activity, contextual problem and comprehension test.

The design of Iceberg, teacher’s book and student’s book can be seen in Figure 2.

4.3. The result of self evaluation

Self evaluation stage uses self evaluation sheets. Self evaluation is conducted to HLT, the design of teachers’ book and students’ book. The mistake of HLT are the choice of contextual problem, mistyping, sentence ambiguity and punctuation. The mistakes in teacher’s book are in presenting, the appropriateness of color and picture for supporting the contextual problem. The mistake in students’ book are the choice of color, view and typing. All those mistakes have been revised.

5. Conclusion

The instructional design in form of RME in set materials for students at grade VII of junior high school is based on the result of preliminary research that produces HLT, teacher’s book and students’ book. HLT consists of learning goal, activity, and hypothesis of how students learn. For operational of learning, HLT is created in form of teacher’s book and students’ book. This paper is limited on preliminary research, the development of HLT design, teacher’s book and students’ book. The evaluation that has been conducted is also still limited on self-evaluation.

The next research is suggested to conduct the test for validity and practicality of teacher’s book and students’ book. The evaluation stage of the instructional design can be done to see students’ comprehension or students’ level of thinking.

References

