Development of Learning Flow for KPK Based on Interactive Multimedia Assisted RME Based on Students PGSD UNRI

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Abstract. This study develops a learning trajectory with the Realistic Mathematics Education (RME) approach which is assisted by interactive multimedia that are valid, practical, and effective for learning KPK topics on PGSD UNRI students in low-grade mathematics subjects. The research method used is design research (design research), which is characterized by a cyclical process of preparing for the experiment, conducting the experiment, and retrospective analysis. This research is focused on designing the learning flow, validating it, and then testing it one-to-one and in small groups. The revised learning flow is then implemented in the classroom. Research data were collected through observation, interviews, checklist, video taping, analysis of student work, and tests. The collected data is analyzed by quantitatively and qualitatively. From the research that has been carried out, the KPK learning flow has been generated in the valid students of PGSD UNRI in terms of RME state-of-the-art, content and construction. In its implementation, the learning flow that is designed can work in accordance with what was hypothesized, so students can rediscover concepts in the KPK topic through horizontal and vertical processes of mathematical process. The resulting learning flow is also effective in improving students’ mathematical reasoning abilities. Keywords: learning flow, RME, interactive multimedia

1. Introduction
Education is a very important thing and cannot be separated from life. The importance of education is a benchmark for the progress of a nation. Developed countries are countries that have quality human resources, both in terms of spirituality, intelligence and skills. One thing that can be done to achieve this goal is a continuous renewal in education, especially mathematics [1]. Students are expected to use mathematics and mathematical thinking in everyday life and learn various types of science that emphasize the logical arrangement and formation of student characters and also the ability to apply mathematics [2]. Analysis of PISA 2013 data by Scherer & Beckmann (2014) states that mathematics and scientific competence contribute significantly to problem solving throughout the country.

The fundamental purpose of teaching mathematics is to enable students to solve problems in everyday life [3]. The ability to solve mathematical problems itself is not only a goal in learning mathematics but also something that is very meaningful in everyday life [4], and in the world of work; being a problem solver can provide benefits [5]. Learning by connecting with the real world is understood as human activity is an approach in RME [6]–[9]. Therefore, learning must be developed to educate students to realize and solve the problems they face [10]. To support the implementation of learning in the classroom, learning media are needed to make it easier for students to understand learning material and make learning more varied and not boring [11].
The results of observations about PGSD students’ reasoning abilities show that most of them are at the level of partial understanding and on the rote understanding model related to Low Grade Mathematics courses. The results of further observations show that the condition of students is closely related to the learning practices carried out by lecturers who support Low Class Mathematics courses that use approaches that are less supportive of instilling an understanding of teaching materials. Whether we realize it or not, the existing mathematics of learning could not give meaning. Students cannot understand what exactly they have learned between actual life and learning activities, as if they have no connection. Whereas students are expected to solve problems in their lives as a result that they have learned mathematics, thus when they have become teachers, students can apply suitable learning methods to their students. Students have studied the material in the Low Class Mathematics subject of the KPK material before entering higher education, but there are still many students who find it difficult to study and understand this course.

One way to solve the problems that have been raised is to develop a learning design that can make students active and curious. The learning design that developed is in the form of a learning flow that contains the learning objectives, activities and predictions of student answers. This learning flow is designed to facilitate students to be more active in developing and developing their ideas and thoughts when constructing mathematics. Learning flow is a series of activities that are actually passed by children in solving a problem or understanding a concept [12]. The learning flow provides instructions for the teacher to determine and formulate learning objectives to be achieved.

The learning flow provides instructions for the teacher to determine and plan learning goals to be achieved. [13], [14]. The RME approach is an approach with a paradigm that mathematics is a human activity and learning mathematics means working with mathematics (doing mathematics) [15].

2. Methodology

The research method used is design research proposed by Gravemeijer & Cobb (2006), which is characterized by a cyclical process of preparing for the experiment, the conducting of the experiment, and the retrospective analysis.

The design research started by Gravemeijer & Cobb focused on developing the order in which material is presented in mathematics learning. To do this, it starts with a thought experiment (though experiment), thinking about the route / path of learning that students will go through. The results of further thought experiments were tried out in class. By reflecting on the results of experiments in class, though, the next experiment is carried out. In the long-term process, both of these activities can be seen as cumulative cyclic processes as shown in Figure 1.

![Figure 1. The Reflection Relationship between Theory and Experimentation (Gravemeijer & Cobb, 2006)](image)

2.1. Preparing for The Experiment

The principal aim of the phase of preparing for the experiment is to formulate HLT, which will be refined during the research process. There are two principal things done in this phase. First, reviewing various literature on RME, and literature on how to teach KPK topics. Second, Designing HLT (a series of activities to solve contextual questions) and their completeness. In designing HLT, End Points are first determined, namely the goals to be achieved through various activities to solve contextual questions in learning the KPK topic. This purpose is used as a guide for learning activities that are designed. Starting Points are determined, which is the initial knowledge or informal
knowledge that students have to carry out various activities to solve contextual questions to achieve the stated objectives. So that these goals can be achieved well, designed with predictions about students’ thinking processes in solving contextual problems, along with their anticipation.

2.2. Conducting the Experiment
The principal purpose of this second stage is to test and improve the conjecture that has been made in the preparation stage and develop an understanding of how the design works performed (Gravemeijer & Cobb, 2006). In this phase, the component that plays an important role is HLT. HLT is used to observe the learning process and as a guide for teaching by giving contextual problems. The research subjects were used from several students of PGSD UNRI in low grade mathematics courses.

2.3. The Retrospective Analysis
The third stage is retrospective analysis. What is done at this stage is to evaluate whether the HLT that has been planned is running under what is expected. The learning trajectory plan used in a retrospective analysis is a basic guide and reference in answering the research problem formulation. The main objective at this stage is to contribute to the development of HLT in supporting students’ understanding of the material being studied. The role of HLT in this stage is to be a guideline in determining the focus of analysis in research. The analysis process is not only on the factors that support learning success but also on some allegations of learning that do not get a response from students. The explanation got is used to make conclusions and answer research questions.

3. Results and Discussion

3.1. Result Preparing for The Experiment
Based on the literary study results on the RME and research results on the learning flow, then the RME approach-based learning flow is generated, for learning the KPK topic on PGSD students, consisting of seven activities that begin by explaining the notion of multiple numbers, and ending with the activity of finding the Corruption Eradication Commission 2 number two numbers. The following describes each activity in HLT and its rationale.

3.2. Prototype Design / Learning Flow
3.2.1. Hypothetical Learning Trajectory (HLT)
At this stage, the Hypothetical Learning Trajectory (HLT) was designed. HLT was designed to adopt HLT [17] consisting of three parts, namely learning objectives, learning activities, and hypotheses of the learning process to predict how students’ minds and understanding develop in learning activities. The learning objectives at HLT are targets or achievements, students must understand that after they complete a mathematical topic or concept. Learning objectives are set at the beginning and then followed by a series of activities and predictions of student answers and anticipation of answers by lecturers by giving inducement questions to achieve the learning objectives that have been set.

The inducement question is given to stimulate students’ thinking skills so that the learning objectives set can be achieved. Student activities and prediction of student answers are designed starting from simple and then continued with more complex problems. This activity is expected to develop the ability of horizontal mathematical towards vertical mathematical. In research on social arithmetic, 5 HLTs were designed.

First, explain the meaning of multiples of a number, through the context of counting rose petals. This will stimulate students to find that in determining multiples of a number is to do the same number of repeat numbers. This context was chosen because it introduced the Malay has cake, the rose cake.

Second, determine the multiples of a number, with the context of counting the number of groups of flowers made of panel cloth. This will stimulate students to find that understanding the KPK concept can be done by counting flower petals made from panel cloth. Many flowers can be compared with the number of flower petals made.
Third, determine the Corruption Eradication Commission 2 number two numbers, with the context of counting the number of petals from two flowers. The discovery asked students to make two flowers with a different number of petals. Through the activity of making flowers from panel cloth with original amounts will be discovered by the KPK concept of 2 numbers. This will stimulate students to find how many petals are needed for flower A and flower B, so students can determine how many flowers A and how many flowers B can be obtained with the same number of petals.

3.2.2. Lecturer Books and Student Books
The lecturer book, designed in this RME study, has several components. The lecturer book components are learning objectives, media and tools, time allocation, learning to plan, prediction of student answers and lecturer anticipation. Student books have components of learning objectives, student activities, contextual issues and understanding tests.

3.3. Formative Evaluation
Formative evaluations are carried out to assess the quality of the product designs developed.

3.3.1. Result Expert Review
HLT, lecturer books, and student books that have been examined at the evaluation stage themselves, are then consulted and discussed with experts as validators. The experts who became validators came from 3 areas of expertise, namely 3 mathematics lecturers, 1 education technology lecturer and 1 Indonesian lecturer. In the HLT aspects observed are the content and language aspects. HLT validation results can be seen in Table 1:

| No  | Rated aspect         | Average | Category |
|-----|----------------------|---------|----------|
| 1   | Content aspect       | 3,1     | Valid    |
| 2   | Language Aspects    | 3       | Valid    |
|     | **Overall Average** | **3,1** | **Valid** |

Based on Table 1 it can be seen that the overall value of HLT validity is 3.1 with a valid category. Thus it can be concluded that the aspects of the RME-based KPT HLT component are valid.

Implementation products (lecturer books and student books) are also validated. The results of lecturer book validation can be seen in Table 2:

| No  | Rated aspect         | Average | Category |
|-----|----------------------|---------|----------|
| 1   | Content aspect       | 3,1     | Valid    |
| 2   | Language Aspects    | 3,2     | Valid    |
| 3   | Presentation Aspects| 3,1     | Valid    |
| 4   | Display Aspects     | 3       | Valid    |
|     | **Overall Average** | **3,1** | **Valid** |

In the lecturer book the aspects observed were the content aspect, the language aspect, the presentation aspect, and the display aspect. The overall validity value of the lecturer books is 3.1 with a valid category. Thus it can be concluded that the RME based lecturer book that was designed was valid.
Table 3. Results of Student Book Validation

| No | Rated aspect               | Average | Category |
|----|----------------------------|---------|----------|
| 1  | Content aspect             | 3,1     | Valid    |
| 2  | Language Aspects           | 3,1     | Valid    |
| 3  | Presentation Aspects       | 3,2     | Valid    |
| 4  | Display Aspects            | 3,1     | Valid    |
|    | **Overall Average**        | 3,1     | Valid    |

In the student book the aspects observed were the content aspect, the language aspect, the presentation aspect, and the display aspect. The value of the validity of student books as a whole is 3.1 with a valid category. Thus it can be concluded that the RME-based student book designed is valid.

3.3.2. Result Conducting the Experiment

The learning flow that has been declared valid by experts is then tested in a one-to-one, small group, and to the actual class. The results of the trial show that the learning path of the KPK topic can work as hypothesized, after undergoing a revision (in one-to-one and small group trials). Observation data shows that implementing the KPK topic of learning flow did not experience significant obstacles in the classroom. This shows that the learning flow meets practical criteria.

The results of conducting the Experiment phase in the class show that students solve contextual problems, as predicted. Probing Questions prepared by lecturers have a role to help students in conducting mathematical processes, both horizontal and vertical. In addition, discussions conducted after the completion of contextual problems (students’ contribution) have also played a role in helping students carry out vertical mathematization.

3.3.3. Result Retrospective Analysis

Retrospective analysis has given a large role in improving the designed learning flow, especially during one-to-one and small group trials. Some other results from retrospective analysis show that lecturers must provide different treatments for each ability not exactly the same. The direction given by the lecturer in the form of probing question is very influential on the continuity of the discussion. The learning flow implementation runs according to predictions and what is hypothesized. This is because the obstacles that may arise have been minimized and expected based on the results of one-to-one and small group trials.

The main results of this study show that through the activity of solving contextual problems in each learning path students can find: 1) explain the notion of multiples of a number, through the context of counting rose petals, 2) Determine the multiples of a number, with the context of counting the number of groups of one flower made of panel cloth, 3) Determine KPK 2 two-digit numbers, with the context of counting the number of groups of two flowers. The RME principle, namely guided reinvention, didactical phenomenology, and emerging models stimulated this discovery [6] and the characteristics of RME, especially students 'free production and students' contributions [7], [8]. The results also showed that the learning path of the KPK topic developed had a positive impact on students’ mathematical reasoning abilities. Test results at the end of the study showed that 73% of students had the ability to reason with very good criteria. This is stimulated by the activity of solving contextual questions that involve horizontal and vertical mathematical processes, so that what students learn becomes their own knowledge [6], [18]

4. Conclusion

The learning flow of the KPK topic with the RME approach developed in this study fulfills valid criteria, with characteristics: the learning flow reflects the state-of-the-art knowledge, and is under the key principles and characteristics of the RME. The developed plot also fulfills practical criteria because it can work under what was hypothesized, and is effective in improving students’ reasoning abilities.
Acknowledgment
Acknowledgments We would like to thank DIPA LPPM Riau University in 2020

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