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Indonesian realistic mathematics education learning design for least common multiple material using calendar context for grade VII students

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Abstract

Students frequently encounter difficulties comprehending and applying the least common multiple (LCM) concepts due to traditional teaching methods lacking engagement and failing to incorporate relevant real-life contexts. Through the Indonesian Realistic Mathematics Education approach, students are expected to be able to solve the problems given related to the Least Common Multiple (LCM) topic and understand it more deeply. This research is design research with a validation study type that includes three main stages: preparing for the experiment, designing an experiment, and retrospective analysis. A literature review and needs analysis were conducted in the preparation stages to identify problems in learning this LCM topic. The design experiment stage involved using activity sheets, which were implemented into teaching and integrated the LCM concept utilizing the context of a calendar. This stage involved data collection through observation, questionnaire, documentation, and field notes. Retrospective analysis was conducted to evaluate the learning design and make revisions based on the evaluation result and feedback from students, teachers, peers, and lecturers. The result showed that using the context of the activity calendar in learning for LCM topics can enhance students' understanding of the material and make the learning process more contextual and interesting.

Keywords: indonesian realistic mathematics education, least common multiple, learning context, calendar.

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I. Introduction

Mathematics is one of the subjects that has an important role in daily life (Utami et al., 2018). Mathematics is autonomous and does not depend on external factors (Harahap et al., 2023). By studying mathematics, students can learn to think logically, analytically, and systematically, which is very useful for solving various problems that exist in life (Setyaningsih & Nurhidayati, 2024). However, many students still believe mathematics is difficult and abstract (Susanti, 2020). This is evidenced by the result of the 2022 Programme for International Student Assessment (PISA) survey, which placed Indonesia in 65th out of 79 countries in terms of mathematics ability (OECD, 2023). This position shows that there are still many challenges in improving the quality of education, particularly

in mathematics education in Indonesia. These difficulties occur not only in Indonesia but also in many other countries.

One topic currently being studied and still considered difficult by students is the Least Common Multiple (LCM) (Nurhayanti et al., 2021). The concepts in LCM are basic, but students often understand only how to calculate them without truly grasping their underlying meaning. Students frequently encounter difficulties when presented with simple problems embedded in real-life scenarios. This indicates that many students still don't fully and deeply understand the concept of LCM (Rodliyah et al., 2018). Understanding LCM is frequently encountered in various applications such as schedule calculations, planning, and other daily problems. In high school, students find it difficult to solve problems related to LCM even though this topic has been taught in elementary school. This difficulty is often caused by the teaching method that remains too abstract and rarely connects with students' real-life experiences. In reality, the concept of LCM is closely related to everyday life. Students can better understand and apply the concept by connecting them to practical and familiar contexts like calendars for scheduling. This approach can make learning more engaging and meaningful for students, helping them see the relevance of mathematics in their daily lives.

An example of the LCM concept is determining when two toys, which require battery replacement every 6 and 8 days, must be replaced on the same day. This context can be recorded with the help of a calendar. Using a calendar can enable the determination of the exact date when both batteries need to be replaced at the same time. Using a calendar is a familiar and easily accessible context for students. This calendar context can provide a concrete illustration, making learning more engaging and enhancing students' understanding of the LCM concept.

One of the approaches that is often used is Indonesian Realistic Mathematics Education (Indonesian RME). This approach emphasizes the use of real contexts in learning mathematics. (Sari, 2017). The Indonesian RME approach is adapted from Realistic Mathematics Education (RME) from the Netherlands, emphasizing context's importance in learning mathematics. This approach makes the chosen context relevant and understandable to students. (Kamsurya & Masnia, 2021). Indonesian RME-based activity sheets can be used to learn and understand concepts (Adha & Refianti, 2019). In this case, the calendar selection as a context can be used as a practical visual aid to understand the concept of LCM better. Using teaching materials in the form of Activity Sheets containing activities can be important to support and implement the Indonesian RME approach.

It is still rare to see teachers using contextual teaching materials in school lessons (Purnasari & Sadewo, 2020). Teaching materials that are often used usually focus on problem-solving procedures without providing meaningful opportunities to build understanding. On the other hand, using context in learning can help students better understand LCM topics (Unaenah, 2023). Using Indonesian RME-based teaching materials in learning using a context in the form of a calendar is expected to solve problems in learning LCM topics. Through the Activity Sheet used, students can explore concepts more meaningfully and connect with real daily experiences. In addition, using calendar context can also help in understanding the application of LCM material in real life.

This study aims to produce a learning trajectory of the least common multiple topics using the Indonesian RME approach in the calendar context. This learning path is expected to facilitate students' understanding of the concept of LCM and provide a more meaningful learning experience. This research is also expected to be one of the alternative innovations that can be implemented in mathematics learning by using contexts relevant to students who are specialized in understanding LCM topics.

Several studies have explored similar material. For instance, a study by Fauzan et al. (2020) employed the RME approach to teach LCM concepts to elementary school students, concluding that the learning trajectory was both valid and practical. Implementing the RME-based learning trajectory positively influences students' ability to reason mathematically. Furthermore, Nugraheni and Sugiman (2013) investigated the impact of the Indonesian RME approach on junior high school students' engagement and comprehension of mathematical concepts. Their research shows that the PMRI approach improves students' understanding of mathematical concepts by connecting them to everyday situations. This contextualization facilitates easier comprehension and application of the concepts across various contexts. These studies indicate that the PMRI approach effectively teaches mathematical concepts, including LCM. Additionally, they underscore the importance of practical and valid learning trajectories that offer meaningful learning experiences for students.

II. Research Method

The research method used in this research is Design Research with Validation Study type. Design Research is a way to answer research questions and achieve research objectives. This research aimed to develop a Hypothetical Learning trajectory (HLT) for the Least Common Multiple (LCM) topic by using a calendar context with activities in it. This research was conducted in SMP Negeri 9 Palembang, and the research subjects consisted of 40 students from class VII. This research process includes three main stages of design research, namely: (1) preparing for an experiment, (2) designing the experiment, and (3) retrospective analysis (Gravemeijer & Cobb, 2006).

The first stage is preparing for the experiment. The essence of this stage is to prepare by making a learning design consisting of learning activities that are in accordance with the learning objectives to be achieved and the hypothesis of the learning process that will occur. The Hypothetical Learning Trajectory (HLT) will contain this learning design.

The second stage is the design experiment. At this stage, the HLT that has been designed is implemented in the classroom. This stage collects data that is used to analyze the learning activities that have been carried out.

The last stage is retrospective analysis. At this stage, all the data collected is analyzed. The designed HLT is compared with the student's actual learning process. The results of the analysis are used to answer the research questions raised.

Data collection techniques used during the research, such as observation, questionnaires, documentation, and field notes, were collected and analyzed to improve the HLT that had been designed. The data obtained were analyzed retrospectively with HLT as a reference. The data was analyzed descriptively based on observation, questionnaires, and documentation results.

III. Results and Discussion

Preliminary Design

The first stage is Preparing for the experiment. At this stage, the researcher conducted a literature review on the PMRI approach and LCM topic in the school curriculum. Furthermore, the initial HLT design was carried out, which consisted of three components: learning goal, learning activities, and hypothetical learning conjecture (Majid & Mariana, 2024).

Based on the study's results, several fundamental problems were found in LCM topics at school. First, students have difficulty understanding the concept of LCM. (Fariana et al., 2022). Students are more likely to fixate on the solution algorithm procedure without understanding the real meaning of the LCM concept. Second, teachers explain more procedures for solving LCM material problems mechanically, and students look passive in

learning and only record or follow the steps given. In addition, the learning pattern implemented has not provided sufficient space for students to construct their understanding. This made it difficult for students to see the relevance and use of LCM material in a practical context. Therefore, in this study, the initial HLT design can be seen in Table 1.

Table 1. Initial HLT of LCM topic in calendar context

Learning Goal	Learning Activities	Hypothetical Learning Conjecture
After doing it for the first time, students can determine when two people will do an activity together again.	Learners observe the activities recorded on the calendar	1. Students can understand the activity notes in a calendar 2. Students can read but do not understand the data given.
	Students record each person's schedule of activities	1. Students can record the time of implementation of activities carried out by each person
	Students determine the date when two people study independently at the same time.	1. Students present data by recording activities 2. Students present data by recording activities on the calendar 3. Students use LCM to determine the time when self-learning at the same time 4. Students are wrong in doing the calculation 5. Students cannot determine the time when they study independently simultaneously.
Students can determine how many times two people will do an activity together in a given time interval	Students determine the date when two people were studying independently simultaneously.	1. Students present data by recording activities 2. Students present data by listing activities on a calendar 3. Students use LCM to determine the time when self-study at the same
	Students can determine how many times two people will do an activity together in a given time interval	1. Students are wrong in doing calculations. 2. Students are unable to determine the time when they are self-learning at the same time 3. Students can determine the time when they study independently at the same time appropriately

The designed HLT is then implemented and used as a reference for making activity sheets, which are then used in the next stage.

1st Cycle

The Design Experiment

The stages in the design experiment of the first cycle involved a pilot experiment. During this cycle, a Hypothetical Learning Trajectory (HLT) trial was conducted with six students. In this activity, the six students worked on the provided Activity Sheets. The students' answers were used as input to refine the HLT and make it more perfect. Improvements were needed to clarify the activities based on analyzing the student's answers to each problem. The results of the students' Activity Sheet, which will be used to improve the HLT, are presented in Figure 1.

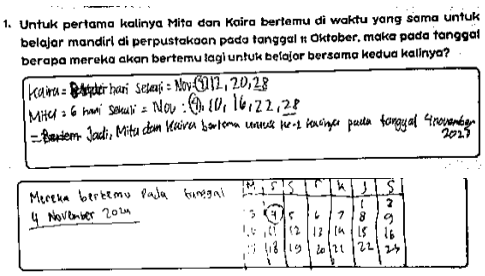
1. Untuk pertama kalinya Mita dan Kaira bertemu di waktu yang sama untuk belajar mandiri di perpustakaan pada tanggal 11 Oktober, maka pada tanggal berapa mereka akan bertemu lagi untuk belajar bersama kedua kalinya?

Figure 1. Students' answer

The problem asks to determine when Mita and Kania will meet again to study independently in the library after their first meeting on October 11. From the answers given, students tried to solve the problem creatively. Some students make a calendar in November to obtain the meeting date. However, some students still experienced difficulties and needed help and guidance from the teacher in answering the questions provided. So, additional steps are necessary to get to the answer to the problem.

The Retrospective Analysis

Students' answers in the first cycle of the pilot experiment were used as evaluation material to revise the series of activities in the student activity sheet. In addition, some input from peers and teachers was obtained to improve the Activity Sheet. Based on the results of student answers and suggestions, the Activity Sheets used were revised as follows in Figure 2 and Figure 3:

Figure 2. Activity sheet before revision

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Figure 3. Activity sheet after revision

Some additional steps to solving the Main Problem in the Activity Sheet were provided. The range of days used was also corrected so that students did not misunderstand the concept of LCM.

2nd Cycle

The Design Experiment

The stage in this second cycle of design experiments is the teaching experiment. The revised Activity Sheet was then tested on 40 students. Learners were divided into heterogeneous small groups of 3 - 4 people. The main problem in the LAS is presented in Figure 4.

Figure 4. The first problem in the activity sheet

1st activity: Students are asked to write down the information obtained in the problem given. This first activity encourages students to identify and record the information they get from the given problem. It is important to build initial understanding before they move on to the problem-solving stage.

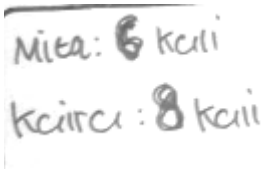

Figure 5. Student's answer on the first activity

In this first activity, students were asked to record the information they obtained from the given problem. Some students answered that Mita studied independently every 6 days, and Kaira studied independently every 8 days. This information can be used to solve the given problem related to KPK material.

2nd Activity: Students are asked to determine when each activity is carried out within the specified time interval. In the second activity, students were asked to determine when Mita and Kaira did independent study during November. As seen in Figure 6, learners gave the same answer in problem 2.

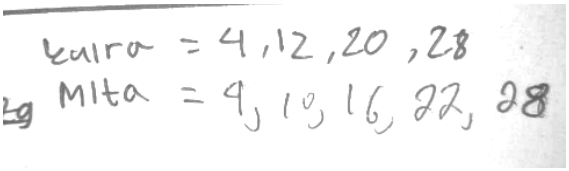

Figure 6. Student's answer to the second activity

They answered that Mita follows an 8-day pattern, so her study days are 4, 12, 20, and 28. Meanwhile, Kaira follows a 6-day pattern, so her study days are 4, 10, 16, 22, and 28.

3rd Activity: Students are asked to determine the time of the activity done together. In this third activity, students are asked to determine when Mita and Kaira do independent learning activities together. Where in a 24-day interval, they will always meet on the days that are counted.

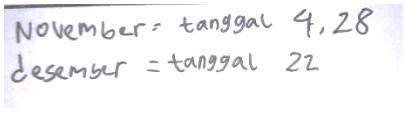

Figure 7. Student's answer to the third activity

Figure 7 shows the answers from one of the groups. The students' answers in each group

are almost the same. After October 11, they will meet again on November 4 in the library.

4th activity: Students are asked to determine when activities are done together over a certain interval For this fourth activity, students are asked to determine when Mita and Kaira do independent study together in a certain time interval. Based on the previously identified patterns, it can be used to solve the student answer problem shown in Figure 8.

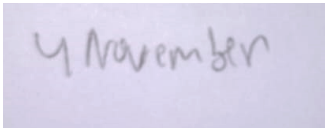

Figure 8. Student's answer on the fourth activity

In November, which has 30 days, these two students will do independent learning activities together on November 4 and November 28. Mita and Kaira will do an independent study together on December 22.

5th activity: Students provide conclusions based on the results of the answers that have been done before. Students conclude from the results of their previous answers. They synthesize their findings and present a summary, reflecting on the problem-solving process and the mathematical concepts they have explored.

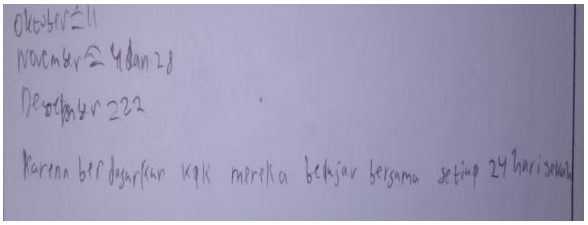

Figure 9. Student's answer on the fifth activity

Figure 9 shows that students can solve the given problem well and can apply the LCM concept to solve it.

Then, at the end of the Activity Sheet, a more in-depth problem is given by giving three subjects. 2nd problem can be seen in Figure 10

Figure 10. The second problem in the activity sheet

The Retrospective Analysis

Based on student answers at the teaching experiment stage, the results show that students can solve problems well despite still making some mistakes. The mistake is that students often forget that there are dates in a month. They often forget which months have 31 days or 30 days.

In cycle 2, the learning process was carried out after the researcher made revisions to the HLT that had been implemented in cycle 1. After making changes to the Activity Sheet, students could understand the learning design and solve the problems well. Based on the results of these answers, the use of calendar context in the Indonesian PMRI approach is effective in helping students understand the concept of LCM. Using a calendar, students can easily visualize the pattern of multiples and the cycle of days, which supports their understanding of the concept of LCM. In addition, this contextual learning also increases students' engagement and motivation, as they can see the real application of mathematical concepts in daily life. Practical experiences such as marking dates on the calendar help students internalize the concept more deeply and enjoyably. Based on the results of students' answers, they can more quickly understand and apply the LCM concept after participating in learning by using the calendar context, showing the effectiveness of this method in improving their mathematical understanding. Based on the research that has been done, the learning trajectory using calendar context with the Indonesian RME approach worked as intended. It can be one of the alternatives in learning LCM topics. In addition, Based on the analysis of the student's work, we also found an improvement in the students' reasoning.

IV. Conclusion

Learning Trajectory is the flow of student learning in understanding learning. It consists of three components: learning objectives, tasks in learning activities, and stages of student thinking and learning. Learning trajectory is obtained based on a hypothetical learning trajectory that was tested. The benefit of learning trajectory is to design learning objectives, activities, teaching materials, and assessments.

The study results indicated that a series of specially designed activities could assist students in solving problems related to Least Common Multiple (LCM) problems. The activities were created to integrate the concept of LCM in a context that is more familiar and relevant to students. Using calendars as a context for problems in LCM learning effectively gives students a more concrete and applicable understanding of the concept. Using the calendar context, students can more easily understand how to determine LCM in real situations, such as calculating days for repetitive activities. This research shows that the calendar context makes learning more interesting and improves students' ability to apply the LCM concept practically.

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