

## DEVELOPMENT OF LOCAL INSTRUCTIONAL THEORY TOPIC DIVISION BASED ON REALISTIC MATHEMATICS EDUCATION IN BASIC SCHOOL

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### ABSTRACT

This research is motivated by barriers to student learning on the topic of division. The problem solving ability is the impact of the less effective learning that has been carried out. In this case, the importance of learning is based on Realistic Mathematics Education (RME). The research was conducted by developing valid, practical and effective Local Instructional Theory (LIT) through development research revealed by Gravemeijer and Cobb. The subjects of the trial came from third grade students of SDN region IV, Koto Tengah sub-district, Padang City. Research is supported by data collection techniques in the form of document analysis, observation, interviews, questionnaires, and tests. Data analysis was performed using descriptive statistics and parametric statistics. Validation results show valid LIT which can be seen from aspects of content, language, didactic, and presentation that are in accordance with the principles and characteristics of the RME. The trial results also show very practical categories that are seen in terms of ease of use, student readability and availability of time so that students can carry out a series of LIT learning activities. In addition, LIT has an impact on students' effective problem solving abilities. This can be seen from the comparison of the average mathematical problem solving abilities of students who use LIT by not using LIT. The hypothesis test addresses the experimental class data higher than the control class data.

**Keywords: LIT, RME, Division**

### INTRODUCTION

The main abilities in mathematics are counting. Counting is one of the abilities that plays a major role in mathematics learning. As revealed by Hasan (2012), the

mastery of basic counting operations is very important because this operation will be the basis for those who want to learn mathematics, therefore numeracy skills must be truly understood by those who will study mathematics. Ability to count often becomes a problem in elementary school. One part of counting which becomes a problem is division. The division is the calculated operation which is the most difficult to learn among other counting operations (Hasan, 2012). Mariani (2016) also revealed that many elementary school graduates are less skilled at completing simple, even count questions. The results of Antari (2015) state that 12 out of 24 students have not reached the target completeness value or 50% of students have not finished learning the distribution material, this is because there is no teacher using a learning approach that matches the characteristics of students. Then, Armanto (2002) research also states that the errors experienced by students in the distribution material are caused by learning standardized sharing algorithms that students learn mechanically in the classroom. Students only memorize, but do not apply the distribution procedure correctly. Learning activities have an impact on students' problem solving abilities.

Problem solving ability is the basic ability possessed by someone to identify and solve problems that include critical thinking, logical and systematic (Syarifuddin *et al.*, 2017). One of the benefits of problem solving is that students learn that there are many ways to solve problems (different thoughts) and there are more than one possible solution that occur and students are trained to explore, think and reason comprehensively, and logically (Syarifuddin *et al.*, 2017).

The problems found above, if left unchecked, certainly will have a negative impact on students' understanding of the concept of mathematical learning, especially the division, as well as the next learning process. Learning activities designed are expected to make students rediscover mathematical concepts or algorithms. This is what is called the principle of reinvention. In this case, students experience the process of describing and solving contextual problems by developing their informational strategies into language or mathematical algorithms. With contextual problems given, it is able to encourage students to find the relationship of a material learned with real-world situations (Desyandri *et al.*, 2018). Giving problems is able to encourage students to be able to understand about what, why a problem occurs and how students attempt to

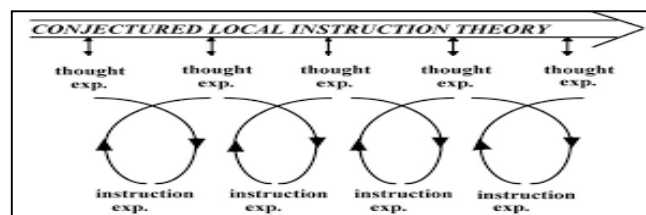
overcome the problem (Desyandri and Vernanda, 2017). In the end, contextually learned material can color its abilities in everyday life (Desyandri, 2012). One of the relevant lessons for this activity is realistic mathematics education (RME).

RME is an approach to learning mathematics which was first born in the Netherlands. Realistic Mathematics Education is interpreted as an approach in mathematics education that teaches mathematical concepts based on student experience so that they become solid and meaningful (Fauzan and Sari, 2017). In designing RME-based learning, a teacher needs to pay attention to the main principles of the RME to achieve the desired goals. Gravemeijer *in* Fauzan (2002) presents three main principles of RME that must be understood, namely guided reinvention through progressive mathematics, didactical phenomenology, and self-developed models or emergent models.

Through this research a learning flow of division topics was developed. Learning flow is a way to describe pedagogic and didactic aspects in mathematics learning (Fauzan *et al.*, 2017). Products that are born from the learning path are called Local Instructional Theory (LIT). LIT is a theory about the learning process for a particular topic with activities that support it (Gravemeijer and Eerde, 2009). The developed LIT is adjusted to consider the principles and characteristics of the RME. The topic used relates to the division for grade III elementary school. The initial form of the product developed is the Hypotetical Learning Trajectory (HLT) and supported by RPP and LKS as a means of supporting the learning process. HLT is related to the activity of the teacher imagining how students think and learn on a topic of learning. This is as explained by Hadi (Harini and Rosyidi, 2016) that HLT is the guesswork of researchers or teachers about the possibility of learning flows that occur in the classroom when designing learning. Based on the findings stated above, researchers took the title "Development of Local Instructional Theory Topics Based on Realistic Mathematics Education in Primary Schools", with the final product produced by Local Instructional Theory (LIT) in the form of Hypotetical Learning Trajectory (HLT) and supported by RPP and LKS as an alternative to overcome the problem of division.

## METHOD

Research conducted using the type of development research (developmental research approach) proposed by Gravemeijer and Cobb (2013). The design of this study consisted of three phases, namely preparing for the experiment, experimenting in the classroom, and conducting retrospective analysis (Gravemeijer and Cobb, 2013). This design is used to develop LIT with the initial form of HLT. To make HLT, the activity begins with a thought experiment that is thinking about the learning path that students will go through and then reflecting on the results of the experiments conducted. If the goal has not been achieved, then continued with the next thought experiment and instruction experiment with the same material, so that LIT guides the thought experiment and instruction experiment. This relationship is illustrated in Figure 1.



**Figure 1.** Reflection relationship between theory and experiment (Gravemeijer and Cobb, 2013)

In the experimenting in the classroom phase, there are three schools that are the subjects of the study, namely third grade students of SDN 39 Tanjung Aur as small group trial subjects, third grade students of SDN 37 Sungai Bangek as the test subjects or experimental class and third grade students. SDN 21 Sungai Bangek as the subject of the control class. Data collection techniques used are document analysis, observation, interviews, tests, and questionnaires. This is based on the research phase and research focus with the research instruments. The research instruments were analyzed descriptively and parametric statistics can be seen in table 1.

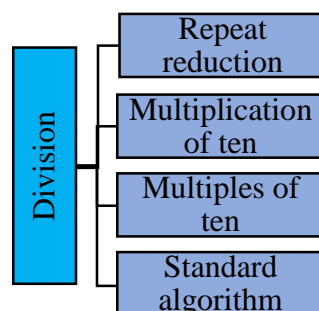
**Table 1.** Research Instruments

No	Research Phase	Research Focus	Research Instruments
	preparing for the experiment	context	<ul style="list-style-type: none"> <li>• Document analysis sheet</li> <li>• Structured interview guidelines</li> </ul>
	experimenting in the classroom & conducting retrospective analyses	effectiveness	<ul style="list-style-type: none"> <li>• HLT validation instrument and validation sheet</li> <li>• RPP validation instrument and validation sheet</li> <li>• LKS validation instrument and validation sheet</li> <li>• Observation sheet and validation sheet</li> <li>• LKS practical questionnaire for students and validation sheet</li> <li>• Test and validation sheet</li> </ul>
	experiment Phase		

## RESULTS AND DISCUSSION

### Phase prepares for the experiment

In this phase there are several activities carried out, namely needs and context analysis, reviewing literature, designing products, and validating products. In the needs and context analysis there are also several stages of activities carried out namely curriculum analysis, concept analysis, student analysis, and environmental analysis. The results of curriculum analysis found that the division taught to class III students was to divide three numbers. With the breadth of basic competencies in the curriculum, the division topics are taught for 4 meetings or more. Learning activities carried out related to the activity of resolving contextual problems. Which of the learning steps is carried out, based on the realistic mathematics education (RME) approach. Meanwhile, the results of the concept analysis carried out, products that are designed to have a learning sequence of the division carried out can be seen in Figure 2.



**Figure 2.** Concept Map of Division

Products designed must be tailored to the characteristics of students. In this case adjusted to the results of the questionnaire that has been given, namely LKS using A4-size paper with portrait rotation, LKS uses arial type letters measuring 16, LKS is dominated by blue, LKS contains images related to nature, and problems given relate to parental work students, such as trading and teachers, *congklak* games, skill-making activities, borrowing books and stationery, saving activities, drawing and buying and selling activities. In addition, in analyzing the environment an interview was conducted with the teacher. The results found that the problems presented were related to reading books and borrowing stationery, raising chickens, picking coconut trees.

A review of the literature on division teaching resulted in sharing learning using RME. Learning begins with problems related to the division or previous concepts that have relevance. Then, students are presented with daily problems. The problems presented were 2 at each meeting, activity 1 and activity 2. Problems were solved by discussion. During the discussion, the teacher provides guidance. The activity was continued by writing down the findings obtained from the results of discussions conducted by students. Students give opinions on the findings obtained. Findings obtained by students are discussed together with the teacher. After that, the activity continued with problems that had a number greater than before. During the learning process, there is an evaluation of student completion models from informal to formal.

Based on the results of the needs and context analysis as well as the literature review that has been carried out, the prototype 1 (HLT, RPP and LKS) is designed according to the results found. Before the product is validated, self evaluation is conducted to minimize the possibility of poor validation results. Validation was carried out by 3 experts on the products that had been made, namely 1 UNP mathematics lecturer, 1 UNP Indonesian language lecturer, and 1 UNP Art lecturer. Suggestions for improvements provided by the validation are the improvement material for the product (prototype 2). The results found are products that are designed to have a very valid category with an average value of HLT 93.75, an average value of RPP 91.88 and an average value of worksheets 93.75.

## **Phase Experimenting in the Classroom and Phase Conducting Retrospective Analyzes**

### ***Small Group***

Small groups are also known as small groups. Small group testing is conducted on 6 people by providing LKS and implementing learning based on the HLT and RPP that have been designed. The 6 selected people were grouped into 3 groups, namely the high, medium and low ability groups. Groups are formed homogeneously, with the aim being to find out the possibilities that occur in the test field test later on the various abilities of students, so that appropriate anticipation can be made. The small group trial was held for four meetings outside of school hours. Each meeting has 2 activities

carried out in learning activities. The results of the small group trials that have been carried out have found several things that must be revised based on the results of the Conducting Retrospective Analyzes. Revisions were made to HLT and adjusted also to RPP. The revised results are prototype 3.

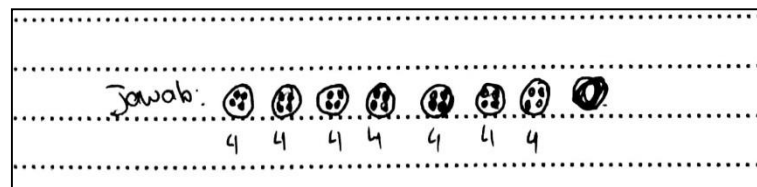
### ***Field Test***

Inputs and suggestions obtained from students in the small group stage are used as revision material. After the revision, then continued the field test which aims to assess the revised prototype. Activities at this stage are focused on the field test phase which aims to find out whether the learning pathway developed is practical and effective. Field test trials are carried out by providing LKS and implementing learning based on the HLT and RPP which has been revised from the results of the small group trial. This field test trial was carried out for four meetings in class hours.

The learning flow based on HLT carried out during the field test is as follows.

#### **1st meeting. Division with recurring reductions**

In this first meeting, there were different solutions for solving problems by students. Where there are students who solve problems using images, there are also those who finish by doing repeated reductions down, and there are also those who finish with repeated reductions to the side. For students who solve problems using images certainly not in accordance with the expected learning objectives in this first meeting, to direct the answers or thoughts of students as the researcher gives a probing question. This is illustrated as solving problems given in activity 1, students complete the drawing, such as figure 3.



**Figure 3.** Student Answer Activity 1 LKS 1 (Field Test)

With an answer like that, the researcher gives a probing question, such as the following conversation quote.

Teacher : "Do we need to make an image like that to solve it?"

Student : "mmm ,. shut up? "



Teacher : "Can we not write down the mathematical sentences?"

Student : "mmm ... can you sir"

Teacher : "Let's try to do it"

In activity 2, in general students have used repeated repetitions downward, but there are also some students using repeated subtraction to the side in solving the problems given. Of course this is in accordance with the expected learning objectives at the first meeting. This is seen in figure 4.

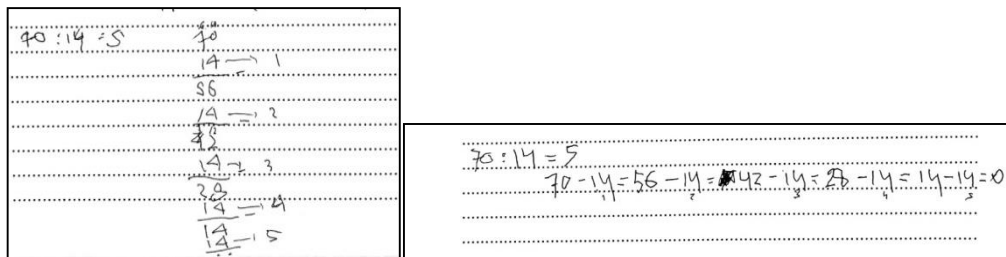


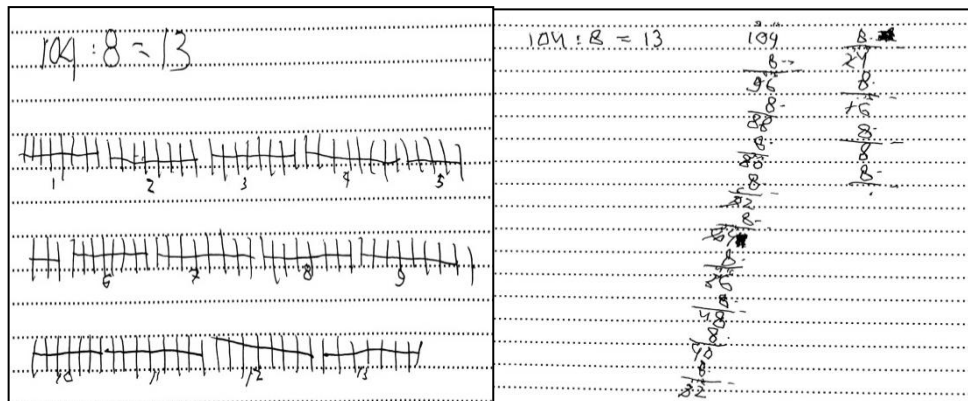
Figure 4 shows two examples of student work on a grid. The left example shows a vertical division of 70 by 14, with the quotient 5 written to the right of the grid. The right example shows a horizontal division of 70 by 14, with the quotient 5 written below the grid.

**Figure 4.** Student Answer Activity 2 LKS 1 (Field Test)

## 2nd meeting. Division with multiplication of 10

In this second meeting, solving problems in activity 1 completed by students there are several descriptions of student thinking. There are students who solve the problem by using repeated repetitions to the bottom and there are also students who use horizontal lines to complete the division. Settlement of student answers like this is not predicted by previous researchers, so in this case there are new findings beyond the predictions of researchers and will be included in the HLT later. In addition, there is also a problem solving that is done by students by doing the whole division. This has not been predicted and anticipated beforehand and this includes findings. This is illustrated as the problem solving given in activity 1, where students solve the problem of division like Figure 5.





**Figure 5.** Results of student work on activity 1 LKS 2 (Field Test)

With an answer like that, the researcher gives a probing question, such as the following conversation quote.

Teacher : "Do we need to do repeated reductions throughout that?"

Student : "mmm ,. shut up?"

Teacher : "How many times have you made eight deductions?"

Student : "13 pack"

Teacher : "Are there other ways we can use it?"

Student : "mmm, silent (confused)"

Teacher : "Is it the same amount of ten times you reduce eight by the amount of 8 x 10?"

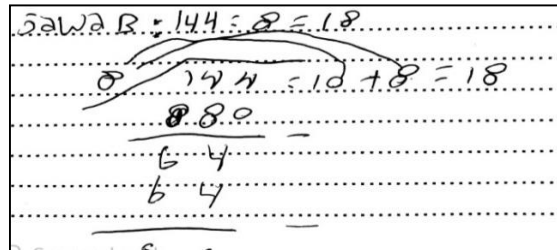
Students : "(Students count) ,. Yes sir, sir

Teacher : "Can we use multiplication 10?"

Student : "can sir"

Teacher : "Let's try to do it?"

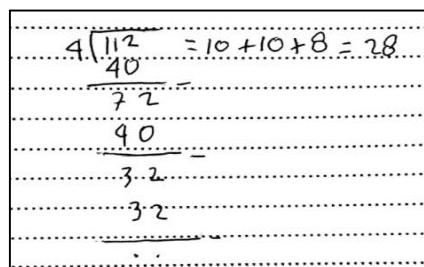
In activity 2 the problem is given with a greater number of activities 1. Overall students have been able to solve the problem given by multiplication 10. However, there are also some students who still use repeated reduction. Completion of problems in activity 2 carried out by students can be seen in Figure 6.



**Figure 6.** Results of Student Work on Activities 2 LKS 2 (Field Test)

### 3rd meeting. Division with multiples of multiples of 10

In this third meeting, solving the problems made by students in activity 1, where students complete the distribution problems given with multiplication 10. Students still use multiplication 10, even though a solution like this is a settlement at the previous meeting. Students divide 112 by 4 by making the results for them 10, then the results for those multiplied by the dividing number is 4, where the result is 40. Then 112 minus 40 the results are 72. Then 72 divided by 4 and students still make the results for him again. Then 72 minus 40 can get the result 32. Then 32 is divided again by 4 the result is 8. Of course this is not as expected. Settlement made is the goal of previous learning. This is illustrated as solving the problem given in Activity 1, students still finishing with multiplication 10, like Figure 7.



**Figure 7.** Results of Student Work Activities 1 LKS 3 (Field Test)

With an answer like that, the researcher gives a probing question, such as the following conversation quote.

- Teacher : "Are there other ways we can use it?"
- Student : "mmm ,. shut up? "
- Teacher : "Do you know the number ten in any number?"
- Student : "mmmm, you know sir"
- Teacher : "What are the ten multiples?"

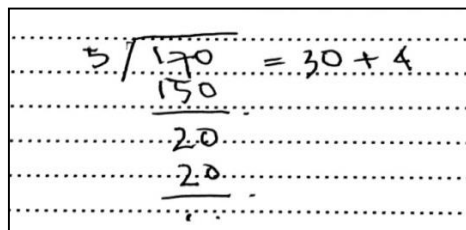
Student : "10,20,30,40, ..."

Teacher : "can we use multiples of 10 on this problem?"

Student : "can sir"

Teacher : "Try to do it"

In activity 2 with numbers greater than the number of previous activities, students have solved the problem using multiples of 10. Only a few students still use multiplication 10. But overall the students solve the problem of division in multiples of 10. This is seen in figure 8.



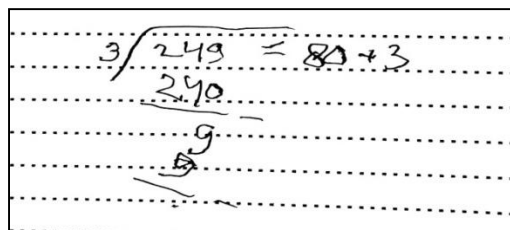
$$5 \overline{) 170} = 30 + 4$$

$$\begin{array}{r} 170 \\ - 150 \\ \hline 20 \\ - 20 \\ \hline 0 \end{array}$$

**Figure 8.** Results of Student Work on Activities 2 LKS 3 (Field Test)

#### 4th meeting. Division with standard algorithms.

At this fourth meeting, students solve problems in activity 1 by using multiples of 10. Where students make 249 results divided by 3 with 80 numbers, then students multiply 80 with 3 obtained 240. Then 249 minus 240 results 9, and then students dividing 9 by 3 and the quotient obtained 3. Then the students add the results of the division, so that the results are obtained 83. But there are also students who use multiplication 10. By solving problems such as certainly not in accordance with the expected learning objectives, students can find the result of division with a standard algorithm. This is illustrated as solving problems given in activity 1, students complete with multiples of 10, like figure 9.



$$3 \overline{) 249} = 80 + 3$$

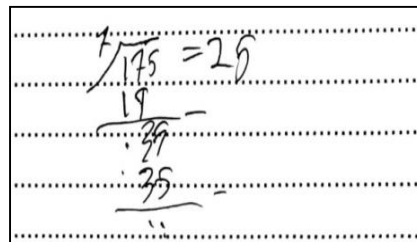
$$\begin{array}{r} 249 \\ - 240 \\ \hline 9 \\ - 9 \\ \hline 0 \end{array}$$

**Figure 9.** Results of Student Work on Activity 1 LKS 4 (Field Test)

With an answer like that, the researcher gives a probing question, such as the following conversation quote.

- Teacher : "Are there other ways we can use it? simpler  
 Student : "mmm ,. shut up? "  
 Teacher : "Can we divide by 3?"  
 Student : "can sir"  
 Teacher : "how many results are there 24: 3 ??"  
 Student : "(count) 8 packs"  
 Teacher : "means can we divide 24 by 3?"  
 Student : "can sir"  
 Teacher : "Try to do it like you said."

In activity 2, students have done the problem solving provided with a standard algorithm. Students have not used the division in multiples of 10 such as the things done in activity 1. With this solution the learning division is as expected. This can be seen in Figure 10.



$$\begin{array}{r} 175 = 29 \\ \underline{19} \phantom{0} \\ 34 \phantom{0} \\ \underline{35} \phantom{0} \\ 0 \end{array}$$

**Figure 10.** Student Work on Activities 2 LKS 4 (Field Test)

Based on the trial field tests that have been carried out, there are some things that are revised. Revisions are made to HLT and adjusted also to the RPP. The HLT revision results are the end of the development carried out, so this HLT can be referred to as LIT (prototype 4).

The results of the observation sheet from the trials conducted showed that learning during the small group carried out using the RME for the division topic had a very practical category with an average of 88.39. Then, the results of the observation sheet of the implementation of the RME-based RPP that have been used in the field test stage also show an average value of 91.07 in a very practical category. In addition, the practicality of the product is also seen from the results of questionnaires given by

students. The results of the questionnaire when testing the small group showed an average value of 83.51 in the practical category. Then, the results of the questionnaire when testing the test field showed a value of 89.06 in a very practical category.

The posttest results given after field test trials found that the average percentage of mathematical problem solving abilities in the field test class or experimental class showed an effective category with a percentage of 83.33. Meanwhile, the average percentage of mathematical problem solving abilities of the control class shows the category to be quite effective with a percentage of 69.38. When testing hypotheses, the results found that the two classes are normally distributed data with  $D_{\text{count}} < D_{\text{table}}$  and have homogeneous data. In looking at the comparison of the two classes, a t test was carried out with testing criteria, that is if  $t_{\text{count}} < t_{\text{table}}$ , then  $H_0$  is accepted and if  $t_{\text{count}} > t_{\text{table}}$ , then  $H_0$  is rejected,  $H_1$  is accepted. Based on the formulated hypothesis, the results of the t-test show that  $H_1$  is accepted with a  $t_{\text{count}} > t_{\text{table}}$  ( $3.36 > 1.68$ ). That is, students' mathematical problem solving abilities using Local Instructional Theory (LIT) are higher than those taught conventionally. The ability of experimental class students is higher than the ability of control class students who do not use LIT.

## CONCLUSION

Local Instruction Theory which was developed on the topic of distribution based on realistic mathematics education in third grade students of elementary school fulfills valid, practical, and effective criteria. These results illustrate that the product developed has very valid characteristics from aspects of content, language, didactic, and presentation that are in accordance with the principles and characteristics of the RME so that it is feasible to be applied in the division learning in grade III SD. LIT has very practical characteristics in terms of ease of use, student readability, and availability of time so students can carry out a series of activities through horizontal mathematics to vertical mathematics in solving problems presented. LIT has effective characteristics of students' mathematical problem solving abilities. This is known from the comparison of the average mathematical problem solving ability of students and hypothesis testing of the experimental class data which is higher than the control class students.

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