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DEVELOPMENT OF LOCAL INSTRUCTIONAL THEORY ON PARALLELOGRAM TOPICS BASED ON RME TO IMPROVE MATHEMATICAL PROBLEM-SOLVING SKILLS

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ABSTRACT
The purpose of this research is to develop a local instructional theory on parallelogram material and examine the improvement of students' mathematical problem-solving skills by using local instructional theory. This research uses the Design Research method, which uses the Gravemeijer and Cobb development model and the Plomp model. The Plomp development model has three stages, namely, preliminary research, prototyping phase, and assessment phase. The research subjects were seventh-grade students of MTs N 5 Jambi City. Data analysis techniques in this study used Quantitative data were obtained through questionnaires, while qualitative data were obtained through observations, interviews, field notes, and final test questions. The results of this study indicate that the local instructional theory on the topic of RME-based parallelogram in class VII is valid. The learning design met the practical criteria based on the results of the questionnaires and interviews. Based on the final test conducted shows that the local instructional theory is already in the effective category. So, the learning flow produced is valid, practical and effective. The implication of this research is that the development of local instructional theory on RME-based quadrilateral material can significantly improve students' mathematical problem solving ability. This shows that through the right approach in learning design, as implemented in this study, the problem solving ability problems that students often experience can be overcome. Thus, this approach has the potential to be widely applied in improving the effectiveness of mathematics learning in schools.

Keywords: Local Instructional Theory, Mathematical Problem Solving, Parallelogram.

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INTRODUCTION

The low mathematical problem-solving ability of students can also be seen from the results of diagnostic tests in the form of story problems conducted by Siagian solving ability is an important aspect for every learner in order to solve problems in the learning process and everyday life (Ruswati et al., 2018). Many parties have realized the importance of developing problem-solving skills, as evidenced by the inclusion of problem-solving skills in the learning objectives of mathematics in Indonesia since the 2004 curriculum (Wirdaningsih et al. 2017). However, in reality, students' mathematical problem-solving skills are still below the expected standard. This can be seen from several studies that have been conducted previously, including research conducted (Putra, 2017) in class VIII SMP 1 Pulau Panggung, which showed that out of 32 students, only 9 students reached the KKM.et al. (2019). Based on the results of interviews with one of the mathematics teachers of MTs Negeri 5 Jambi City also said that students still have difficulty in answering problem-solving questions in the form of story problems. This was evidenced when conducting a mathematical problem-solving

ability test on ajargenjang material at SMPN 16 Jambi City and MTs N 5 Jambi City, where the average problem-solving ability result was 47.74. Based on the tests of the two schools, it was found that most students had relatively low mathematical problem-solving skills. This is caused by learning that has so far focused on developing mathematical abilities in quantity rather than in quality. Whereas in mathematics learning, it is expected that students are involved in learning so that they not only use certain formulas and procedures to solve problems, but more than that, students are also expected to be able to solve some mathematical problems related to real life (Matang & Owens, 2004).

Based on the above problems, it is hoped that students will have the opportunity to be guided into situations to find concepts in their way so that learning becomes more meaningful (Wijaya, 2013). The role of the teacher can be maximized by developing a learning design. The design in question is *a Hypothetical Learning Trajectory (HLT),* and after being tested, it will become *Local Instructional Theory (LIT)* (Hidayat & Riyana, 2021). LITs can help to support learning achievement and can also help teachers evaluate and rethink teaching, possibly before they start teaching (Andrews-Larson et al., 2017). In learning design, an approach is needed, namely the *Realistic Mathematics Education* (RME) approach (Afriansyah, 2017). RME is an approach that connects subject matter with real-world problems (Wahyudi, 2016). So that RME can help improve students' ability to solve mathematical problems (Gee, 2019); (Kelen, 2020). Based on these problems, the purpose of this study is to develop a *local instructional theory* based on *realistic mathematic education (*RME) in class VII SMP / MTs that is valid and practical. This research is expected to improve students' mathematical problem-solving skills through the development of local instructional theory (LIT) based on realistic mathematics education (RME). The RME approach relates mathematical material to real-world situations, helping students understand mathematical concepts better and apply them in everyday life. In addition, with the RME approach, mathematics learning is expected to become more meaningful and relevant to students, increasing their involvement in the learning process.

METHOD

This research is a design study that uses two development models: the Gravemeijer & Cobb model and the Plomp model (Hered et al., 2021). Gravemeijer and Cobb's design is used in the prototype development stage or learning flow in the Plomp design. To implement the learning flow, a teacher's book and student book were designed with the Plomp design. Furthermore, the learning flow is developed using the Gravemeijer and Cobb design.

Through the combination of the two models, the research phase consists of preliminary research, development or prototyping phase, and assessment phase. In the preliminary research stage, which is reviewing the literature related to concept discovery and clarifying theoretical intentions, then some needs analysis is carried out as a basis for designing a learning flow that is in accordance with the Plomp model. Based on the results of the analysis at the preliminary research stage, a realistic mathematics education-based learning path was designed. At the prototyping stage, the developed prototype was evaluated based on formative assessment.

The formative evaluation carried out on the prototype that has been designed is a self-evaluation, validation by experts (expert review), and was conducted by three mathematics lecturers, one Indonesian lecturer, and one educational technology lecturer. After the developed product is declared valid, a one-to-one evaluation, small group evaluation, and field test are

conducted to determine its practicality. The test subjects in this study were students of class VII MTs N 5 Jambi City. Research data collected through validation sheets was used to see the feasibility of instruments and products assessed by experts at the expert review stage; teacher and learner response questionnaires were used to see the practicality of products tested at the one-to-one, small group, and field test stages, local instructional theory implementation observation sheets used to see the implementation of the learning process using teacher books and realistic mathematic education (RME)-based student books, interview sheets are also used to ask students' opinions on student books at the one to one, small group and field test stages. Data from the interview results were described to revise the developed learner book, and the test of students' mathematical problem-solving ability was used to see the effect of the tested book on students' mathematical problem-solving ability.

RESULTS AND DISCUSSION

The results of research on the development of *local instructional theory* based on RME in an effort to improve mathematical problem-solving skills from the preparation stage to retrospective analysis are explained, namely:

Initial Investigation Stage

At the initial investigation stage, several activities were carried out to gather information about the problems found in learning mathematics. At this stage, needs analysis, curriculum analysis, learner analysis and literature review analysis are carried out. Based on the results of this initial investigation, a learning design was designed in the form of a *local instructional theory* based on RME to improve the mathematical problem-solving skills of seventh-grade students.

Development Stage

Design of Hypothetical Learning Trajectory

At this stage, HLT will be developed to contain contextual problems that are adapted to the daily lives of students. Then, some activities will help students construct their knowledge and find the concept of parallelogram. This HLT consists of three parts, namely learning objectives, learning activities and prediction of students' answers and educators' anticipation. The learning flow consists of three HLTs consisting of

Activity 1: Listing parallelogram-shaped objects in daily life. This activity is designed for students to explore their knowledge of various parallelogram-shaped objects in daily life. In this activity, students are asked to determine the shape of a plane from the roof of a modern house, which is a parallelogram. Then, students record objects that are in the shape of a parallelogram in everyday life.

Activity 2: Students discover the concept of area of a parallelogram by comparing two cartons that have different shapes: rectangle and parallelogram. In this activity, students determine which carton is wider and conclude the comparison of the two carton sizes.

Activity 3: Determining the concept of the perimeter of a parallelogram through objects in the daily environment. In this activity, students are asked to determine the perimeter of an object in their daily environment that is in the shape of a parallelogram based on their experience. Informally, students will discover the concept of the perimeter of a parallelogram.

Teacher's book and Learner's book

The teacher's book and learner's book are designed based on RME. The teacher's book has several

components, namely cover, learning objectives, time allocation, material summary, learning activities, predicted learner answers, teacher anticipation and assessment. As for the student book, the components are covered, learning objectives, learner activities, contextual problems, and let's practice.

Validation of HLT, Teacher's Book and Learner's Book

The validation stage was conducted after the *self-evaluation* stage of the HLT, teacher's book, and learner's book were conducted. Activities carried out at the *self-evaluation* stage include looking at typing errors, sentences that are not clear in meaning, and punctuation errors, as well as choosing the right colour and font size. This was followed by the validation stage carried out by five experts, namely, three mathematics lecturers, 1 Indonesian lecturer, and one lecturer in educational technology. In the HLT, the aspects assessed in the validation were content and language aspects. The aspects assessed in the HLT validation were content and language aspects.

Table 1. Average overall HLT validation results

No.	Assessed Aspect	Average	Category
1	Contents	3,52	Very Valid
2	Language	3,39	Valid
	Overall Average	3,45	Valid

Based on the results shown in Table 1, it can be concluded that the HLT is valid and suitable to be tested on students. The HLT on the topic of parallelogram that has been implemented into the teacher's book and learner's book is also validated with the aspects assessed, which are content, language, didactic or presentation, and graphical or display aspects.

Table 2: Average Results of Teacher's Book Validation by Experts

No.	Assessed Aspect	Average	Category
1	Contents	3,52	Very valid
2	Language	3,71	Very valid
3	Didactics / presentation	3,61	Very valid
4	Graphics/display	3,46	Valid
	Overall average	3,58	Very valid

Table 3. Average Results of Learner Book Validation by Experts

No.	Assessed Aspect	Average	Category
1	Contents	3,58	Very valid
2	Language	3,75	Very valid
3	Didactics / presentation	3,50	Very valid
4	Graphics/display	3,42	Valid
	Overall average	3,56	Very valid

The overall validity value of teachers' and learners' books is in the very valid category. Thus, it can be concluded that RME-based teachers' and learners' books can be used.

After all the products are valid*, a one-to-one* or individual test is carried out. The subjects of this activity were three students of class VII MTs N 5 Jambi City with high, medium and low abilities. In this activity, students are asked to try to do the activities in the student book. The implementation of one-to-one communication was carried out to see the obstacles faced by students in finding the concept of the area and perimeter of the parallelogram through RME-based student books. Then, learners are asked to provide feedback on the learner book that has been used in terms of spelling, punctuation, activity instructions, and ease of use.

The revised product based on the results of the one-to-one evaluation was named Prototype 4 and continued at the small group stage. At the small group stage, the evaluation was carried out on six students who were divided into two heterogeneous groups. In the problems in each activity, students are able to understand and find the concept of the area and perimeter of the parallelogram. Furthermore, students are given a practicality questionnaire to see the ease of the student book used.

Table 4. Practicality Results of the Student Book at the Small Group Stage

No.	Assessed Aspect	Average (%)	Category
1	Ease of Use	84,72	Practical
2	Time Efficiency	83,33	Practical
3	Attractiveness	86,11	Very Practical
4	Ease of Understanding	82,3	Practical
5	Benefits	80,83	Practical
	Practicality Score	83,45	Practical

After the small group evaluation is complete, a *field test is* then conducted. The evaluation was carried out by testing the product on one class consisting of 30 heterogeneous learners. This learning begins with a class discussion; students sit in groups of 5 learners. This class discussion not only aims to build and develop student interactivity in accordance with the characteristics of RME but also to stimulate students' basic knowledge of the concept of the area and perimeter of a parallelogram.

Table 5. Practicality Results of the Learner Book at the *Field Test* Stage

No.	Assessed Aspect	Average (%)	Category
1	Ease of Use	92,5	Very Practical
2	Time Efficiency	87,3	Very Practical
3	Attractiveness	82,3	Practical
4	Ease of Understanding	84,5	Practical
5	Benefits	88,3	Very Practical
	Practicality Score	86,9	Very Practical

Table 6: Practicality Results of Teacher's Book

No.	Assessed Aspect	Average (%)	Category
1	Ease of Use	95,8	Very Practical
2	Time Efficiency	84,5	Practical
3	Attractiveness	82,3	Practical
4	Ease of Understanding	88,9	Very Practical
5	Benefits	87,5	Very Practical
	Practicality Score	87,8	Very Practical

From the results of Tables 5 and 6, the student book and teacher book have a practical value with a very practical category. The results of the interview also showed that the instructions and problems presented in the student book were clear overall. Learners also said that the colourful and illustrated design makes students interested in reading and understanding it. Most of the work on student books can be carried out according to the time allocation provided. Thus, the student book used in terms of ease of use, readability, and presentation, as well as the time used, is very practical.

The effectiveness of the HLT on the topic of parallelogram based on RME was seen from the test results of students' mathematical problem-solving ability. The effectiveness test was conducted after the students participated in the small group and field tests. Of the six students who took the

test during the small group, 4 of them completed it with an average score of 81. While the test results during the *field test* with 30 students, on average, obtained a score of 80, and only five people were below the KKM. In accordance with the effectiveness criteria, the RME-based mathematics learning design is effective if the number of students who reach the KKM is more than 65%. Thus, because the number of students who reach the KKM is more than 65%, the *local instructional theory on the* topic of parallelogram based on RME can be effective.

This is in accordance with the research expectation that LIT can improve mathematical problem-solving skills. Research has revealed that learning mathematics through *local instructional theory* based on RME can further improve mathematical abilities (Harnas & Hidayati, 2021). Other research results also show that students can understand the concept of perimeter and area by using RME-based learning trajectories (Simamora, 2021).

CONCLUSION

Based on the results of the research that has been done, it can be concluded that the local instructional theory on the topic of parallelogram based on realistic mathematic education (RME) to improve the mathematical problem-solving skills of students in grade VII MTS, which is implemented into the teacher's book and student book has been valid, practical and effective. Based on the above results, the local instructional theory on the topic of parallelogram learning grade VII SMP/MTs can be used as a guide for teachers in implementing learning to improve students' problem-solving skills.

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