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Development of Realistic Mathematics Learning Devices with Problem Based Learning Models for Teaching Tube Materials

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Abstract: ***This article contains a report on the process and results of development research that aims to describe the steps for developing realistic mathematics learning tools with a Problem Based Learning model to teach Tube material at the junior high school level. The learning tools developed include Learning Implementation Plans (LIP), Student Worksheets (SW), and Learning Outcome Evaluation Instruments (LOEI). The process of developing the learning device was carried out using a 4-D model (Thiagarajan, et al, 1974) which was modified by not applying the Disseminate stage (Trisna, 2006). The assessment of the results of device development is based on Nieveen's (1999) criteria which include Valid, Practical, and Effective criteria.Through the first 2 (two) stages of the 4-D development model, namely the Define and Design stages, a document package has been produced consisting of 3 (three) LIP, 3 (three) SW and 1 (one) LOE instrument called Draft A. -3 of the 4-D model is the Develop stage with the main activities being expert validation and field trials to obtain data about the practicality and effectiveness of the developed device. Validation was carried out 2 (two) rounds because in the first validation, the 3 devices did not meet the valid criteria. The trial was carried out on grade IX students of Tawaang Christian Middle School in 2 (two) rounds because the assessment of practicality and effectiveness aspects in the first round had not reached the criteria. At this stage we get a valid, practical and effective learning tool to teach Tube material for Class IX SMP students.***

Keywords: Development Research, 4-D Model, Learning Tools, Realistic Mathematics Approach, Problem Based Learning Model, Tube Material.

1. Preliminary

Many problems related to the implementation of mathematics learning and student learning outcomes on various topics of mathematics material that occur in various junior high schools in South Minahasa Regency. Problems in the implementation of mathematics learning include student activities, interactions between students, student interactions with teachers, student responses to learning and learning components, all of which have an impact on student learning outcomes. The main problem is that the learning tools that include Learning Implementation Plans (RPP), Student Worksheets (LKS) and Learning Outcomes Evaluation (EHB) instruments used by teachers are less varied and developed without using scientifically tested models and approaches to learning mathematics.The practice of learning mathematics is generally teacher-centered and the teacher dominates the class using the lecture method. The teacher is the source of all information so that in learning students only wait for the final result and completion from the teacher. This reality can be seen from the mathematics learning outcomes of students who are still low and have not reached the minimum completeness criteria (KKM). The learning outcomes of students in question are the results achieved by students on daily tests, mid-semester tests and end-of-semester tests.This is in line with the results of research (Soedjadi, 2001; Marpaung, 2003; Ratumanan, 2003; Jaeng, 2004; Kaluge, 2005) showing that learning mathematics has been centered on teachers and students as objects of learning who carry out activities in completing exercises in accordance with examples provided by the teacher. The learning practiced by the teacher in the classroom has never changed, namely mechanistic learning to achieve instrumental understanding. Students do not have enough time to construct the knowledge they learn in learning mathematics. Concepts and principles in mathematics are given in "finished" form from the teacher to the students without going through the construction process themselves by the students. Learning with the conditions as described above does not make it easier for students to learn the basic objects of mathematics in a meaningful way.

In order to overcome this problem, it is necessary to apply a mathematics learning system that involves the active role of students and brings mathematics lessons closer to everyday life. The learning process by applying approaches in everyday life, is not a new approach but is already known. One of the learning theories that can be applied is learning using a realistic mathematics approach or better known as Realistic Mathematics Education (RME). RME is an approach to learning mathematics developed by Freudenthal in the Netherlands. Gravemeijer (1994) which explains that what can be classified as these activities include problem solving activities, finding problems and organizing the subject matter.It is said that there are three key principles of learning with the RME approach, namely (1) guided reinvention and progressive mathematizing, (2) didactical phenomenology, (3) self-constructed models -developed models. According to Gravemeijer there are 5 (five) steps to the RME learning approach, namely: (1) understanding the problem/context (understanding problem/context), (2) Explaining contextual problems (explaining contextual problems), (3) Solving problems contextual (solving contextual problems), (4) Comparing and discussing answers (comparing and discussing answers), and (5) drawing conclusions (drawing conclusions).Astuti's research (2009) shows that realistic mathematics learning tools

developed to teach Integers have high validity, practicality, and effectiveness values. The study also concluded that the results of field trials of realistic learning approaches can increase student activity so that student learning achievement is better. The results of Sari's research (2016) on learning tools consisting of Syllabus, RPP, LKS, and Learning Outcomes Tests to teach Spatial Building material with a Realistic Mathematics approach show that the Basic Competency Achievement Test and Mathematical Connection Ability Test meet the criteria valid, practical, and effective. Efuansyah and Wahyuni (2018) from the research results show that the quality of teaching materials with a Realistic Mathematics Approach can be seen from the aspects of validity and practicality which are included in good criteria.

Several studies have shown that the Problem-Based Learning (PBL) model can be relied on to support the implementation of the 2013 curriculum, especially for teaching Tube material. Ngalimum (2014) concludes that the studies conducted by Boud, Felleti, and Forgaty show that PBL is a learning approach that involves confronting students with practical problems. In the form of ill-structured, or open ended through a stimulus in learning. Furthermore, it is said that Ward's research shows that PBL is a learning model that involves students to solve a problem through the stages of the scientific method so that students can learn knowledge related to the problem and at the same time have the skills to solve problems.The learning device material for Constructing Curved Side Space with the Problem Based Learning model has been shown to meet valid criteria and practical criteria (Valiant, 2014). The learning steps in the classroom that apply the PBL model follow the syntax as proposed by Kurniasih (2013), namely (1) Providing problem orientation to students, (2) Organizing students for investigations, (3) Conducting investigations, (4) Developing and presenting the work, and (5) Analyze and evaluate the investigation process. The description of the learning steps according to the PBL model with the RME approach can be seen in Table 1.

Table 1: Description of Learning Steps according to PBL Model with RME Approach

Sintaks PBL	Kegiatan Guru dan Siswa	Inklusi Langkah RME
Stage 1. Provide problem orientation to students	Discuss learning objectives	
	Describe the logistical needs for learning, motivate students to be actively involved	
	Explore contextual problems related to learning materials	RME 1st and 2nd steps
Stage 2. Organizing students for investigation	Group students and assist students in defining and organizing learning tasks and investigations to solve problems.	2nd and 3rd steps of RME
	Helping students understand the problem	1st, 2nd and 3rd steps of RME
Stage 3. Investigation	Encouraging students to obtain the right information	
	Carry out investigations and seek explanations for solutions	
Stage 4. Develop and present the work	Helping students plan appropriate and relevant products, such as reports, video recordings, and so on for the purpose of delivering results	1st, 2nd and 3rd steps of RME
Stage 5. Analyze and evaluate the investigation process	Helping students reflect on their investigations and processes	4th and 5th steps of RME
	Give feedback	

The learning steps developed were formulated with reference to the description of the learning steps according to the PBL model with this RME approach.

Developed Learning Tools

Suhadi said learning tools are a number of materials, tools, media, instructions and guidelines that will be used in the learning process. Plomp, Visser and Richey also state the same thing that the development, learning model is said to be good when it meets the criteria of being valid, practical, and effective. Nazarudin (2007), suggests that the learning device is a preparation prepared by the teacher so that the implementation and evaluation of learning can be carried out systematically and obtain the expected results. Learning tools include: effective week analysis, annual program, semester program, syllabus, Learning Implementation Plan (RPP), Student Worksheet (LKS), and Learning Outcome Evaluation Instrument (IEHB).

Middle School Level Tube Material

The basic competencies to be achieved through teaching the Tube material are (1) Making generalizations of the surface area and volume of a cylinder, (2) Solving contextual problems related to the surface area and volume of a cylinder. Related to learning the PBL model with the RME approach, the researcher as the teacher asks students to solve the problems that have been formulated using objects from the student context as shown in Figures 1 and 2 below.

Figure 1: Objects in the student context related to the Tube material

It is hoped that solving such problems will lead students to enter the horizontal mathematization process by thinking about the problems below.

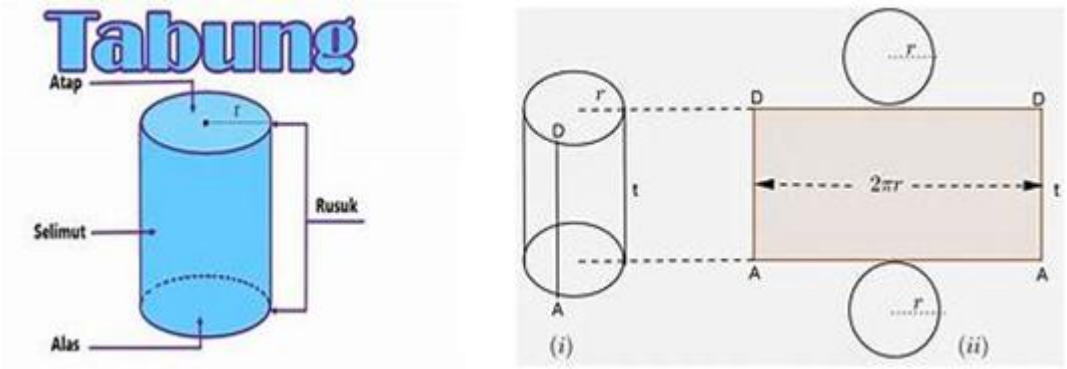

Figure 2: Description of the Tube material and its elements

2. Research Procedure

This development research was carried out based on the 4D model (Thiagarajan, 1974) which consisted of 4 stages, namely (1) Define with Early-Late Analysis activities, Student Analysis, Material Analysis, Task Analysis, and Specification of Learning Objectives, (2) Design with activities Making Initial Design, Selection of Media, Selection of Format and Preparation of Tests, (3) Develop with activities of Expert Assessment and Field Trials, and (4) Disseminate. In this application, modifications were made by eliminating the 4th stage due to limited funds and the author's time. The series of activities in each stage of the development are cyclical, depending on the achievement of the decision criteria (Nieveen, 1999) at each stage. The activity flow chart is shown in Figure 1.The focus of the research is the development of mathematics learning products consisting of Learning Implementation Plans (RPP), Student Worksheets (LKS), and Learning Outcomes Tests (THB) to teach the topic of Tubes for students in grade IX of SMP. The development is based on the Problem Based Learning (PBL) model with a Realistic Mathematics Approach. The measure of the achievement of research objectives is that each tool is valid, practical and effective (Nieveen, 1999). Validity data was obtained through the assessment of experts and practitioners of mathematics education obtained with the Validation Format instrument. Practicality data and effectiveness data were obtained through observation on trial activities and conducting learning outcomes tests and distributing questionnaires to class IX students of Tawaang Christian Middle School in the 2021/2022 academic year.

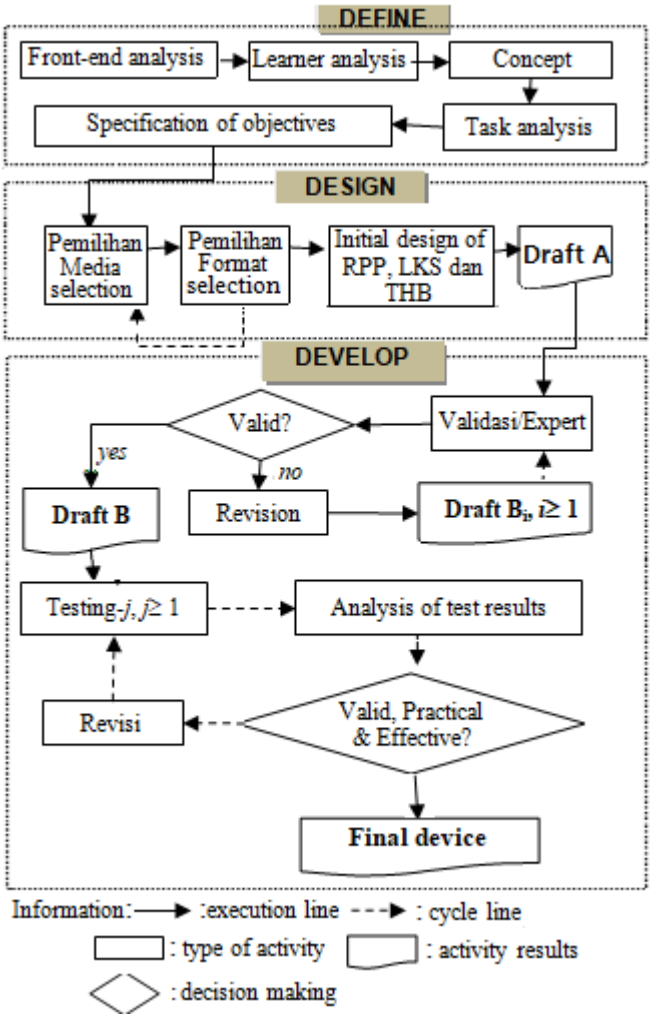

Figure 3: Description of the steps for Developing Learning Tools based on the 4-D model

3. Results and Discussion

Through the first stage of the 4-D Development Model, namely the Define Stage, which includes Early-Late Analysis activities, Student Analysis of test subjects, Tube Material Analysis (Cylinders), Task Analysis, Competency Achievement Indicator Specifications related to the Tube material, a draft A can be designed. learning tools based on the PBL model with a Realistic Mathematics Approach. The design of draft A is carried out through the activities of preparing the evaluation of student learning outcomes on Tube Materials, Selection of Learning Media for Tube materials which are set with a Realistic Mathematics Approach, Selection of RPP Format, LKPD format, EHB format and all of them are set forth as Initial Design or called Draft A Learning Tools.

Furthermore, through the second stage of the 4-D Development Model, namely the Development Stage, Expert Validation is carried out to obtain data on the validity of the Draft A device and a trial is carried out to obtain Practicality and Effectiveness data.

After two expert validations were carried out, a draft B learning device was obtained that met the valid criteria. The following is presented in Figure 4, the results of the assessment of the Validators in the second validation process of the RPP.Furthermore, through the second stage of the 4-D Development Model, namely the Development Stage, Expert Validation is carried out to obtain data on the validity of the Draft A device and a trial is carried out to obtain Practicality and Effectiveness data.After two expert validations were carried out, a draft B learning device was obtained that met the valid criteria. The following is presented in Figure 4, the results of the assessment of the Validators in the second validation process of the RPP.

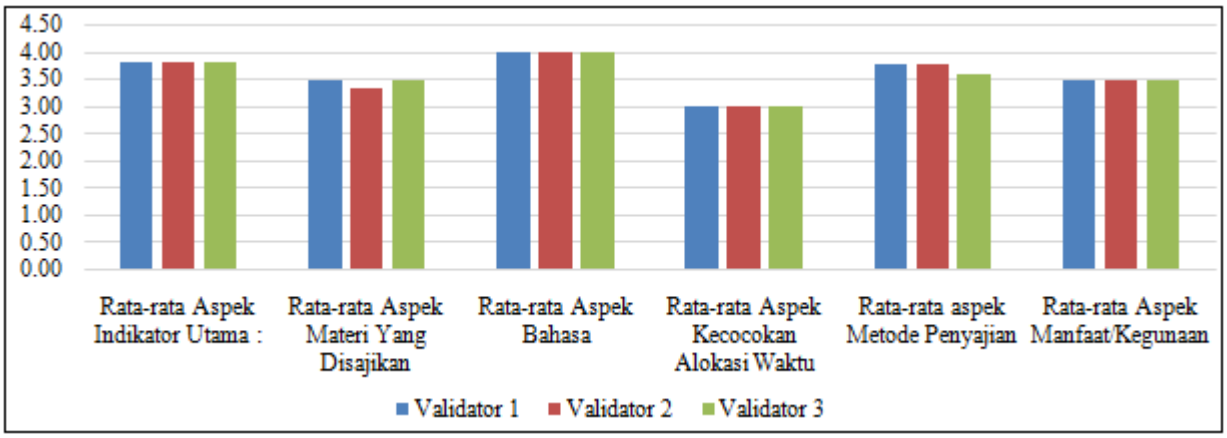

Figure 4: The Average Value of each Assessment Aspect given by the Validators in the second round of Validation of the RPP Draft A . Tool

In Figure 5, the results of the assessment of the LKPD validators in the second round are presented.

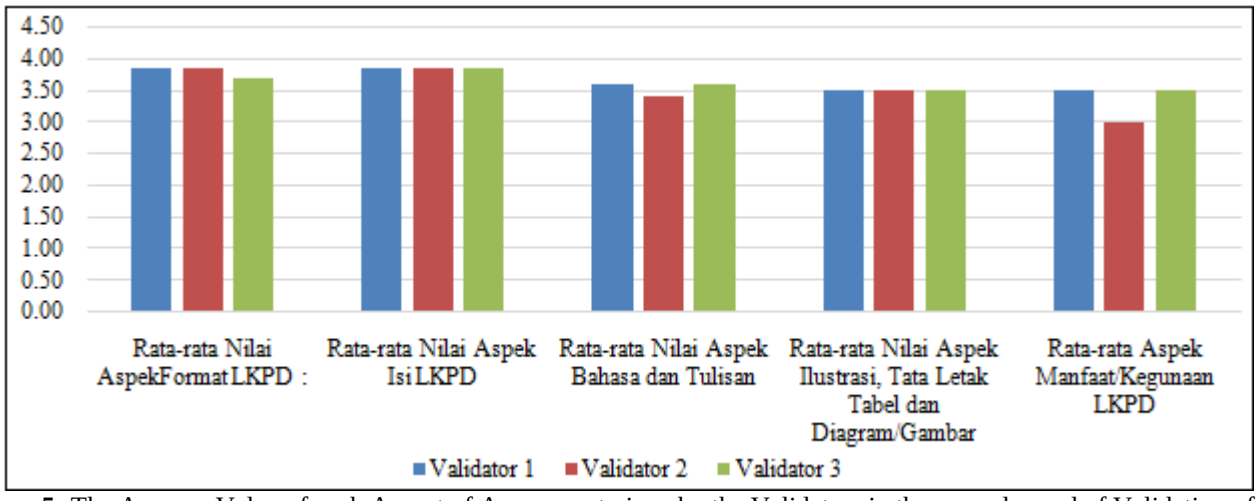

Figure 5: The Average Value of each Aspect of Assessment given by the Validators in the second round of Validation of the LKPD Tool Draft A

Table 2 contains the results of the validators' assessment of the Student Learning Outcome Evaluation instrument as part of the tool developed.

Table 2: Results of the Validation of Learning Outcome Evaluation Instruments

NO. POINT	Contents Validation				Language and Question Writing				Conclusion			
	V	CV	KV	TV	SDP	DP	KDP	TDP	TR	RK	RB	PK
1	3				3				3			
2	3				3				3			
3	3				2	1			3			
4	3				3				3			
5	3				3				3			

Information:

V	: Valid	SDP	: Very understandable	TR	: can be used without revision
CV	: Quite Valid	DP	: Understandable	RK	: can be used with minor revision
KV	: Less Valid	KDP	: Not understandable	RB	: can be used with major revisions
TV	: Invalid	TDP	: Can't understand	PK	: still not usable

The evaluation of the three validators on the components in the EHB is valid for content validity, very understandable for language and question writing, and can be used without revision for the recommendations of this test.

Practicality data was obtained through observing the Teacher's Ability to Manage Learning using the Draft B learning tool. Practicality and Effectiveness indicators could be met after two Trial activities were carried out. Practicality indicators are data on the ability of teachers to manage learning using Draft B learning tools, with the results shown in Figure 3.

The practical aspects of the learning tools developed were assessed using observational data on the teacher's ability to manage learning in the classroom in the 2nd trial. There are 5 (five) main indicators that are observed on the ability of teachers to manage learning which include (1) Preliminary Activities, (2) Core Activities, (3) Closing Activities and (4) Time Management, and (5) Class Atmosphere. Observations were made in 4 (four) learning meetings. The average results of observations of the 5 indicators in three learning meetings, can be seen in Figure-6

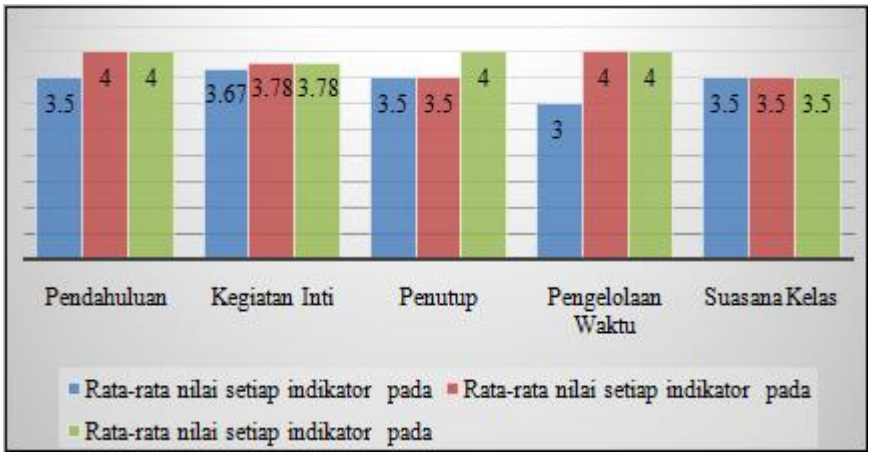

Figure 6: Teacher's Ability to Manage Learning

When consulted with the criteria for the ability of teachers to manage learning, this data shows that the ability of teachers to manage learning is classified as very good so it can be stated that the learning tools used in learning are in the practical category.

Furthermore, effectiveness data is presented which includes student learning outcomes data and student activity data in learning that was captured in the 2nd trial. Data on student learning outcomes on the Tube topic have reached the criteria for completeness, namely from 30 students there are 24 students or 80% which are classified as individual complete criteria.Students' activities observed during learning are categorized into 8 categories, namely (1) Listening/paying attention to teacher explanations actively, (2) Reading/understanding questions/problems, (3) Answering teacher questions or asking the teacher, (4) Solving questions/problems , (5) Comparing answers and discussing in study groups, (6) Presenting/delivering answers, (7) Responding to friends' answers or conveying opinions/ideas/ideas and (8) Writing conclusions/summaries in notebooks. The percentage of time activities carried out by students is shown in Figure 7.

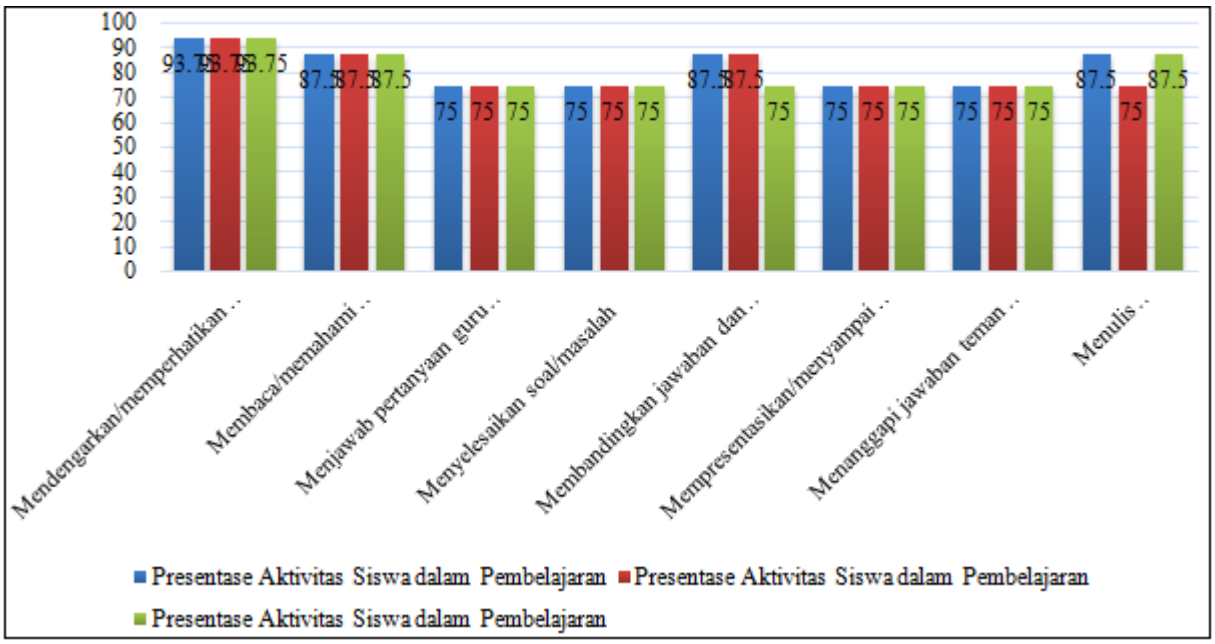

Figure 7: Data Percentage of Student Activity Time in Learning

In general, these data state that the learning tools developed are categorized as effective. These results indicate that students experience the expected learning situation of the PBL model with the RME approach, which seems to be more prominent in the advantages of the PBL model than the disadvantages.

4. Conclusions and Suggestions

Based on the results of research on the development of realistic mathematics learning tools with a Problem Based Learning model on tube material in class IX of Tawaang Christian Middle School and the research objectives and research processes for developing learning devices using a modified 4-D model through 3 stages, namely the stages of defining, designing and developing, the following results were obtained; (a) At the design stage, learning tools are produced in the form of Learning Implementation Plans (RPP), Student Worksheets (LKPD), and Evaluation of Learning Outcomes (EHB).Validation and observation instruments use instruments that have been developed by previous researchers, (b) At the development stage through expert validation and field trials, the results are that the learning tools are suitable for use with necessary revisions. The results of the field trial analysis showed that the validity of the evaluation of learning outcomes was in the high and very high categories, and the reliability of the test was high. And the activities of students during the learning process in the effective category, (c) Learning tools oriented to realistic mathematics learning with a Problem Based Learning model on tube material in class IX of Tawaang Christian Middle School concluded that a learning device in the form of a lesson plan (RPP) has been produced. student worksheets (LKPD) and evaluation of learning outcomes (EHB) from the development of learning tools tested for validity, effectiveness and practicality.

Based on the conclusions and discussion of the research results, the researchers provide several suggestions related to the development of learning tools for realistic mathematics approaches with Problem Based Learning models, namely as follows: (a) The resulting learning tools need to be tested in other schools in order to obtain suitable learning tools. really qualified, (b) It is recommended for further researchers, the development of realistic mathematics learning tools with PBL models needs to be developed on other materials.

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