International Journal of Academic Research and Development
ISSN: 2455-4197; Impact Factor: RJIF 5.22
Received: 07-06-2020; Accepted: 19-06-2020; Published: 08-07-2020
www.academicjournal.in
Volume 5; Issue 4; 2020; Page No. 51-56

Development of problem based instruction learning tools with a realistic mathematical approach to statistics subject

Gabriela Karen Tuuk [1], I Wayan Damai[2], Robby J Wenas[3]
[1] Student of Master Program, Mathematics Education Study Program, Postgraduate Program, Manado State University, Indonesia
[2, 3] Mathematics Education Study Program, Postgraduate Program, Manado State University, Indonesia

Abstract
The purpose of this study is to find out how to develop learning tools using the Problem Based Instruction model with a realistic mathematical approach on the subject of statistics and to produce learning tools using the Problem Based Instruction model with a realistic mathematical approach to the subject of valid, practical, and effective statistics. The sample in this study was taken from students of class VII A, SMP Negeri 10 Manado. The number of students studied was 38 students. In this research the RPP, LKS, and THB models of Problem Based Instruction are developed with a realistic mathematical approach on the subject of statistics. The development model used in this study is a modification of the 4D model. The results of this study stated that the products developed met valid, practical, and effective criteria. Learning devices with an average score of 3.57 with valid criteria. The practicality results of learning tools are obtained from the ability of teachers to manage learning categorized as good which is located in intervals of $3 \leq P < 4$ and student questionnaire responses that are above 80% of students' positive responses. The effectiveness of learning tools obtained from evaluating student learning outcomes that indicate the value of student learning completeness above 70.

Keywords: problem based instruction, realistic mathematical approach, development, learning, statistics

1. Introduction
Mathematics is a subject that can be connected with daily life. One characteristic of mathematics is that it has abstract objects. This abstract nature causes many students to experience difficulties in learning mathematics. There are some students who still find it difficult to solve the problems given by the teacher, so this also results in students' learning outcomes in mathematics being l./ow. The low student learning outcomes can be caused by several factors, namely (1) the material in the textbook is too much and difficult to follow; (2) traditional and non-interactive learning methods (3) ineffective learning media (4) abstract mathematical problem forms (5) students lack understanding of usage for daily life. The low learning outcomes of mathematics that occur in grade 10 Manado Junior High School. There are many difficulties faced by students in learning, including students only tend to be taught to memorize mathematical concepts without understanding. As the authors found in statistical material, where students have difficulty in understanding concepts.
Based on observations made by researchers, most students when studying statistics about determining averages, they will interpret as the sum of all data divided by two. Students interpret the average median because in teaching and learning activities teachers usually only give examples of two data and add them and then divide by two. This results in a misunderstanding of concepts in students. In that observation too, it was seen that the teacher also very rarely relates teaching material to its use in daily life so students are less interested in learning the subject. Also in learning students are less enthusiastic even tend to feel bored with learning because teachers are less able to innovate in utilizing existing learning models and approaches, and making learning tools that are less attractive so that students have difficulty in solving problems and resulting in low student achievement, especially statistical subjects .
To improve the quality of mathematics learning, teachers need to provide opportunities for students to explore their abilities in learning mathematics but still in teacher mentoring. To overcome the above problems, the solution that can be considered is the teacher can prepare and develop appropriate learning through the use of the problem based instruction learning model with a realistic mathematical learning approach that is applied in the development of learning tools in the form of lesson plans, worksheets, THB that are in accordance with the stages of the PBI learning model and PMR approach.
Referring to the background that has been described above and also supported by several theories from experts about PBI learning models and PMR approaches, in this study the researchers wanted to develop a learning tool in this case RPP, LKS, and THB using the Problem Based learning model instruction with the PMR approach on the subject of statistics in class VII SMP Negeri 10 Manado.

2. Research Methods
2.1 Types of research
This research can be classified in the type of research development. As for what will be developed in this study are learning tools and research instruments.

2.2 Development of Learning Devices
The development model that will be used to develop learning tools in this study is a modification of the Thiagarajan (1974) model known as the Four-D Models (4D Model), starting from the defining stage to the development

stage [1].

3. Result and Discussion

This learning tool was developed based on a modified 4-D model, Thiagarajan which initially consisted of four stages but after being modified only produced three stages, namely the define, design, and develop stages. The results of this development are in the form of Learning Implementation Plan (RPP), Student Worksheet (LKS), and Learning Outcomes Test (THB). The steps are as follows.

A. Description of Learning Device Development Results

1. Define Phase

a. Initial to Final Analysis

To overcome the above problems, it is necessary to develop learning tools in the form of RPP, LKS, and THB mathematics in in class VII of SMP Negeri 10 Manado on the subject of statistics more specifically the presentation of data and the size of the concentration of data. With the hope that the development of this learning tool can be a source of learning for students so that they can be active in the learning process and can increase student interest in learning and be a source of reference for mathematics subject teachers.

b. Student Analysis

Grade VII students of SMP Negeri 10 Manado in 2018/2019 academic year, average age 12-13 years, at this age students already have logical thinking skills, but only with concrete objects (Piaget in Hardiyanti 2018). Therefore, it is very appropriate if mathematics learning is carried out with a problem based instruction model with the PMR approach to train students to learn more independently and be actively involved in the learning process [2].

c. Task Analysis

Based on the analysis of the material on the subject matter of statistics, obtained tasks that refer to indicators of competency achievement in K-13. Basic competence on the subject of statistics is to present data in the form of diagrams and analyze data based on data distribution, average values, medians, and modes for drawing conclusions, making decisions, and making predictions. The tasks that refer to indicators of competency achievement are as follows:

1. Gather information about how to present data in the form of diagrams and tables
2. Present data in the form of tables and diagrams and analyze data
3. Find the mean formula, the median of the data
4. Find the mean, median, and mode of the data
5. Specifications of learning objectives

The learning objectives are adjusted to the basic competencies listed in the 2013 curriculum. The specifications of the learning objectives are carried out by describing indicators of achievement of learning outcomes into more specific indicators based on concept or material analysis and task analysis.

1. Students are able to present data in tabular form
2. Students are able to present data in the form of bar charts
3. Students are able to present data in the form of pie charts
4. Students are able to analyze data and make conclusions
5. Students are able to determine the mean, median and mode of the data
6. Students are able to count the number of arithmetic sequences
7. Students are able to solve contextual problems related to mean, median, mode of data.

2. Description of the Results of the Design Stage

a. Media Selection

Media needed in the implementation of learning with problem based instruction models on the subject matter of statistics include Student Activity Sheets, Learning Implementation Plans, and Learning Outcomes Tests as well as several learning aids such as LCDs, whiteboards, markers, rulers, etc.

b. Format Selection

The format of the lesson plan (RPP) is based on the principles, characteristics, and steps of learning with the problem based instruction learning model with the PMR approach that is adapted to the learning plans in the 2013 revised 2017 curriculum. While the learning content refers to the results of the material analysis, the results of the task analysis, and competency achievement indicator specifications. The activities consist of introduction, core activities, and closing. Textbooks for students and worksheets are made so that students are expected to be interested and motivated to learn.

c. Initial Design

At this stage the learning device design is made. The tools compiled are the lesson plans (RPP), student activity sheets (LKS), and learning achievement tests (THB). The planned learning plan is oriented towards the 2013 revised 2017 curriculum using the PMR approach and problem based instruction learning model consisting of core competencies, basic competencies, indicators of competency achievement, learning objectives, learning materials, learning methods, learning media, learning resources, steps learning steps, and assessment.

The lesson plan (RPP), which was compiled as much as 2 meetings and was accompanied by LKS with the following details:

- RPP-1 accompanied by LKS
- RPP-2 accompanied by LKS

3. Description of Results of Development Phase

a. Expert Validation

The results of the development of learning tools from each of these development activities are expert validation and the results of their revisions. Validation by experts is one of the main criteria to determine whether or not a learning device is used. A draft produced is then validated by an expert. The results of expert validation in the form of corrections, criticisms, and suggestions are used as a basis for making revisions and improvements to the learning tools. The revised learning device based on input from the validator and which has been declared valid by the validator is called Draft B.

Table 1: List of Validator Names

No	Validator Name	Occupation/Position
1	Dr. I Wayan Damai, M.Pd, M.Sc	Secretary of Mathematics Education Study Program Postgraduate Program UNIMA
2	Dr. Jhon Robby Wenas, MS	UNIMA Mathematics Lecturer
3	Sonne. J. Engka S.Pd, MM	Principal of SMP Negeri 10 Manado
4	Rini Sumire, S.Pd	Mathematics Teacher of SMP Negeri 10 Manado

The assessment conducted by the validator includes several indicators namely format, content, language or writing, and the benefits of the learning implementation plan. In making revisions, researchers refer to the results of the discussion by following the suggestions and instructions from the validator.

b. Validation Results

1. RPP Validation Results

The assessment conducted by the validator includes the lesson plan format, objectives, prerequisite material, subject matter, assessment, learning activities, language and writing, time allocation, and the benefits or usefulness of the lesson plan. The results of expert validation on the lesson plan (RPP) can be seen in the appendix. In carrying out the revision of the lesson plan, the researcher refers to the results of the discussion by following the suggestions and instructions of the validator. In general, the assessment of experts, learning implementation plans compiled by researchers get validated validity and can be used with a little revision.

2. LKS Validation Results

The assessment conducted by the validator of the worksheet includes: format, content, language and writing, illustrations, layout of tables and diagrams as well as the benefits or usefulness of the worksheet. In making revisions, researchers refer to the results of the discussion by following the suggestions and instructions of the validator.

Based on the results of the assessment that four validators gave ratings of 3 and above, it means that the components in the worksheet received a valid rating. The four validators concluded that the worksheet could be used with a slight revision. Thus the LKS was revised only based on the advice of the validator.

3. Readability Test

Before the trial was conducted, the readability test for Draft B. First, the readability test for Draft B was conducted for 10 VII grade students of SMP Negeri 10 Manado consisting of 3 high ability students, 4 moderate ability students, and 3 low ability students.

4. Simulation

Researchers simulate RPP and LKS. The simulation was followed by 15 students from grade VII of SMP Negeri 10 Manado and partner teachers. This class is not used for test classes. In this simulation, the researcher acts as a teacher with the aim that the partner teacher has an idea of how to implement learning in accordance with the learning tools developed by the researcher. The readability test results of the readability and simulation results were then revised, but in this study the readability and simulation results did not undergo revision.

5. Trial of Learning Devices

The learning device trial aims to improve the learning device before the learning device is used. The trial was held 2 meetings, according to the learning plan, and 2 meetings for pre-test and post-test. The selected class is Class A VII SMP Negeri 10 Manado with 38 students. The trial was also followed by 2 observers who had different tasks. One observer observes student activity and another observer observes the ability of the teacher to manage learning. In this learning activity, students are grouped 5-6 people in one group, consisting of 1 student in the upper group, 3-4 students in the middle group, and 1 student in the lower group. Top, middle, bottom groupings based on previous math test scores and interviews and consultations with the teacher. Thus, it can be said that the average ability of each group is relatively the same. Observation of student activities is carried out on 1 group consisting of 5-6 students consisting of 1 person each representing the top, middle, and bottom groups, for 4 times the implementation of learning. Observations are carried out continuously every four minutes (plus one minute to take notes) throughout the learning process. Data obtained during the trial in the form of student activity data, teacher ability to manage learning data, pre-test data, post-test data, and student response data. This data is analyzed, then the results are used as consideration for revising Draft B to Draft C into a final set.

B. Analysis of the Effectiveness of Learning Tools

1. Analysis of Student Response Questionnaire

Based on data from the student response questionnaire that was filled out by 38 students after participating in class learning for statistical subjects using the problem based instruction model with the PMR approach, the following results were obtained.

Table 2: Student Responses to Learning Activities

No	Rated Aspect	Student Response	
1	How do you feel about:	**Happy**	**Not Happy**
	a. Subject matter	36	2
	b. Student activity sheet	37	1
	c. The atmosphere of learning in class	38	0
	d. The way the teacher teaches	38	0
2	What do you think of:	New	Not New
	a. Subject matter	36	2
	b. Student activity sheet	37	1
	c. The atmosphere of learning in class	38	0
	d. The way the teacher teaches	38	0
3	Are you interested in participating in the next learning activity as you are currently taking part?	Interested	Not Interested
		38	0
4	What do you think about:	Good	Not Good

	a. The language used in LKS and THB	36	2
	b. Appearance (writing, drawing, location of the image) contained in the worksheet and THB	38	0

Based on data from the student response questionnaire that was filled by 38 students after participating in learning activities for statistical subject matter using the problem based instruction model with the PMR approach, it can be said that student responses to all aspects were above 80%. Every aspect was responded positively by students.

2. Analysis of Ability Data from Teachers to Manage Learning

a. Analysis of the Ability of the Teacher Managing Learning

The results of observations of learning processors by teachers during learning activities are presented in the following table.

Table 3: Ability of the Teacher Managing Learning

No	The observed aspect	Meeting to-	
		1	2
1	Preliminary		
	a. Motivate students	4	4
	b. Link today's lesson to the previous lesson	4	4
2	Core activities		
	a. Provide problems related to learning subject matter	3	4
	b. Provide worksheets with problems related to learning subject matter	4	3
	c. Provide guidance to students in solving problems	4	4
	d. Ask a portion of the group pair to present the results of the discussion in front of the class	4	4
	e. Provide opportunities for other group pairs to give responses	4	4
Closing			
3	a. Guide students to make a summary	3	4
	b. Tell the material to be discussed at the next meeting	4	4
	c. Provide an assessment in the form of a test	4	4
4	Time Management		
	Manage time	3	4
5	Class situation:		
	a. Enthusiastic Students	4	4
	b. Enthusiastic Teacher	4	4
Average		3.76	3.91

Based on the criteria, the teacher's ability to manage learning at the first meeting until the second reaches the "Good" category, which is located at an interval of 3.50≤TKG<4.50.

Thus, the ability of the teacher to manage learning has reached a good category, then this learning device does not undergo revision based on observations of the ability to manage learning.

C. Practical Analysis of Learning Devices

1. Analysis of Student Activities

Table 4: Analysis of Student Activities

No	Observation Category	Percentage of Student Activities in Learning Activities (%)		Effectiveness Limitation Criteria (%)
		RPP 1	RPP 2	Average
1	Active listening/paying attention to teacher explanations	13.14	14.24	13.69
2	Read/understand the LKS problem as a group	13.73	15.78	14.75
3	Doing assignments/questions	35.18	36.48	35.83
4	Discuss/ask questions between students and teachers	14.17	15.79	14.98
5	Discuss/ask questions between students and students	15.34	15.66	15.5
6	Behavior that is not relevant to KBM	0.33	0.15	0.24

Observations of student activities during the learning activities take place are observed by an observer. Observations were made on 7 students consisting of 3 upper class people, 2 middle class people, and 2 lower class people.

The results of observations of student activities during learning activities that student activities during learning are within the criteria of effectiveness limits, and it can be said that the activities of students during the learning process are good.

2. Completeness of Student Learning Outcomes

Table 5: THB Completeness Analysis

Number of Students	Number of Students Completed	Percentage of Completions	Number of Students Not Completed	Percentage of Inaction
38	38	100%	0	0%

Based on the table above, it can be seen that the percentage of the number of students who reach completeness is included in the very good criteria with a percentage of 100%. This shows that the learning tools developed are effective in their use in learning activities.

3. Analysis of Learning Outcomes Test Data

THB trial aims to obtain data about the validity of test items, test reliability, and sensitivity of test items that will determine whether the developed test needs to be revised or not. The results of the analysis of the three indicators are as follows.

a. Validity

Based on the product moment correlation formula, the validity of each test item is obtained as follows.

Table 6: Results of Analysis of Test Item Validity

No. Question	r_{xy}	Validity Level	No. Soal	r_{xy}	Validity Level
1	0.617	Valid	4c	0.623	Valid
2	0.614	Valid	4d	0.652	Valid
3	0.735	Valid	5	0.615	Valid
4a	0.624	Valid	6	0.617	Valid
4b	0.614	Valid	7	0.600	Valid

Based on the table above, the level of validity of each test item is in the "high" category. Then all test items can be said to be valid.

b. Reliability

Based on the calculation results, the reliability coefficient α = 0.823 was obtained. From the results obtained, the reliability of the learning achievement test instruments included in the “high” category, and the instruments can be said to be reliable.

Based on the previous description, the learning tool developed is “valid” based on expert validation, “practical” based on the results of the ability of the teacher in managing learning which is categorized as good and the response of students to positive learning seen from the results of student questionnaire responses, and “effective” based on activity analysis students are categorized well and classical learning outcomes are complete.

Thus, a mathematics learning tool has been produced using the problem based instruction learning model with the PMR approach to statistical subject matter in class VII SMP Negeri 10 Manado. The learning tools produced include RPP, LKS, and THB.

4. Discussion

Based on the results of data analysis through the validity test, the reliability was obtained that the learning tools that have been made namely RPP, LKS, and the specific learning outcomes test for statistical subject matter can be developed because it meets these criteria namely valid, practical, and effective.

Thus, the learning tools that have been produced by researchers, namely the mathematics learning device problem based instruction model with the PMR approach meet the valid, practical, and effective criteria for statistical subject matter in class VII SMP Negeri 10 Manado. The resulting learning tools are in the form of lesson plans, worksheets, and learning outcomes tests.

5. Conclusion

1. Mathematics learning tools problem based instruction learning model with PMR approach on statistical subject matter is developed using a 4-D development model that is modified so that it becomes 3 stages: defining, designing, and developing producing learning tools valid which refers to the problem based instruction model and PMR approach. The resulting learning tools include: learning implementation plans, student worksheets, and learning achievement tests.
2. Practical learning tools to teach statistical subject matter using the problem based instruction model with the PMR approach, this is shown from the observation of the ability of the teacher in managing learning and student activities in effective learning.
3. Mathematics learning using the problem based instruction model with the PMR approach to statistical subject matter in class VII SMP Negeri 10 Manado can be said to be effective, this is demonstrated by the ability of the teacher in managing learning as well as student activities.
4. Classical learning completeness in THB shows the percentage of students who complete 85%, students complete individually.
5. Student responses are also in positive learning.

References

1. Thiagarajan S, Semmel DS, Semmel MI. Instructional Development for Training Teachers of Exceptional Children. Indiana:Indiana University Bloomington, 1974.
2. Sujono. Pengajaran Matematika untuk Sekolah Menengah. Jakarta: P2LPTK, 1988.
3. Hasratuddin. Pengembangan Perangkat Pembelajaran Matematika Unit Geometri dengan Pendekatan Realistik di SLTP 6 Medan. Tesis. UNESA, 2002.
4. Hudojo H. Pengembangan Kurikulum dan Pembelajaran Matematika. Malang: Universitas Negeri Malang, 2001.
5. Ratumanan. Model Pembelajaran Menciptakan Proses Belajar Mengajar yang Kreatif dan Efektif. Jakarta: Bumi Aksara, 2002.
6. Tim MKPBM. Jurusan Pendidikan Matematika. Strategi Pembelajaran Kontemporer.Bandung: JICA Universitas Pendidikan Indonesia, 2001.
7. Bakker Arnold B, Leither Michael P. Work Engagement: A Handbook of Essential theory and research. New York: Psicology Press, 2010.
8. Soedjadi. Kiat Pendidikan Matematika di Indonesia. Jakarta: Direktorat Jendral Pendidikan Tinggi Departemen Pendidikan Nasional, 2000.
9. Streefland Leen. Realistic Mathematics Education in Primary School Utrecht: Freudenthal Institute, 1991.
10. Bakan VH. Peran praktek corporate governance sebagai moderating variable dari pengaruh earnings management terhadap nilai perusahaan. Jurnal. Pasca Sarjana Program Ilmu Akuntansi Universitas Indonesia. Jakarta, 2002.
11. Nieveen N. “Prototype to reach product quality. Dlm. van den Akker, J., Branch, R.M., Gustafson, K., Nieveen, N., & Plomp, T.”. Design approaches and tools in educational and training. Dordrecht: Kluwer Academic Publisher, 1999.
12. Dick, Carey. The Sistematic Design of Instruction. Fourth Edition: Harper Collins College Publisher, 1996.
13. Gronlund NE. Constructing Achievement Tests. Third

Edition. London: Prentice-Hall, Inc., Englewood Cliffs, 1982.
14. Yustianingsih R. Pengembangan Perangkat Pembelajaran Matematika Berbasis Problem Based Learning (PBL) Untuk Meningkatkan Kemampuan Pemecahan Masalah Peserta Didik kelas VIII. Jurnal Nasional Pendidikan Matematika. 2017; 1(2):17.