



# Development of fourth grade math teaching materials using the PBL model on student learning outcomes

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## ABSTRACT

This study intends to elaborate on a material as a mathematics learning material with a Problem Based Learning system for 4th grade elementary school children in one of the elementary schools in the city of Medan in order to convey teaching material that will be delivered in learning. Exploration here is a formative test in the form of improvement which will be adjusted to the Four-D form. Judging from the consequences of the assessment of several experts, in particular: material experts, linguists, as well as media experts, it can be seen that factual learning material with a problem-based system meets the standard will be valid normally 0.76. While the results of the examination of the evaluation of the fairness of student educator sheets obtained, the problem-system statistical material met functional standards with a typical score of 95%.

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## INTRODUCTION

Education is something that every human being needs to pay attention to with the increasingly rapid progress of the times in this modern era (Nua et al., 2018). This matter is equivalent to the direction of national education in fact students can develop their abilities so that people of faith are responsible. In this modern era, learning is known as 21st century learning which is included in transitional learning where the curriculum developed guides schools to change the learning approach from one that is teacher-driven to one that is student-centered (Stroobants et al., 2001). This is in line with future demands where students should have the ability to think critically and learn independently. The curriculum plays a role that is very instrumental in the realization of successors, creative, innovative. The curriculum requires learning to think from teaching to learning. The teacher is not only a benchmark for learning, but students also become a benchmark for learning. The teacher's position in the current curriculum is desirable not only to present lessons but also to be able to provide students with all learning activities (Ahid & Chamid, 2021).

Based on this statement, as a teacher we are asked to be able to teach well and interestingly and to be able to design various stages of learning, for example being creative in applying learning

methods, equalizing students' situations and determining appropriate teaching materials for learning. Therefore, it is necessary to improve and improve Mathematics learning, for example interesting and innovative teaching materials so that students are motivated and interested in learning. Thus, educators are expected to be able to teach properly and be able to make educational changes, for example being creative in coordinating learning styles (Barrett, 1998), adapting to student conditions (Forbes-Riley & Litman, 2009; Numonjonov, 2020), and choosing teaching materials that will be very interesting and suitable for learning mathematics (Ellis, 1997; Sukma et al., 2019).

Based on the results of the assessment analysis by the three experts, namely: linguists, materials experts, and media experts, it can be seen that the teaching materials on statistics based on problem-based learning meet the valid criteria with an average score of 0.76. While the results of the analysis of the assessment of the practicality of the teacher and student sheets consisting of 9 people obtained that the teaching material for statistical material based on problem-based learning met practical criteria with an average score of 95%, so it could be concluded that the teaching material for statistical material based on Problem Based Learning met the valid criteria. , practical and can be used in learning, while current research According to the presentation of data analysis with the help of SPSS software, the results obtained are the results of students' KPM analysis at a significance level of  $\alpha = 0.05$  which is 0.000. The initial conclusion of the Anova test according to the significance value of the results for the SPSS output is, if the significance value is  $<0.05$  then  $H_a$  is accepted. Therefore the significance value obtained is  $0.000 < 0.05$ , meaning that  $H_0$  is rejected and  $H_a$  is accepted. So it can be concluded that it has a positive and significant impact on the PBL learning method for increasing students' KPM (Bryant et al., 2017; Koutsoumpis et al., 2022).

The problem will occur in one of the elementary schools, namely the teaching staff will still carry out learning as usual, teaching materials will be used very minimally, as we will see, learning here has become an educator's (teacher's tool.) to move material and can ask questions. - students will have to study questions and assignments, but in fact the demonstration material will be difficult for students to understand because they are unable to understand the intent and meaning of each question will be contained in the demonstration material, then these things can affect the child's findings will not be useful being able to achieve the most extreme educational experience, the teacher is expected to be able to make the experience develop will be able to encourage and activate children in developing experiences (Darling-Hammond, 2020).

To support the improvement of children's mathematics learning outcomes it is very important to get support in a form of learning that will be appropriate and in accordance with what is expected in general. According to (Hanipah & Sumartini, 2021; Hardiyanti et al., 2017) explains that a form of material will be seen as ready to work in terms of children's thinking abilities, namely issue based mastering (Issue Based Learning). Given the description of the foundation above, it is important to do.

Based on the basic description above, it is necessary to develop teaching materials namely "Development of Mathematics Teaching Materials with a Problem Based Learning System for Class V Elementary School children".

## RESEARCH METHODOLOGY

The author elaborates teaching materials using the RnD research method. (Kharisma & Asman, 2018) explained that development research is research that will make products of valid quality and easy to see on KPM and students' study abilities. The author here produces a product that is Mathematics teaching material in a form (PBL) regarding statistical material. The teaching materials here are developed through various steps, namely by using the 4-D development form, namely the 1) definition stage, 2) planning stage, 3) development stage, 4) deployment, but in research the authors limit it to the development stage (Aziz, 2020; Simbolon et al., 2019).

1. Data collection technique

a. Interview

Interviews are used as data collection if the researcher wants to do research first to find the problem that he wants to study, and also if the researcher wants to see things about the respondents that are clearer, and the number of respondents is small or small (S. Sugiyono et al., 2018). techniques for Knowledge of respondents are reported in more detail and the number of respondents is low/minority. According to some of the expert explanations above, it can be concluded that interviews are a technique or method researchers use to obtain information from informants. That information should not be known for us to know. The interview here was carried out by the researcher asking questions to the teacher as well as the child and gathering information as needed by the researcher (Irani, 2019).

- b. Questionnaire (Pardjono et al., 2015) explains that a questionnaire is a data collection technique that will be carried out by observing a question or written statement to the respondent for explanation. In this explanation, it is concluded that a questionnaire or questionnaire is a way that researchers will use to get information from respondents about a kind of question or statement designed at the beginning and then being able to achieve the goals will be determined. The next step after obtaining information from respondents is a way to measure the responses of respondents and students about Mathematics teaching materials which will be designed, and the results of the questionnaire will be in the form of questions and then analyzed using a Likert scale and Guttman scale (Aini et al., 2018; Farooq, 2018).

2. Data analysis technique

Researchers apply quantitative descriptive analysis to manage the data in this study. Descriptive statistics are statistics that will be used to identify data and explain the data that will have been obtained. Based on the opinion (D. Sugiyono, 2013) Descriptive statistics are useful for explaining or assuring an overview of the object to be studied through sample data or population data where it actually is, without carrying out analysis and making conclusions that will apply to the general public. According to this explanation, it is understandable that the statistics here are useful for assuring information so that the data will be obtained by researchers, can be used by other people, will cover adequate analysis, student responses, and assessment of children's responses to teaching materials will be designed forever (Rasmitadila et al., 2020).

a. Arikunto's Validity Test of Teaching Materials

(Rijal & Egok, 2019) states that validity is one measure that will explain the level of validity and validity of an instrument, an instrument is said to be valid if it can measure what will be expected if it can state the data on the variable will be examined clearly. The validity test for the step here is theoretical validity, namely validation will be made against experts in their field. The characteristics that will be validated are language, material, and media, the following validator analyzes the teaching materials that will be made and provides suggestions and input on the design of teaching materials. The assessment paper will show that the data will be used to determine the validity of products such as teaching materials using the PBL form (Lestarani et al., 2023). Validity assessment data were obtained from media expert lecturers, linguists, and material experts,

- 1) Assess the score for each item with very good (4), good (3), not good (2), and very bad (1) answers.

- 2) submission of validity values using the following formula:

$$V = \frac{S}{n(c-1)}$$

Note:  $S = r - lo$

$Lo$  = The validity rating score will be lowest (in this case = 1)

$c$  = The validity rating score will be the highest (in this case = 5)

$r$  = The number will be given by the appraiser 3)

Matching the average validity with the validity criteria of teaching materials in Table 1.

**Table 1.**

Aiken Validity Interpretation's V	
Correlation coefficient	Validity Interpretation
>0.80	Tall
$0.60 \leq V < 0.80$	High enough
$0.40 \leq V < 0.60$	Enough
$0 \leq V < 0.40$	Bad

b. Teaching Material Practicality Test

According to (Rustham et al., 2012) explains that practicality is a requirement for a standard test. The practicality of teaching materials using form (PBL) can be observed in the results of the perception of the practicality questionnaire of children and teachers (Andriyani & Suniasih, 2021). The results of the assessment of children and teachers on efficiency sheets are solved in the following way: 1) Questionnaire for children's responses is given a score for each item in response "Yes" (1) as well "No." (0). Meanwhile, for the teacher's response questionnaire, a score of strongly agree (4), agree (3), disagree (2), strongly disagree (1). 2) The calculation of the value of efficiency according to the formula is:

$$\text{Kindergarten} = \frac{\text{jumlah skor yang diperoleh}}{\text{jumlah skor total}} \times 100\%$$

(1)

**Table 2.**

Criteria for the Practicality of Teaching Materials	
Average score interval	Clarification
81% - 100%	Very Practical
61% - 80%	Practical
41% - 60%	Pretty Practical
21% - 40%	Less Practical
0% - 20%	Impractical

**Table 3.**

Research Design			
Class	Pre-test	Treatment	Post-tets
Experiment	T1	X1	T2
Control	T1	-	T2

Information :

X1 = Teaching in the form of PBL learning

T1 = Value/result of class observation before treatment

T2 = Value/class observation results after treatment

The instrument that will be used to determine children's mathematics learning outcomes is a test. The form of the test that will be applied is an essay test which will consist of 4 questions. In this study, the tests that will be used are the initial test (pre-test) and the final test (post-test).

The data analysis technique that will be applied is by applying the Anova test formula. Before carrying out the test, first calculate the average value and  $S_b$ , then carry out the normality test using the Liliefors test and then the homogeneity test using the F-test.

## RESULTS AND DISCUSSIONS

Seeing the consequences of this exploration, then obtained exam questions as science teaching materials with an Issue Based Learning system that will examine factual material. The demonstration material here is made using a 4-D form of improvement which will consist of characterization, planning, and coaching stages. The discussion in the review here is an overview of the consequences of testing which will be directed at testing the legitimacy and fairness of

Mathematics teaching materials to be made. The stages of the interaction plan for the advancement of mathematics learning materials with the PBL system are as follows:

### **Defining Stage (Define)**

The characterization stage is the investigation stage, the examination stage will be completed by scientists at this stage, including initial investigation, student investigation, assignment examination, idea investigation, and learning objectives investigation. Considering that the main exams will have been completed, then it can be seen that the education plan will be applied to elementary schools, namely the 2013 education program. Then several problems will be experienced in learning mathematics, namely the learning techniques that will be used by elementary school teachers in grade V actually use a traditional framework, experience mathematics will develop still focused on educators (instructor focused), not wearing additional teaching materials. This situation has a bad impact on students, then children will be less dynamic, free and imaginative in learning. Besides that, the problem of mathematics learning material is that it will be difficult for students to understand, therefore the teacher must be able to process and relate it to real problems in everyday life so that children can definitely understand measurement learning material. Then the fifth-grade math books will be worn by educators actually requiring the inclusion of material, not interesting for students to master questions, and questions on broadcast material are difficult for students to understand, then educators are expected to be more imaginative. as well as creative on experience will develop. then at that point, the setting that can be applied is the use of Mathematics learning material with a Problem Based Learning system because this learning material can stand out for children in a presentation that is not tiring and helps children learn effectively material.

### **Design Stage (Design)**

The planning stage is the advanced stage which will consist of 4 stages, namely the readiness of the benchmark reference test, determining the media, selecting the design, and planning the introduction. First of all, it starts at the stage of making reference test references, at this stage the expert makes questions to be applied to presenting material that will relate to material measurements. Questions will be made consisting of training questions by finding which will be given to children and discussed at meetings or conversations. Individual task questions as fields and descriptions by seeking answers to individual questions. Followed by the next stage, namely determining the media, at this stage the researcher chooses teaching materials as the media to be used to work by explaining learning materials to students.

### **Development Stage (Develop)**

The implementation in the advanced stage here is agreeing on the broadcast material by experts followed by corrections and coordination, small group introductions, as well as the teacher's fairness test to determine the common sense of the broadcast material to be made. The discussion of legitimacy mechanisms and common sense is as follows:

#### **a. The Validity of PBL-System Mathematics Teaching Materials**

Arithmetic teaching materials will be prepared and explained by 3 experts in their fields, namely etymologists, materials experts, and media experts. Approval to provide evaluation and further input for Mathematics learning materials with an Issue Based Learning System will have been planned, as a result of this agreement there are still many deficiencies in presenting the material to be made. Updates are carried out in accordance with the information and ideas of experts who have agreed that Mathematics demonstration material will be made, starting with learning material on demonstration material, syntax and composition, image format, tone or activity will be applied, questions will be subject to learning assessments, and presenting material in view Issue Based Learning. Even though there are still deficiencies in the mathematics teaching material that will have been made reviewed on Issue Based Learning, the validator is of the opinion that the mathematics

teaching material on statistics material that has been planned in general is very important to be worn in class V SD because it contains material. planned to use the Issue Based Learning form of learning and arranged deliberately and compactly. Given the results of the evaluation of the validity of the demonstration material by the statistical material experts with the Issue Based Learning system, things here get a very good reaction, seen in the results of the validator's evaluation of the Mathematics demonstration material with the Issue Based Learning system which will be ranked high enough or equivalent to be valid, and allows for use tried with several upgrades according to the information and ideas of the three validator experts.

b. Linguist

The results of the etymologist's evaluation were examined using the Aiken's V equation to determine the validity of the problem-based mathematics learning material for fifth grade elementary school children in statistics lessons to be collected and made. The results of the agreement will have been described using the V Aiken equation presented as Table 4 which will be arranged based on the angles to be surveyed.

**Table 4.**  
Results of Validation Analysis of Linguists wearing Aiken'V

Aspects will be assessed	Rating indicators	Many grains	Aiken figure's V	Aiken' coefficient criteria
Language Eligibility	straightforward	3	0.7	High enough
	communicative	1	0.7	High enough
	Dialogic and interactive	1	0.7	High enough
	Developmental suitability of participants	3	0.7	High enough

c. Material Expert

The results of the validation will have been analyzed using the Aiken formula. The following s V's are presented in Table 5 and will be sorted according to the aspect to be assessed.

**Table 5.**  
Results of Material Expert Validation Analysis wearing Aiken's V

Aspects will be assessed	Rating indicators	Many grains	Aiken figure's v	Aiken coefficient criteria's v
Content eligibility	KD suitability of the material	3	0.8	Tall
	Material accuracy	4	0.85	Tall
	Material update	2	1	Tall
	Encourage curiosity	2	0.85	Tall
Feasibility aspect	Serving technique	1	0.7	High enough
	Presentation support	4	0.85	Tall
Presentation	Presentation of learning	1	0.87	High enough
Aspects of Problem Based Learning assessment	Truth content or material	3	0.8	Tall
	Material systematic disorder	2	0.85	Tall
V average			0.82	Tall

d. Media Expert

Regarding the validation results after being analyzed using the Aiken formula. The followings V's are presented in Table 6 which will be made based on the aspects to be assessed.

**Table 6.**  
Results of Media Expert Validation Analysis wearing Aiken's V

Aspects will be assessed	Rating indicators	Many grains	Aiken figure's V	Aiken coefficient criteria's V
Graphical feasibility	Material size	2	1	Tall
	Cover design for teaching materials (cover)	7	0.64	High enough
	Teaching material design	18	0.7	High enough
V average			0.78	Tall

e. Results of All Teaching Materials Practicality Analysis

Judging from the general reasonableness assessment of teaching materials, educators and children will try out the material shown above, then it shows that statistical material in the Problem System Learning Framework for class V SD in statistical material will have been collected and sent to obtain a typical score. 95% in form will be very functional. It can be assumed that Mathematics learning materials based on Problem System Learning for fifth grade elementary school students regarding statistics can be considered very appropriate to be applied to educational experiences. Summary of the results of the general fairness assessment of the instructor.

**Table 7.**  
Results of Analysis of Student Posttest-Pretest Difference Data Normality Test

Class		Test of Normality					
		Kolmogorov-Smirnov			Shapiro-Wilk		
Difference	Value	Statistics	df	Sig	Statistics	Df	Sig
Experiment		.108	24	.200	979	24	.886
Control		.093	27	.200	987	27	.973

Based on the table above, it explains that the value of importance (p esteem) in the Shapiro-Wilk test shows a value of 0.886 for the exploration class and 0.973 for the control class. Each has a value of  $> 0.05$  and then tends to be presented, so the difference in information on the exploration class and the control class is usually conveyed.

However, if observed in the Lilliefors test, the table above explains that the p esteem in the experimental class and control class information is 0.200. General information has a value of  $> 0.05$  and then tends to be stated, so posttest and pretest differentiating information for both the trial class and the control class are scattered regularly. because all information is normally circulated, the Anova test conditions are met.

Table 8 Results of Analysis of Student's Posttest-Pretest Difference Data Homogeneity Test

Based on the table above, the importance value (p esteem) was obtained for posttest-pretest differentiating information for the trial and control classes of 0.449. because the information holds an importance value of  $> 0.05$ , the information is considered homogeneous.

**Table 8.**  
Results of Hypothesis Testing Analysis of Students' Posttest-Pretest Difference Data

	ANOVA				
	Sum of squares	Df	Mean square	F	Sig
Between groups	1192,417	1	1192,417	38,851	000
Within groups	1503906	49	30,692		
Total	2696324	50			

Looking at the results table above, it can be seen that the importance value is 0.000. The reason for the dynamics of the F test is that the importance value in the SPSS output is if the importance value is  $< 0.05$  then  $H_0$  is acknowledged. because the importance value is  $0.000 < 0.05$ , then it tends to be suspected that the PBL learning model really has an impact on increasing students' numerical critical thinking skills. In addition, from the results table it can also be noted the value  $F_{hitung}$  is 38,851. When seen in the F dissemination table with an importance level of 0.05 and  $df_1 = 1$  and  $df_2 = 49$  then the value  $F_{tabel}$  is 4.04. The reason for dynamic use on the F test is considering the value  $F_{hitung}$  as well as  $F_{tabel}$  that is, if the value  $F_{hitung} > F_{tabel}$ ,  $H_0$  is recognized and  $H_0$  is removed. because of value  $F_{hitung} > F_{tabel}$  is  $38.851 > 4.04$ , then it tends to be argued that this form of PBL learning has proven to have an impact on improving students' numerical critical thinking skills.

The exam will be directed at Minurul Fadhillah Medan here covering two classes, namely the exploration class and the control class. Before the teaching learning will be different for the two classes, a pretest is first carried out to determine students' basic abilities. on the results of the pretest, the average score of the trial class was 58.23 and the control class was 57.59. The typical capacity of children's numerical critical thinking is called low. According to the results of the class pretest tested, then a normality test and homogeneity test were made, the results obtained were that the two classes were regularly distributed, homogeneous, and the ability to underlie the two classes was not too unique.

After knowing the basic abilities of students, learning will be different for the two classes. The exploratory class was given treatment in the form of Issue learning (PBL) and the control class was given treatment in the form of traditional learning. An important difference in the form of Issue Based Learning (PBL) in the traditional form of learning is that Issue Based Learning (PBL) has existed before in which giving issues will be expected to be able to prepare students' critical thinking skills. Meanwhile, in direct learning, the child is only given a description of the learning material by the educator, then the child completes the evaluation item which will be given.

After the lesson is over, the final ability test or posttest is carried out to determine the extent of the child's numerical critical thinking skills in that class. on the results of the posttest, the typical value of the exploration class was 87.92 and that of the control class was 77.59. Then, at that time, oddness and homogeneity tests have been completed and observed so that the information for the two classes is regularly consistent and homogeneous. This means that the two classes are able to greet the entire fifth grade of elementary school. If it is known, then the two classes are evenly distributed and homogeneous, then a speculative test is carried out on the children's critical numerical ability to think using the ANOVA test.

After decoding the posttest-pretest contrast information with the help of the SPSS program, it turns out that the results of the numerical critical thinking skills test at the importance level  $\alpha = 0.05$  are 0.000. The reason for the dynamics of the Anova test (Test F) according to the importance value of the SPSS output is, if the importance value is  $< 0.05$  then  $H_0$  is recognized as well  $H_0$  is rejected. because the value of interest that will be obtained is  $0.000 < 0.05$ , then at that time  $H_0$  is acknowledged. thus it can be suspected that there is a critical impact on the Issue learning form (PBL) on students' numerical critical thinking skills. in order to strengthen the side effects in this review, experts compared the research here and some of the results of previous studies that would be relevant to this study. Attached is presenting the results of past inspections relating to this exploration.

The study will be exploratory related to be directed by experts, namely the findings will find that the increase in children's numerical critical thinking skills will be educated in a form of PBL learning higher than humans will be educated in ordinary learning. Looking at the test results, the normal posttest score for control class children was 68.10 with the highest score being 85 and the least 47. While the normal posttest score for exploration class children was 76.94 with the highest score being 90 and the least 55. This shows that the ability to think critically, children will learn in a

problem-based learning manner that is superior to the critical thinking skills of children who will learn in an ordinary learning manner.

Then in the test it was found that science learning in the form of issue-based gain is said to be interesting when viewed in terms of numerical critical thinking skills. Looking at the final exam results, the normal value of the numerical critical thinking skills test in the problem-based learning model was 88.22. While the typical value of the numerical critical thinking skills test in the regular form is 76.38.

Considering the results of testing the increase in related issues learning statistics material in terms of statistics for grade V SD, the objectives can be drawn, among others: to the statistics material. The impact of this review was predictable, so that the statistics material depended on Issue Based Learning for fifth grade elementary school students about statistics. Exploration here is guided by using the Four-D (4-D) improvement form which will be arranged into 4 phases including the characterize, plan, create, and spread stages, namely the characterize, plan (planning), and develop (create) stages. At the characterizing stage, there are several stages that will be carried out, namely initial examination, student examination, task investigation, examination of ideas, and setting learning goals. Then in the planning step the things to be implemented are readiness of reference tests related to the results of assignments and ideas exams, selection of media through the presentation of material to achieve learning targets, selection of organizations, initial planning of learning devices and assembling instruments to measure the nature of the material will show the material will consist of master surveys and teacher and student practice sheets. The master poll is used to measure.

Looking at the results of checking information with the help of the SPSS program, it is known that the results of examining children's numerical critical thinking skills at the level of importance  $\alpha = 0.05$  is 0.000. The reason for the dynamics in the Anova test according to the importance value in the SPSS results is, if the importance value is  $<0.05$  then  $H_a$  is recognized. because the value of interest to be obtained is  $0.000 < 0.05$ , meaning that  $H_0$  is rejected, and  $H_a$  is recognized. then it tends to be suspected that there is a positive and critical influence of PBL learning forms for improving students' numerical critical thinking skills.

## CONCLUSION

Drawing from the author's data on the creation of instructional resources centered on problem-based learning (PBL) mathematics material for fourth-grade students in primary schools. The present study can assert that it generates pedagogical resources in the form of problem-based learning (PBL) incorporating statistical content. The present study's findings suggest that utilizing problem-based learning (PBL) as a framework for developing mathematics teaching materials can be effective for enhancing fifth-grade elementary school students' understanding of statistics. The author employs the 4D development model, which comprises four distinct stages, namely definition, design, development, and dissemination. The data analysis presentation utilizing SPSS software indicates that the KPM analysis of students yielded results at a significance level of  $\alpha = 0.05$ , resulting in a value of 0.000. Based on the SPSS output, the Anova test's preliminary inference is that  $H_a$  is accepted when the significance value is less than 0.05. The obtained significance value of 0.000 is less than the predetermined alpha level of 0.05, leading to the rejection of the null hypothesis ( $H_0$ ) and acceptance of the alternative hypothesis ( $H_a$ ). In conclusion, the utilization of the problem-based learning (PBL) approach has been found to have a noteworthy and favorable effect on enhancing students' knowledge, skills, and attitudes (KSAs), particularly in relation to the key performance measures (KPMs).

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