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Development of Learning Tools with Didactic Situation Design to Improve Student Learning Outcomes

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ABSTRACT: This study aims to develop learning tools consisting of teaching modules, student worksheets (LKPD), and learning outcome tests using a *problem-based learning* model with valid, practical, and effective didactic situations. This study is a development study using Thiagarajan's 4D development model. Data collection techniques used include observation of the implementation of learning tools, student observation, student test results, and student response questionnaires. The research subjects consisted of 31 students in the trial class, 31 students in the experimental class, and 31 students in the control class. The findings from this study are that the learning tools developed are valid, practical, and effective. Validity was obtained from the validity coefficients of the teaching modules, student worksheets, and numeracy test questions, which were 4.66, 4.50, and 4.29, respectively. The practicality criteria were obtained from the results of a practicality analysis based on observations of the implementation of the learning tools, student observations, and student response questionnaires, which were 91.1% in the very good category, 89% in the good category, and 90.04% in the very positive category, respectively. The effectiveness criteria were based on the results of the learning outcome test analysis, which obtained 83.87% with an average N-Gain score increase of 0.73 in the very high category. Another finding from this study is that the learning tools developed had a significant effect on improving student learning outcomes, as shown by the average N-Gain score of the experimental class of 0.77 in the high category and the average N-Gain score of the control class of 0.65 in the moderate category. Based on statistical tests in both classes, it was found that the N-Gain scores of the experimental class and the control class obtained Sig. (2-tailed) = 0.01 (sig <0.05) and the *pretest* and *posttest* scores of the experimental class and the control class based on statistical tests obtained Sig. (2-tailed) = 0.016 (sig <0.05). This indicates that the application of the *problem-based learning* model with didactic situations to improve student learning outcomes has a significant effect.

KEYWORDS: Didactic situations, Learning tools, problem-based learning.

INTRODUCTION

Currently in Indonesia, the state of education remains unstable in the aftermath of the pandemic. The government has established a new curriculum, known as the Merdeka Curriculum, which is considered an improvement on the previous curriculum. In this curriculum, students face many learning obstacles in understanding the applied learning. Obstacles in the didactic situation or learning obstacles experienced by students include difficulty understanding concepts and questions, difficulty calculating, difficulty solving problems, lack of motivation, and fear of mathematics. The obstacles experienced by students, as described in the research entitled " (The Effect of the Merdeka Curriculum on Junior High School Students' Learning Outcomes in Mathematics) by, related to the didactic obstacles of junior high school students in solving geometry problems include the lack of emphasis by teachers on basic geometry concepts in the learning process, the presentation of an inappropriate learning sequence , and the lack of teaching aids used in understanding geometric objects, resulting in students still experiencing difficulties.

Some of the obstacles experienced by students can be caused by internal or external factors. The results of the analysis conducted by Maharani *et al*. (2022) in their research related to learning obstacles in junior high school students, the internal factors that influence include (1) *ontogenic obstacles* in the form of dislike, lack of interest in subjects, lack of conceptual understanding so that students have difficulty in understanding concepts, (2) *epistemological obstacles*, where students solve problems based on their own beliefs without analysis and reasoning, and (3) *didactic obstacles*, where learning conditions are not yet in line with the characteristics of students. The characteristics of students in the learning process are very important because each child has different characteristics, so teachers must know and understand the characteristics of students so that the learning process can be accepted by students (Estari, 2020). Barung *et al*. (2024) mention that other internal factors that influence student obstacles are emotional

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intelligence and motivation because they affect student learning activities. If emotional intelligence and intellectual intelligence in learning activities are high, students can achieve good learning outcomes (Utami *et* al., 2020). Rahmi *et* al. (2021) regarding the influence of learning motivation and learning independence through cooperative learning such as TPSQ has a positive influence of 33.5% on the ability to understand concepts, so that learning motivation can influence the improvement of student learning outcomes (Nurrawi *et* al., 2023).

In line with this, the results of research by show that there is a positive relationship between learning motivation and mathematics learning outcomes. In contrast to internal factors, Ayu *et al*. (2021) mentions external factors that influence students' learning difficulties, including a lack of parental attention to students' learning activities, an unfavorable learning environment, and the influence of mass media, which causes most students to be lazy in their learning activities. One solution to the obstacles experienced by students is to develop learning tools with a didactic situation design. Didactic situation design, as indicated by Fuadiah (2021) regarding the application of *the Theory of Didactical Situation* (TDS) in mathematics learning, can be developed during learning with the teacher as a facilitator and students as activators. Didactic situation design can be used as an alternative solution in overcoming the obstacles experienced by students. This is in line with the results of research by Riastuti & Suryadi (2023) regarding didactic design on the properties of triangles based on Van Hiele's geometric thinking levels in seventh-grade students at MTs Negeri 1 Majalengka, which found that didactic situation design can minimize learning obstacles, as shown by an increase in mathematical understanding and thinking levels of 57%. Therefore, research will be conducted on the design of didactic situations to improve the learning outcomes of eighth-grade students at SMP Negeri 10 Jember by providing learning tools.

Based on interviews with eighth-grade mathematics teachers at SMP Negeri 10 Jember, it was found that most eighth-grade students experience learning difficulties caused by several internal and external factors. These factors include students' fear of mathematics, lack of interest and motivation in learning mathematics, students' difficulty in understanding concepts and solving problems, and the use of conventional learning methods. Prameswara & Pius X (2023) argue that the frequent use of conventional learning methods can make students bored with learning. Therefore, the research will use a problem-based learning (PBL) model. The combination of didactic situation design in the PBL learning model is expected to overcome student obstacles, because PBL learning involves student activity in critical, creative, and mathematical thinking. Didactic situation design combined with learning strategies can be a challenge for students (Hortelano & Prudente, 2024). Fitriani *et al*. (2023) conducted research on the design of didactic situations using a realistic mathematics approach, proving that the design of didactic situations can reduce student barriers. These findings are in line with the findings of regarding the design of didactic situations, where the developed didactic situation design can improve and overcome students' low mathematical reflective thinking skills.

RESEARCH METHOD

This study used development research using Thiagarajan's 4D model. The 4D development model consists of four stages, namely *the* definition stage, the *design* stage, the *development* stage, and *the* dissemination stage. SMP Negeri 10 Jember was chosen as the location for the development research because it had never previously implemented PBL learning tools with the didactic situations used in schools to overcome student obstacles and improve student learning outcomes. The research subjects consisted of 31 students in the test class, 31 students in the experimental class, and 31 students in the control class.

The research products developed were teaching modules, student worksheets (LKPD), and student learning outcome tests. The learning model used was PBL with didactic situations in the teaching modules and LKPD. The research instruments used in this study included observation sheets on the implementation of learning tools, student observation sheets, and student response questionnaires. The 4D model development stage begins with the definition stage. The definition stage aims to define the requirements needed in developing learning tools. The next stage is the design stage, which aims to design learning tools that include teaching modules, student worksheets (LKPD), and learning outcome test questions. The next stage is the development stage, which produces *a draft* that has been revised based on the suggestions and input of validators. The final stage of the 4D development model is the dissemination stage. The dissemination stage aims to disseminate the results of the development of learning tools that are valid, practical, and effective.

To determine the quality of learning tools, an analysis is required to meet the criteria of validity, practicality, and effectiveness. The validity criteria are based on the validity analysis obtained from the results of the validation analysis by experts consisting of two lecturers from the Mathematics Education Study Program, FKIP, University of Jember, and one mathematics

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teacher from SMP Negeri 10 Jember. The validity of the learning tools is based on Table 1 as follows.

Table 1. Validity Criteria

Value (Va)	Category
$Va = 5$	Highly Valid
$4 \leq Va < 5$	Valid
$3 \leq Va < 4$	Sufficiently Valid
$2 \leq Va < 3$	Less Valid
$1 \leq Va < 2$	Not Valid

The next data analysis is practicality analysis, which is used to determine the level of practicality obtained from the data resulting from observations of the implementation of learning tools, student observations, and student response questionnaires. The practical criteria for learning tools are based on Table 2 as follows.

Table 2. Practicality Criteria

Score	Category
$90\% \leq SR \leq 100\%$	Very Good
$80\% \leq SR < 90\%$	Good
$70\% \leq SR < 80\%$	Fair
$40\% \leq SR < 70\%$	Poor
$0\% \leq SR < 40\%$	Very Poor

The effectiveness analysis is based on student learning test results. The learning tools meet the effectiveness criteria if t he learning outcome completeness is ≥75%, the average increase in learning test results based on N-Gain is categorized as high, and statistical tests show that the application of learning tools has an effect on improving student learning outcomes.

RESULT & DISCUSSION

A. Definition

At the definition stage, five things are carried out, consisting of initial-final analysis, student analysis, concept analysis, task analysis, and learning objective specifications. At this stage, problems in the learning process are identified, including conventional learning methods such as lectures and students still experiencing obstacles in learning. Therefore, it is necessary to develop learning tools that are appropriate for the problems encountered. The learning tools produced will be tailored to the means of achieving the learning outcomes and learning objectives of phase D.

B. Design

The activities carried out at this stage include test preparation, media selection, format selection, and initial design of learning tools. At this stage, the design of learning tools uses the Pythagorean theorem material using the PBL learning model. The teaching module and student worksheet designs are tailored to the steps of the PBL learning model used during three meetings. Examples of the teaching module design, student worksheets, and learning outcome test questions are presented in Figure 1, Figure 2, and Figure 3.

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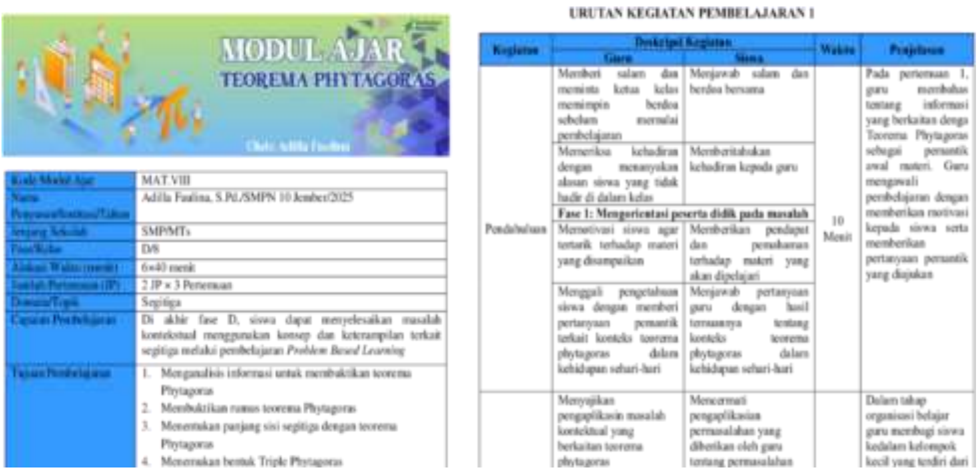

Figure 1. Teaching Module

Figure 2. Student Worksheet

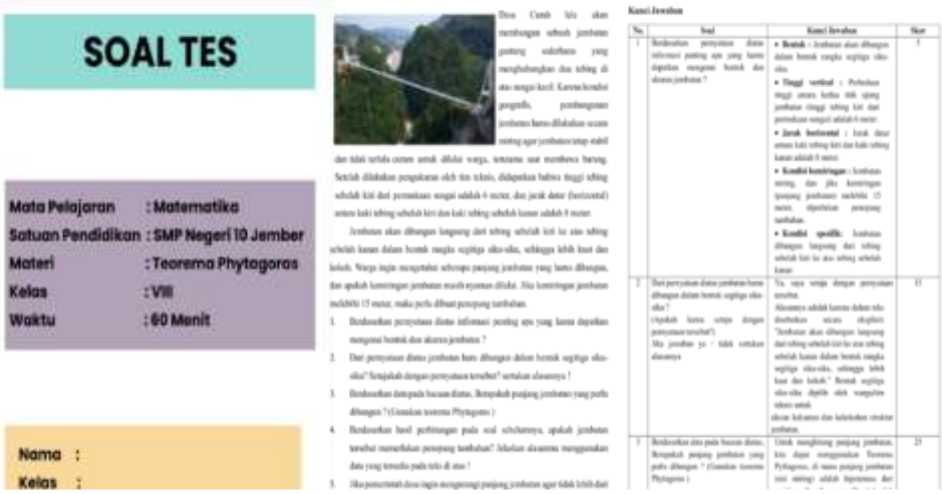

Figure 3. Test Questions

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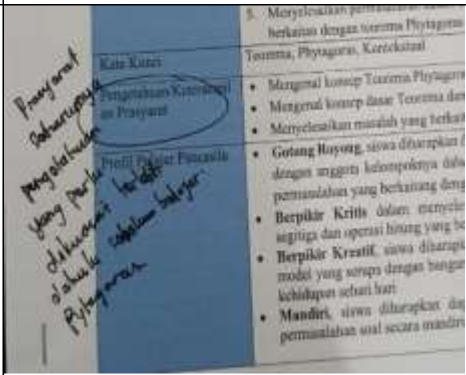
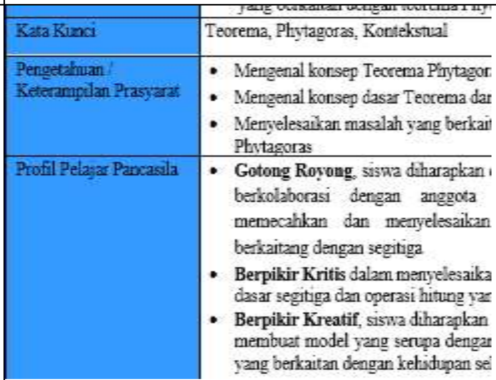
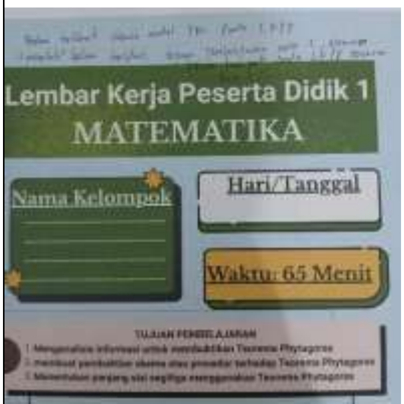
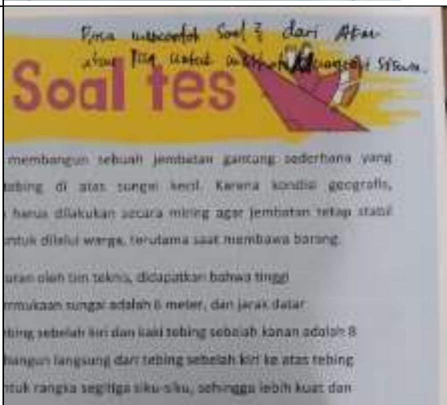
C. Develop

The learning device design that was developed was then validated by experts to obtain suggestions and input for improvements so that it could be tested on students. The suggestions and input from the validators are presented in Table 3.

Table 3. Validators' Suggestions and Feedback

No	Learning Tools	Before Revition	After Revition
1	Teaching Module		
2	Student Worksheet		
3	Test Question		 Desa Curah lele akan membangun sebuah jembatan gantung sederhana yang menghubungkan dua tebing di atas sungai kecil. Karena kondisi geografis, pembangunan jembatan harus dilakukan secara miring agar jembatan tetap stabil dan tidak terlalu curam untuk dilalui warga, terutama saat membawa barang. Setelah dilakukan pengukuran oleh tim teknis, didapatkan bahwa tinggi tebing sebelah kiri dari permukaan sungai adalah 6 meter, dan jarak datar (horizontal) antara kaki tebing sebelah kiri dan kaki tebing sebelah kanan adalah 8 meter. Jembatan akan dibangun langsung dari tebing sebelah kiri ke atas tebing sebelah kanan dalam bentuk rangka segitiga siku-siku, sehingga lebih kuat dan kokoh. Warga ingin mengetahui seberapa panjang jembatan yang harus dibangun.

Based on the analysis of the validation data for the teaching module, LKPD, and numeracy test questions, the respective scores were 4.46, 4.50, and 4.29. This shows that the validity coefficient (Va) was $4 \leq Va < 5$, which is considered valid. The validation results are presented in Table 4 as follows.

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Table 4. Validity Coefficients of Learning Instruments

No	Learning Tools	Va	Criteria
1	Teaching module	4,46	Valid
2	Student worksheet	4,50	Valid
3	Test question	4,29	Valid

After the learning tools were declared valid, they were then tested in class VIII F as a test class. The testing was conducted over three meetings, with tests administered at the beginning and end of each meeting. Based on the test results, the learning tools were deemed practical and effective. The practicality indicator was based on the results of observations of the implementation of the learning tools, observations of student activities, and student response questionnaires. The data on the practicality test results of the learning tools for the first indicator are presented in Figure 4.

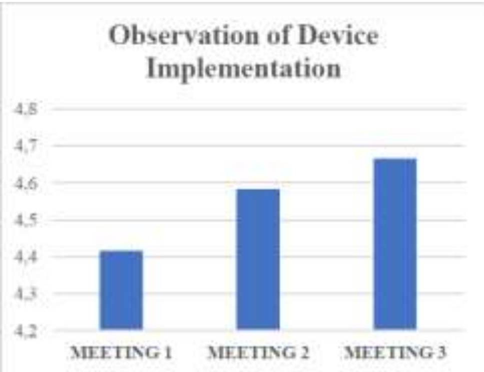

Figure 4. Diagram of the implementation of the learning tool

Figure 4 shows an average of 91.07% and is in the range of 90%≤*SR* ≤100% with a very good category. The second indicator of practicality is based on the results of student observation analysis presented in Table 5.

Table 5. Observation of student activities

Meeting	Group						Average Meeting	Total Average
	1	2	3	4	5	6		
1	94%	92%	78%	84%	82%	76%	84%	89%
2	96%	96%	88%	90%	92%	80%	90%	
3	94%	96%	90%	94%	94%	86%	92%	
Average	95%	95%	85%	89%	89%	81%		
Category	Very Good	Very Good	Good	Good	Good	Good		Good
Criteria								Practical

Based on Table 5 above, the average score was 89% and fell within the range of 80%≤*SR* ≤90%, which is categorized as good. The third indicator of practicality related to the student response questionnaire showed that 90.04% of students responded well to the learning process. From the three indicators of practicality, it can be said that the learning tools were practical for use in learning activities. The next analysis is the analysis of the effectiveness of learning tools based on student test results. The learning

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achievement of 26 out of 31 students with an average score of 81.96 obtained a classical mastery of 83.87%. The effect of the learning tool " " is based on the *post-test* scores of the experimental class and the control class through statistical tests presented in Table 6.

Table 6. *Post-Test* Scores of The Experimental Class and The Control Class

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PRETES	Equal variances assumed	.656	.421	2.471	60	.016	4.548	1.841	.866	8.230
	Equal variances not assumed			2.471	59.633	.016	4.548	1.841	.866	8.231
POSTES	Equal variances assumed	.107	.745	3.445	60	.001	9.323	2.706	3.909	14.736
	Equal variances not assumed			3.445	59.873	.001	9.323	2.706	3.909	14.736

Based on Table 6 above, the Sig. (2-tailed) value obtained is 0.016 (Sig.< 0.05). This indicates that the developed learning tools are effective because students' numeracy skills are complete in a classical manner. Thus, the teaching modules, student worksheets, and learning outcome test questions are declared valid, practical, and effective.

D. Disseminate

The final step was to distribute teaching modules, student worksheets, and learning assessment tests *offline* and *online*. *Offline* distribution of learning materials was carried out at the research site, SMP Negeri 10 Jember, by distributing *hard copies* of the learning materials. *Online* distribution of learning materials was carried out by uploading the learning materials to *Google Drive* and sharing *the link* to the learning materials on social media such as *Instagram* and *WhatsApp* so that the learning materials could be accessed by anyone.

Based on the analysis of the research results, teaching modules, student worksheets, and learning outcome tests that met the validity criteria were then tested. The teaching modules and student worksheets developed were adapted to the syntax of the PBL learning model. In the first meeting, teachers were initially unfamiliar with the PBL learning tools with didactic situation designs. In addition, students were also unfamiliar with group learning using the PBL model, so they were mostly silent and passive during this first meeting. This was because students were accustomed to waiting for instructions and explanations from the teacher, so when they tried to solve problems independently, they tended to be afraid and embarrassed to present the results of their discussions. In the second and third meetings, through learning that was adapted to the PBL-based teaching module, students began to show more activity in group discussions and presentations, making the learning process more conducive than in the previous meetings. Andayani & Pratama (2022) stated that PBL-based mathematics teaching modules can motivate and improve students' problem-solving skills. This finding is in line with Setiawan *et al*. (2023), which states that the PBL learning model can not only increase student motivation but also improve students' ability to collaborate and communicate so that students can overcome didactic obstacles during learning activities. Based on these findings, students are not only active in collaborating and communicating, but they are also more active in understanding and solving problems in everyday life.

Learning tools developed with didactic situations in mind can also overcome student learning barriers. This is in line with the research by which states that didactic design in the development of learning tools can minimize student learning barriers. Ali *et al*. (2022) states that PBL-based LKPD is effective in improving students' mathematical problem-solving skills. This is because LKPD provides *scaffolding* that helps students solve problems independently.

The findings of this study indicate that the experimental class was given PBL learning activities with didactic situation learning tools, while the control class was given learning activities using the lecture method. In the control class, the teacher played an active role in learning by providing questions through textbooks. Students in the control class were predominantly passive and waited for instructions from the teacher to solve problems. Therefore, students in the control class still experienced didactic barriers because they tended to be afraid of making mistakes in solving problems and waited for the teacher to solve them. This distinguishes the control class from the test class and the experimental class, which were active in solving problems. The PBL learning model can

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improve students' mathematical problem-solving skills (Susino *et* al., 2024), creative and critical thinking skills in students so that the design of the PBL model's didactic situation can overcome learning obstacles in students.

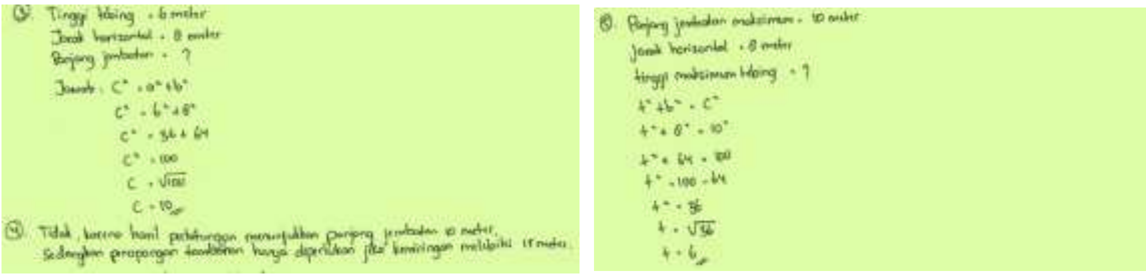

Figure 5. Learning Test Results for the Experimental Class

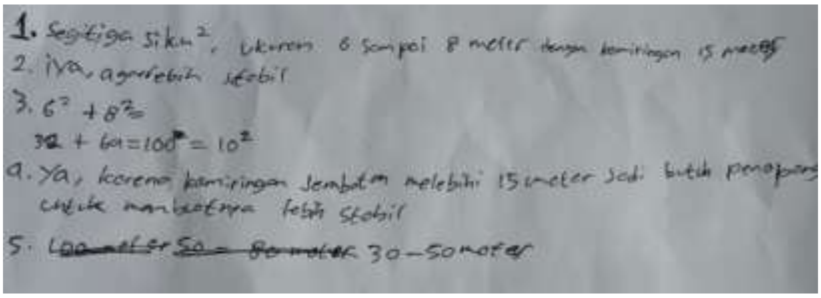

Figure 6. Learning Test Results of the Control Class

From the figure above, students who used the PBL learning model were better able to describe and explain the problems given and provide solutions to the problems compared to students who used the conventional learning model. This is in line with Renita *et al*. (2023) that PBL-based learning tools can improve students' mathematical creative thinking skills so that students can improve their learning outcomes. In both the experimental and control classes, the learning activities were concluded with a *post-test*. The *pre-test* and *post-test* data from the experimental and control classes were then analyzed using statistical tests.

The advantages of PBL learning tools with didactic situation designs to improve student learning outcomes include: 1) teaching modules are arranged and adapted to the independent curriculum with PBL model syntax in each meeting, 2) LKPDs that are arranged and developed are equipped with *scaffolding*, 3) LKPDs are designed *online* using *Canva software* so that they can attract students' attention and students are not likely to get bored studying LKPD.

CONCLUSION AND RECOMMENDATIONS

Based on the presentation of the results and discussion above, it can be concluded that the PBL model mathematics learning tool with a didactic situation developed using the Thiagarajan 4D model can improve student learning outcomes and overcome student obstacles. The validity coefficients of the teaching module, student worksheets, and learning outcome test questions were 4.66, 4.50, and 4.29, respectively. The practical criteria were obtained from the results of the analysis of the implementation of the learning tools, student observations, and student response questionnaires, which were 91.1%, 89%, and 90.04%, respectively, with a category of "very good." The effectiveness criteria were based on the results of the numeracy test, which was 83.87%. Therefore, the learning tools developed meet the criteria of validity, practicality, and effectiveness. In addition, the learning tools developed can have a significant effect on improving student learning outcomes based on statistical tests of N-Gain values for the experimental class and control class obtained Sig. (2-tailed) = 0.01 ($sig.<0.05$) and *pretest* and *posttest* values for the experimental class and control class obtained Sig. (2-tailed) =0.016 ($sig.<0.05$). In this study, it is hoped that other researchers can develop learning tools by presenting everyday problems using other learning materials or other subjects by developing similar learning tools.

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