

Effectiveness of Developing Problem-Based Learning Models Integrated with Pedagogical Technology Content Knowledge to Improve HOTS Skills

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ABSTRACT:

This study aims to test the effectiveness of the Problem-Based Learning (PBL) model based on Technological, Pedagogical, and Content Knowledge (TPACK) in improving the HOTS of elementary school teacher education (PGSD) students. The research method used was a development research with the Plomp model. The subjects were PGSD students from the Faculty of Teacher Training and Education, Muhammadiyah University of North Sumatra. The instruments developed included a learning model validation sheet, learning tools, and HOTS questions, which were validated by experts and practitioners. This study resulted in a TPACK-based PBL learning model that met validity criteria and significantly improved students' HOTS skills. The integration of PBL within the TPACK framework has been proven to strengthen student-centered learning and the pedagogical use of technology. This model is relevant as an alternative learning model at LPTK (Teachers' Training College) in preparing prospective teachers with critical and adaptive thinking. Recommendations for future researchers include implementing the TPACK-based PBL learning model in other courses to assess the impact on prospective elementary school teachers' HOTS skills.

Keywords: Problem-Based Learning Model, TPACK, Higher Order Thinking Skills, Level of Effectiveness.

1. Introduction

Efforts to improve the quality of education in Indonesia are ongoing, one of which is through the preparation of prospective professional teachers through a quality and accountable teacher education system (Nissa, 2022). Based on observational data from elementary school

teacher education (PGSD) students, their higher-order thinking skills, measured by three aspects: analysis, evaluation, and creation, were found to be 65% in analysis, 48% in evaluation, and 37% in creation. These scores fall short of the criteria for maximum mastery for students and are therefore still categorized as low. Hadi

(2021) explains that PGSD students' ability to solve higher-order thinking skills (HOTS) questions is still quite low.

One approach that has proven effective is problem-based learning (PBL) which is based on Technological, Pedagogical, Content Knowledge ((TPACK). PBL emphasizes problem-based learning that enables students to develop critical thinking and problem-solving skills (Hmelo-Silver, 2004). The application of TPACK in PBL provides a technological foundation that enriches the learning process. TPACK is a framework that integrates technological, pedagogical, and content knowledge in the teaching process (Mishra & Koehler, 2006). By adopting TPACK in the PBL model, students not only gain a deeper understanding of the material, but also develop digital skills that support active learning.

Success in improving the learning process depends on its quality and quantity, as well as the lecturer's ability to develop digital literacy and technology. Mastery of technology fosters independent living habits in its use (Xu et al., 2020). One effort to improve the quality of education is to implement a TPACK-based learning model (Koehler et al., 2013). The TPACK model integrates technology with pedagogical strategies appropriate to the learning content. This research aims to develop a TPACK-based PBL learning model to improve students' higher-order thinking skills. The PBL model, combined with TPACK, is expected to stimulate students' critical thinking and assist them in solving problems encountered during the learning process. The products of this research include a PBL-based social studies textbook for prospective elementary school teachers, HOTS-based student worksheets, assessment sheets, and TPACK-based teaching media.

This development research provides solutions to address these problems by developing a

TPACK-based PBL learning model to improve students' higher-order thinking skills. The purpose of this study was to determine the level of effectiveness of developing a PBL-based learning model integrated with TPACK to improve HOTS skills in Elementary School Teacher Education students.

2. Research Method

This research is a Research and Development (R&D) study (Sugiyono, 2022), which aims to test the effectiveness of the TPACK-based PBL learning model in improving students' HOTS. The development of social studies education textbooks through the TPACK-based PBL model was developed using a research flow diagram. The number of samples used in this study was determined using the sample size determination formula proposed by Slovin, with a population of 240 students majoring in Elementary School Teacher Education at the University of Muhammadiyah North Sumatra. So the sample used in this study was 150 students. Instrument testing on this questionnaire was conducted for students as textbook users, namely validating the content. The researcher prepared a user questionnaire and then the researcher selected an expert validator with a scale of 1 to 4. Data analysis used a quantitative approach supported by qualitative data which included descriptive analysis and inferential statistical analysis. The following is a sequential description of the activities carried out in each development phase: Phase-1: Initial Investigation, Phase-2: Design, Phase-3: Realization, Phase-4: Testing, Evaluation, and Revision, Phase-5: Implementation.

2.1 Hypothesis

A research hypothesis is a tentative statement or assumption made by a researcher about the relationship between variables in a study. Based on the objectives of this study, the hypotheses to be tested are as follows:

Table 1. Verbal Hypothesis

H o:	The effectiveness of the TPACK-based Problem Based Learning (PBL) learning model does not significantly improve the Higher Order Thinking Skills (HOTS) abilities of students in the Elementary School Teacher Education Study Program (PGSD).
H a:	The effectiveness of the TPACK-based Problem Based Learning (PBL) learning model can significantly improve the Higher Order Thinking Skills (HOTS) abilities of students in the Elementary School Teacher Education Study Program (PGSD).

3. Results And Discussion

3.1 Plomp Development Model Approach

The PLOMP Development Model was developed by Jan Plomp and is used in research and development of educational products, particularly teaching materials and learning media. This model emphasizes a systematic and continuous development process through five main phases: initial investigation, design, construction, testing, evaluation and revision, and implementation. The stages of the Plomp Development Model are as follows:

Phase 1: Initial Investigation Results

Based on the results of a pre-survey with direct observation of the PGSD Study Program regarding the current conditions related to the

curriculum and learning lectures. Information was obtained that the curriculum currently used has not yet been adapted to 21st-century learning for high-level thinking. Furthermore, student activities are still passive and lack ideas. The characteristics and stages of thinking have not been identified, learning is not yet concrete so it is difficult to develop. Information obtained from the PGSD Study Program lecturers that the lecture orientation is only for delivering material, while ideally the lecture orientation measures the level of mastery of the material with HOTS abilities. The results of the initial HOTS ability test conducted on PGSD Study Program students showed that the level of students' HOTS abilities was at a low level. The HOTS ability test data for PGSD Study Program students can be seen in Table 2 below.

Table 2. Initial Test Data of HOTS Abilities of PGSD Program Students

N0	Question Number										Mark
	1	2	3	4	5	6	7	8	9	10	
1	3	2	1	2	3	2	2	0	2	3	20
2	2	2	2	2	2	2	0	2	2	2	18
3	2	1	2	1	2	3	2	2	4	1	20
4	2	2	2	2	2	0	2	0	4	2	18
5	4	1	2	4	0	2	4	1	0	2	20
6	1	2	2	0	4	2	2	4	2	3	22
7	1	2	3	2	2	4	2	2	0	2	20
8	4	0	2	1	2	2	4	2	4	2	23
average											20

Source: Processed Data 2025

Based on the initial HOTS ability test results for

Elementary School Teacher Education (PGSD)

students, as shown in Table 2, students' HOTS ability is very low. This is suspected to be due to the lecture process not stimulating the development of students' HOTS abilities. Based on the study and identification of learning problems in Basic Social Studies Concepts, an initial idea was obtained for developing a learning model. This learning model is expected to serve as a guideline for lecturers in designing, implementing, and achieving PBL learning objectives.

Based on the knowledge gained, students can then solve problems through small group discussions. This is necessary to collaborate with the group to master the content and deepen their understanding of problem-solving. Students are given the opportunity to present their work, and through this interaction pattern, they can align their perceptions of content mastery with the lecturer. At the end of the lesson, students are expected to form agreements and study groups through reflection on their work. This activity serves as a learning achievement and an indicator of learning success. The final results of this learning design will be assessed using a HOTS ability instrument, which aims to assess student ability levels.

Based on the analysis of pre-survey data, learning remains passive, not prioritizing two-way interaction between students and lecturers. Learning does not encourage the development of a comprehensive and broad mindset by internalizing local excellence and wisdom. Learning is not integrated to meet the overall learning outcomes of graduates within a single program through an interdisciplinary approach. Graduate learning outcomes have not been aligned with the demands of problem-solving skills within their areas of expertise.

The Lecturer's Guidebook (BPD), used as a guide for lecturers in class, is similar to the student's textbook. Furthermore, the Lecturer and Student Handbooks, compiled based on the presentation of the main material, lack any problem-solving steps. Observations of the learning implementation (during the pre-trial)

indicate that the learning process has not yet engaged students. Learning orientation also does not specifically utilize activity sheets (LAM); problems are presented verbally without written instructions. Therefore, the HOTS ability test, in this case, is a set of questions used to measure students' HOTS abilities before and after the learning process. In designing the HOTS ability test for students, the following activities are carried out: (1) creating a HOTS ability test grid, (2) designing problems for each learning achievement indicator, (3) creating answer keys for each problem proposed, (4) creating a scoring rubric (descriptive test).

Phase 2: Design

This assessment sheet is used to measure the effectiveness of the Learning Model using learning tools developed based on mastery of theory and the experience of experts and practitioners. The model's effectiveness is measured using five assessment aspects:

1) Aspects and Indicators of the Model's Availability Observation Sheet

This assessment sheet is used to measure the implementation of the Learning Model using learning tools developed based on mastery of theory and the experience of experts and practitioners. The implementation of the model is measured by assessment aspects, namely syntax, social systems, and the principle of management reactions. Syntax consists of the level of implementation of all stages of the Learning Model between. Next, the social system consists of the level of implementation of democratic situations, the level of implementation of learning, the level of investigation, the level of cooperation, the level of implementation of the social system, and the level of performance and responding to results between groups. Finally, the principle of management reactions consists of the level of implementation of lecturers investigating, accommodating, lecturer behavior providing scaffolding, and lecturers facilitating student learning.

2) Aspects and Indicators of the Observation Sheet and Assessment of Lecturers' Ability to Manage Learning

This observation sheet is used to measure the lecturer's ability to manage learning with the Learning Model with the learning tools provided. The lecturer's ability to manage learning is measured by 4 aspects, namely: Apperception stage, through activities Dividing students into several groups, Orienting the problem, Facilitating formulating hypotheses, carrying out activities, collecting data, and drawing conclusions. Problem Solving Discussion Stage through discussion activities related to the properties, area, and perimeter of flat shapes, and conducting group discussions related to problems. Interaction Pattern Stage with representation and problem solving. Work Result Reflection Stage through reflection activities where students' work results can conclude the learning together.

3) Aspects and Indicators of Student and Lecturer Activity Observation Sheets

This observation sheet is used to measure student and lecturer engagement during learning activities. Student activities are categorized into four stages: Apperception, Problem-solving Discussion, Interaction Patterns with Representations, and Problem-Solving. Lecturer activities are categorized into Apperception, Problem-Solving Discussion, Interaction Patterns with Representations and Problem-Solving, and Reflection on Work Results.

4) Aspects and Indicators of HOTS Ability Test

HOTS ability test aspects and indicators were developed to assess HOTS ability aspects. The level of students' HOTS ability was assessed using a rubric developed by Treffers, A. (1987), the HOTS ability assessment indicators based on the characteristics of Problem Based Learning are as follows: The use of Context, Use Models, Bringing by vertical instrument, Student Contribution, Interactivity, and Intertwinment. Each question refers to an assessment indicator with a score of 2 for each

indicator for each question asked.

5) Questionnaire Aspects and Indicators to Measure Student and Lecturer Responses

This questionnaire is used to measure student and lecturer responses to learning components and activities. Student responses are measured against the assessment component aspects, namely (1) happy/unhappy with the lesson components, (2) statements (3) statements of interest/unhappy with the learning activities, and (4) interest in the handbook and student activity sheets. Lecturer responses are measured with 4 assessment aspects, namely (1) statements of useful/unhappy learning components, (2) good/unhappy assessments of learning components, (3) lecturer opinions used as the main strategy in learning, (4) lecturer opinions about the obstacles faced if this model is implemented.

Phase 3: Realization

In Phase 3, an initial draft of the research product was produced in the form of a Learning Model. This section discusses the implementation instructions for the described model, namely planning tasks so that learning can run practically and effectively and instructions for implementing learning. In Phase 3, an initial draft (Prototype-1) of learning tools was produced that were in accordance with the initial draft that was realized, including RPS, BPD, BM, LAM, and HOTS ability tests. An overview of these learning tools is explained as follows.

1. Semester Lecture Plan

The Semester Lecture Plan (RPS) is prepared based on the components (Prototype-1), especially the learning syntax. The main components of the RPS prepared are: (a). name of the Study Program, name and code of the course, semester, credits, name of the lecturer in charge; (b) graduate learning outcomes assigned to the course; (c) final abilities planned at each stage of learning to meet graduate learning outcomes; (d) study materials related to the abilities to be achieved; (e) learning methods; (f) time provided to achieve abilities at each stage

of learning; (g) student learning experiences manifested in descriptions of tasks that must be completed by students during one semester; (h) criteria, indicators, and assessment weights; and (i) list of references used.

2. Lecturer's Guidebook (BPD)

The lecturer's guidebook (BPD) is compiled based on the components (Prototype-1), especially the support system components and specifically related to the RPS. This book is used as a guide for lecturers in delivering learning materials. This book is equipped with sufficient problems as inspiration for concept discovery, HOTS ability improvement, and principles in the Basic Concepts of Social Studies related to the material being taught. The main components of the BPD book compiled are: (1) a brief description of the Learning Model, (2) graduate learning outcomes assigned to the course, (3) planned final abilities, (4) study materials related to abilities, (5) Presentation of the main material, (6) student learning experiences, (7) criteria, indicators, and assessment weights (8) Problems and answer keys to the problems in the Student Book and LAM.

3. Student Handbook (BPM)

The Student Handbook (BPM) is compiled based on the components (Prototype-1), especially the support system components and specifically related to BPD and RPS. This book is used as a guide for students in studying lecture materials. This book is equipped with directions for students to effectively carry out activities, discover concepts and principles in the Basic Concepts of Social Sciences related to the material being taught. The main components of the BM compiled are: (1) a brief description of the learning model, (2) the assigned graduate learning outcomes, (3) the planned final abilities, (4) study materials related

to the abilities to be achieved, (5) Presentation of the main material following the problem-solving steps, (6) student learning experiences in task descriptions, (7) criteria, indicators, and assessment weights (8) Problems in the Student Book and LAM.

4. Student Activity Sheet (LAMA)

The student activity sheet (LAM) is compiled based on the components (Prototype-1). This LAM is used by students as a place to solve all problems in the BM. This LAM presents steps and instructions for solving problems and discovering various concepts effectively, and at the end, challenges are presented that students will solve. The main components of the student activity sheet (LAM) that are compiled are: (1) graduate learning outcomes, (2) planned final abilities, (3) study materials related to abilities, (4) instructions for using the LAM, and (4) presentation of steps and instructions for using the book.

5. HOTS Ability Test

The HOTS ability test is a set of questions used to measure the level of students' HOTS abilities before and after learning. In designing the HOTS ability test, the following activities are carried out: (1) creating a HOTS ability test grid, (2) designing problems for each indicator of basic competency achievement, (3) creating answer keys for each problem proposed, (4) creating a scoring rubric (descriptive test).

Phase 4: Testing Results, Evaluation and Revision

Data assessing the effectiveness of the Learning Model using learning tools is based on the theoretical mastery and experience of experts and practitioners. The average indicator scores for each assessment aspect from each expert and practitioner are presented in Table 3 below:

Table 3. Average Indicator Values from Experts and Practitioners for Each Aspect of the Assessment of the Effectiveness of the Learning Model

No	Rated aspect	Average Indicator Value for Each Aspect of Expert and Practitioner Assessment					Aspect Value
		I	II	III	IV	V	
I	Students' HOTS abilities	4.3	4.5	4.3	4.3	4.3	4.3
II	Student and lecturer activities	4.3	4.3	4.3	4.3	4.3	4.3
III	Lecturers' ability to manage learning	4.3	4.5	4.3	4.5	4.3	4.3
IV	Student and lecturer responses to learning components and processes	4.2	4.4	4.4	4.2	4.2	4.3
EI Value or Total Average Value							.3

Description: Intended ↔ Experiential (IE from experts and practitioners)

Source: Processed Data 2025

The average indicator scores in Table 3 above are obtained by dividing the sum of the indicator scores for each observation aspect provided by the observer by the number of indicators. The aspect score is obtained by dividing the average number of indicator scores provided by the experts and practitioners as assessors. Furthermore, the IE score, or the total average aspect score, is 4.3, obtained by dividing the sum of the aspect scores by the number of aspects used as assessment criteria to determine the effectiveness of the learning implementation

model. The model's IE score is 4.3, based on previously established criteria. It is concluded that the effectiveness of the Learning Model, assessed based on the mastery of theory and experience of experts and practitioners, is at a high level. After revisions to the learning model book, learning tools, and related instruments, the Learning Model, along with all learning tools and research instruments, met the criteria and was ready for field testing in the classroom. To determine the consistency of the instruments, the following reliability test was conducted:

Table 4. Reliability Test of Aspects of Learning Model Effectiveness Assessment

Reliability Statistics	
Cronbach's Alpha	N of Items
.892	15

Source: Processed Data 2025

Based on data analysis, the Cronbach's Alpha value obtained was 0.892. This value exceeds the standard threshold of 0.70, indicating that all

items in the instrument are strongly correlated and consistently measure the same construct perfectly (excellent).

Table 5. Reliability Test of the Effectiveness Assessment Aspects of the Intraclass Correlation Coefficient Learning Model

Intraclass Correlation ^b		95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.615 ^a	.385	.824	8.982	14	56	.000
Average Measures	.889 ^c	.758	.959	8.982	14	56	.000

Source: Processed Data 2025

Based on the data analysis, the Intraclass Correlation Coefficient (ICC) test using a two-way mixed effects model showed a Single Measures value of 0.615 and an Average Measures value of 0.889. This indicates a good level of agreement between assessors. Furthermore, the F-test results showed a significance value of $0.000 < 0.05$, indicating statistical significance. It can be concluded that the instruments used have high reliability and are reliable. However, the implementation observation sheet, the assessment sheet for lecturer learning management skills, and the HOTS ability test still need to be measured for reliability, validity, and sensitivity based on empirical data. Therefore, they are suitable for use in measuring the effectiveness of the learning model using the developed learning tools.

Table 6. Students' HOTS Abilities After Being Taught with the Learning Model

No. Respondent	Proportion		HOTS Ability Level of Students
	U1	U2	
Average	0.20	0.63	Currently

Source: Processed Data 2025

Based on the data analysis results in Table 6 above, it is clear that, classically, the level of HOTS mastery of Elementary School Teacher Teachers (PGSD) students in the Basic Concepts of Social Studies course on plane geometry is very low (0.20). The comparison of the HOTS mastery of students after being taught using the Learning Model is low (0.63). Individually, 9 prospective teachers had a low level of mastery, and 26 prospective teachers had a moderate level of mastery. A large percentage of students had at least a moderate level of mastery (74% of 35 students). Referring to the established effectiveness criteria for trial 1 data analysis, it can be concluded that the implementation of the Learning Model using the developed learning tools does not meet the established effectiveness criteria.

3.2 Trial Results 1

Trial 1 is an effort to eliminate problems that are still found in the learning process. Through trial 1, data was obtained from the results of the analysis of the effectiveness of the Learning Model using the provided learning tools reviewed from 4 measurement aspects, namely: a) HOTS ability test, b) achievement of the ideal time percentage of student and lecturer activities, c) lecturer ability to manage learning, and d) student and lecturer responses to learning components and activities. Data analysis for each aspect is described as follows.

a) Students' HOTS Skills

The HOTS ability test data for students can be seen in Table 3. The average HOTS ability score for the Basic Concepts of Social Studies learning course is presented in Table 6 below.

3.3 Trial Results 2

The next activity is to conduct a re-trial (trial 2) by paying attention to the indicators of the model's effectiveness aspects that have not been met. The effectiveness of the Learning Model provided is reviewed from 4 measurement aspects, namely: 1) students' HOTS ability tests, 2) achievement of the ideal time percentage of student and lecturer activities, 3) lecturer ability to manage learning, and 4) student and lecturer responses to learning components and activities. Data analysis for each aspect is described as follows.

a. HOTS Ability Test for Students

The HOTS ability test data for students can be seen. The average HOTS ability score for the Basic Concepts of Social Studies course is presented in table 7 below:

Table 7. HOTS Skills of Students After Being Taught Using Learning Models

No. Respondent	Proportion		HOTS Ability Level of Students
	U1	U2	
Average	0.63	0.85	Tall

Source: Processed Data 2025

Based on the data analysis results in Table 7 above, it is clear that, classically, the level of HOTS mastery of Elementary School Teacher Education (PGSD) students in the Social Sciences course during trial 1 was moderate (0.63). Comparing the results of the HOTS mastery of students after reviewing the implementation of the Learning Model, there was an increase, with the proportion of HOTS mastery reaching 85%, categorized as high. Individually, one prospective teacher had a moderate level of mastery, 25 prospective teachers had a high level of mastery, and 9 prospective teachers had a very high level of mastery.

The percentage of students with a high level of

mastery was 3%, 71% with a high level of mastery, and 26% with a very high level of mastery out of 35 students. These percentages were obtained by dividing the number of students with a high level of mastery by the number of subjects in the trial. If the percentage is referred to the previously established learning program completion criteria, it can be concluded that learning on the material on flat shapes has been completed classically.

b. Lecturer's Ability to Manage Learning

Data from observations of lecturers' ability to manage learning through the application of Learning Models in trial 2 are presented in table 8 below:

Table 8. Data on Lecturers' Ability to Manage Study Program Learning

Trial No.	Phase				Average	Information
	1	2	3	4		
2	4.67	4.00	4.00	4.00	4.17	Tall

Source: Processed Data 2025

Table 8 above shows that the lecturers' ability to manage learning improved from trial 1 to trial 2, from moderate to high. This demonstrates the increased effectiveness of the Learning Model.

c. Student Activities

Data from observations of student activities in trial 2 are presented in table 9 below.

Table 9. Student Activity Data of Elementary School Teacher Education Study Program Through the Application of Learning Models

Phase				Average	Information
1	2	3	4		
4.33	4.00	5.00	5.00	4.58	Tall

Source: Processed Data 2025

Table 9 above shows the average student activity in each phase: the Apperception phase had an average of 4.33, the Problem-Solving Discussion phase 4.00, the Interaction Patterns with Representation and Problem-Solving phase

5.00, and the Work Results Reflection phase 5.00. All phases had high levels of student activity.

d. Lecturer Activities
The results of observations of activities during

learning in trial 1 of the application of the Learning Model are presented in Table 10 below.

Table 10. Lecturer Activities Through the Application of Learning Models

Phase	Observer			Average
	1	2	3	
1	4.67	4.67	4.33	4.56
2	4.50	4.50	4.50	4.50
3	4.00	5.00	5.00	4.67
4	4.00	5.00	5.00	4.67
Average				4.60

Source: Processed Data 2025

Table 10 above shows the lecturer activity levels in each phase as follows: the Apperception phase had an average of 4.56, the Problem-Solving Discussion phase 4.50, the Interaction

Patterns with Representation and Problem-Solving phase 4.67, and the Work Results Reflection phase 4.67. All phases of lecturer activity were at a high level.

Table 11. Reliability Test of Lecturer Activities Through the Application of Learning Models

Reliability Statistics	
Cronbach's Alpha	N of Items
.845	9

Source: Processed Data 2025

Based on data analysis, the Cronbach's Alpha value obtained was 0.845. This value exceeds the standard threshold of 0.70, indicating that all

items in the instrument are strongly related and consistently measure the same construct perfectly (excellent).

Table 12. Reliability Test of Lecturer Activities Through the Application of Learning Models

Intraclass Correlation Coefficient

Intraclass Correlation ^b		95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.792 ^a	.660	.910	12.448	8	16	.000
Average Measures	.895 ^c	.820	.960	12.448	8	16	.000

Source: Data Processed 2025

Based on the data analysis, the Intraclass Correlation Coefficient (ICC) test using a two-way mixed effects model showed a Single Measures value of 0.792 and an Average Measures value of 0.895. This indicates a good

level of agreement between assessors. Furthermore, the F-test results showed a significance value of $0.000 < 0.05$, indicating that these reliability results are statistically significant and not a result of chance. It can be

concluded that the instrument used has high reliability and is reliable for research data collection.

e. Student and Lecturer Responses

1) Student Response

Student responses to the learning process

Table 12. Student Responses to Learning Components and Activities (Trial 2)

No	Assessment Aspects	Total Score (Happy)	Average Percentage	Criteria
1	Feelings about learning components	465	93%	Very strong
2	Opinions about learning components	462	92,4%	Very strong
3	Interest in participating in further learning activities	97	97%	Very strong
4	Opinions about books and activity sheets	191	95,5%	Very strong
	Combined Average		94,48%	Very strong

Source: Processed Data 2025

Based on the data analysis results in Table 12, it was found that student responses to the overall learning components and activities were in the Very Strong category (94.48%). This achievement indicates that the integration of the course materials, teaching materials in the form of textbooks and activity sheets, and the classroom learning environment comprehensively met student expectations and needs. The high score for student feelings and opinions (93%) indicates that the implemented instructional design was not only substantively superior but also able to engage students' affective side, enabling the process of knowledge transformation to take place in a pleasant atmosphere.

The main factor underlying this high level of positive response lies in the quality of interactions in learning activities, including the lecturer's teaching style and interest in the teaching materials (97%). This proves that

included both positive and negative responses. Positive responses indicated enjoyment, novelty, and interest. Negative responses indicated displeasure, not novelty, and disinterest. The analysis of student responses to the learning components and activities is presented in Table 12 below.

delivering material supported by visually appealing learning media and easy-to-understand language (94%) can increase student active engagement. The tangible impact of satisfaction with these learning components and activities is reflected in students' interest in participating in learning activities (97%). Theoretically, these results indicate that the developed learning model has a very high level of practicality. It can be concluded that student responses to the components and learning activities using the Learning Model are positive.

2) Lecturer's Response

Lecturer response data on learning components and activities were obtained by administering questionnaires and learning tools to three lecturers teaching in the Elementary School Teacher Education Study Program. The results of the lecturer response data analysis on learning components and activities are presented in Table 13 below:

Table 13. Lecturer Responses to Learning Components and Activities (Trial 2)

No	Assessment Aspects	Total Score (Accumulated Score)	Average Percentage	Criteria
1	Description of Learning Tools	83	95,2%	Very Strong
2	Description of Learning Activities	79	90,5%	Very Strong
	Total	162	92,85%	Very Strong

Source: Processed Data 2025

Based on the data analysis results in Table 13, the overall response of lecturers to the learning tools and activities was very high (92.85%) and categorized as Very Helpful. Regarding the Learning Tools aspect, it indicates that supporting instruments such as the RPS, BPD, BPM, and LAM met the standards for material quality and systematics (95.2%). This high figure demonstrates the effectiveness of the developed tools.

In line with this, the Learning Activities aspect

was categorized as Very Helpful (90.5%). This indicates that the designed learning scenarios can be implemented well. Comprehensively, these results confirm that this product has a very high level of acceptability and usability and is suitable for use. The conclusions drawn from the data analysis of trials 1 and 2, referring to the Learning Model effectiveness criteria, indicate that the developed learning tools have met the criteria for the effectiveness of a learning model.

3.4 Results of the Analysis of the Effectiveness of Learning Models

Table 14. Learning Model Assessment Results

Respondents	Pretest	Posttest	Total	Difference (Increase)	N-Gain	Category
1	50	90	140	40	0.80	High
2	55	95	150	40	0.89	High
3	60	95	155	35	0.88	High
4	50	95	145	45	0.90	High
5	60	95	155	35	0.88	High
6	60	90	150	30	0.75	High
7	50	90	140	40	0.80	High
8	55	85	140	30	0.67	Currently
9	50	95	145	45	0.90	High
10	60	95	155	35	0.88	High
11	65	90	155	25	0.71	High
12	60	95	155	35	0.88	High
13	65	90	155	25	0.71	High
14	60	85	145	25	0.63	Medium
15	55	85	140	30	0.67	Medium
16	60	90	150	30	0.75	High

17	60	90	150	30	0.75	High
18	60	85	145	25	0.63	Medium
19	50	80	130	30	0.60	Medium
20	60	95	155	35	0.88	High
21	60	85	145	25	0.63	Medium
22	65	95	160	30	0.86	High
23	55	90	145	35	0.78	High
24	60	90	150	30	0.75	High
25	55	90	145	35	0.78	High
26	50	80	130	30	0.60	Medium
27	65	90	155	25	0.71	High
28	50	80	130	30	0.60	Medium
29	60	90	150	30	0.75	High
30	50	80	130	30	0.60	Medium
31	65	90	155	25	0.71	High
32	55	95	150	40	0.89	High
33	60	85	145	25	0.63	Medium
34	65	90	155	25	0.71	High
35	70	90	160	20	0.67	Medium
36	60	90	150	30	0.75	High
37	55	90	145	35	0.78	High
38	65	95	160	30	0.86	High
39	55	90	145	35	0.78	High
40	60	85	145	25	0.63	Medium
41	50	90	140	40	0.80	High
42	60	90	150	30	0.75	High
43	50	95	145	45	0.90	High
44	55	95	150	40	0.89	High
45	60	95	155	35	0.88	High
46	50	90	140	40	0.80	High
47	50	90	140	40	0.80	High
48	65	90	155	25	0.71	High
49	70	85	155	15	0.50	Medium

50	60	95	155	35	0.88	High
51	50	95	145	45	0.90	High
52	50	80	130	30	0.60	Medium
53	60	85	145	25	0.63	Medium
54	55	95	150	40	0.89	High
55	60	90	150	30	0.75	High
56	50	95	145	45	0.90	High
57	70	90	160	20	0.67	High
58	60	95	155	35	0.88	Medium
59	65	90	155	25	0.71	High
60	65	95	160	30	0.86	High
61	55	90	145	35	0.78	High
62	50	95	145	45	0.90	High
63	60	90	150	30	0.75	High
64	60	95	155	35	0.88	High
65	50	95	145	45	0.90	High
66	60	95	155	35	0.88	High
67	60	90	150	30	0.75	High
68	60	95	155	35	0.88	High
69	60	95	155	35	0.88	High
70	50	95	145	45	0.90	High
71	60	95	155	35	0.88	High
72	60	90	150	30	0.75	High
73	60	90	150	30	0.75	High
74	60	85	145	25	0.63	Medium
75	65	95	160	30	0.86	High
76	65	95	160	30	0.86	High
77	65	90	155	25	0.71	High
78	65	95	160	30	0.86	High
79	65	90	155	25	0.71	High
80	65	85	150	20	0.57	Medium
81	65	85	150	20	0.57	Medium
82	65	90	155	25	0.71	High

83	65	90	155	25	0.71	High
84	50	85	135	35	0.70	High
85	50	80	130	30	0.60	Medium
86	50	95	145	45	0.90	High
87	50	85	135	35	0.70	High
88	50	95	145	45	0.90	High
89	50	90	140	40	0.80	High
90	50	90	140	40	0.80	High
91	50	90	140	40	0.80	High
92	50	80	130	30	0.60	Medium
93	50	90	140	40	0.80	High
94	50	80	130	30	0.60	Medium
95	50	90	140	40	0.80	High
96	50	80	130	30	0.60	Medium
97	70	90	160	20	0.67	Medium
98	70	95	165	25	0.83	High
99	70	85	155	15	0.50	Medium
100	70	90	160	20	0.67	Medium
101	70	90	160	20	0.67	Medium
102	70	90	160	20	0.67	Medium
103	70	90	160	20	0.67	Medium
104	70	95	165	25	0.83	High
105	70	90	160	20	0.67	Medium
106	70	85	155	15	0.50	Medium
107	70	90	160	20	0.67	Medium
108	70	90	160	20	0.67	Medium
109	70	95	165	25	0.83	High
110	70	95	165	25	0.83	High
111	70	95	165	25	0.83	High
112	70	90	160	20	0.67	Medium
113	70	90	160	20	0.67	Medium
114	70	90	160	20	0.67	Medium
115	70	85	155	15	0.50	Medium

116	70	95	165	25	0.83	High
117	70	95	165	25	0.83	High
118	50	80	130	30	0.60	Medium
119	55	85	140	30	0.67	Medium
120	60	95	155	35	0.88	High
121	50	90	140	40	0.80	High
122	60	95	155	35	0.88	High
123	60	90	150	30	0.75	High
124	50	95	145	45	0.90	High
125	55	95	150	40	0.89	High
126	50	95	145	45	0.90	High
127	60	95	155	35	0.88	High
128	65	90	155	25	0.71	High
129	60	90	150	30	0.75	High
130	65	85	150	20	0.57	Medium
131	60	95	155	35	0.88	High
132	55	95	150	40	0.89	High
133	60	90	150	30	0.75	High
134	50	95	145	45	0.90	High
135	55	90	145	35	0.78	High
136	60	85	145	25	0.63	Medium
137	50	85	135	35	0.70	High
138	60	90	150	30	0.75	High
139	60	90	150	30	0.75	High
140	50	85	135	35	0.70	High
141	55	80	135	25	0.56	Medium
142	50	95	145	45	0.90	High
143	60	85	145	25	0.63	Medium
144	65	95	160	30	0.86	High
145	60	90	150	30	0.75	High
146	65	90	155	25	0.71	High
147	60	90	150	30	0.75	High
148	55	80	135	25	0.56	Medium

149	60	90	150	30	0.75	High
150	50	80	130	30	0.60	Medium
Average	59.13	90.07		30.94		0.76

Source: processed data, 2025

Based on data analysis of 150 respondents, this study demonstrated a significant improvement in learning outcomes, as evidenced by an increase in the average score from 59.13 in the pretest to 90.07 in the posttest. The success of this intervention was reinforced by an average N-Gain score of 0.76, which, according to the N-Gain interpretation criteria, falls into the High category. Individually, the majority of respondents demonstrated consistent

effectiveness at a high level, although there was variation in some subjects who fell into the moderate category. Overall, these data provide strong empirical evidence that the method or treatment implemented in this study was highly effective. To assess the effectiveness of the learning model, one-sample tests and paired t-tests were conducted. The data obtained were first tested for normality. The results of the normality test are as follows:

Table 15. Data Normality Test

Unstandardized Residual

N		150
Normal Parameters ^{a,b}	Mean	,0000000
	Std.Deviation	4,51855188
Most Extreme Differences	Absolute	,140
	Positive	,091
	Negative	-,140
Test Statistic		,140
Asymp. Sig. (2-tailed)		,074 ^c

Processed data source: 2025

Based on the results of the normality test using the Kolmogorov-Smirnov test, a significance value of $0.074 > 0.05$ was obtained, thus concluding that the residual data in this study is

normally distributed. Thus, the assumption of normality in the regression analysis has been met.

Table 16. Data Normality Tests Tests of Normality

Kolmogorov-Smirnov ^a				Shapiro-Wilk		
Statistic		df	Sig.	Statistic	df	Sig.
Average	,146	150	,062	,942	150	,087

Processed data source: 2025

Based on the normality test results in the table above, the mean variable shows a significance value of 0.87 in the Shapiro-Wilk test and 0.062 in the Kolmogorov-Smirnov test. Given that

both significance values are greater than 0.05, it can be statistically concluded that the data are normally distributed, thus meeting the basic assumptions for parametric statistical analysis.

Table 17. Hypothesis Test (One-Sample Test)

Test Value = 65

t		Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Average	5,983	149	,000	9,60000	8,8699	10,3301

Processed data source: 2025

Based on the results of a One-Sample t-Test with a reference value of 65, the calculated t-value was 5.983 with 149 degrees of freedom (df) and a 2-tailed significance value (Sig.) of 0.000. Because the significance value is less than 0.05, H_0 is rejected and H_1 is accepted. This indicates a significant difference between the sample mean and the reference value of 65. The

mean difference of 9.60000 indicates that the empirical mean is 9.6 points higher than the reference value. Furthermore, the 95% confidence interval ranges from 8.8699 to 10.3301, all of which are above zero, further confirming that the difference is statistically significant.

Table 18. Hypothesis Test (Paired Samples Test)

Paired Differences							t	df	Sig. (2-tailed)
Mean			Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
	pretest	-	7,62781	,62281	-	-	-	149	,000
	-								
1	postes	30,93			32,1640	29,7026	49,6		
2		333			1	6	68		

Processed data source: 2025

Based on the results of the paired samples test, the average difference between the pretest and posttest was -30.933 (pretest-posttest), indicating that the posttest score was approximately 30.93 points higher than the pretest score. The 95% confidence interval for the difference ranged from -32.164 to -29.703 and did not cross zero, indicating a statistically significant difference. The calculated t-value of -49.668 with 149 degrees of freedom (df) and a 2-tailed significance level (Sig.) of 0.000 (<0.05) confirmed the finding that there was a highly significant difference between the pretest and posttest results. Therefore, the null hypothesis

(H_0) stating no difference was rejected, and the alternative hypothesis (H_1) was accepted. These findings indicate that the treatment or intervention provided was effective in significantly improving the learning outcomes studied.

Phase 5: Implementation

1. Student Orientation to Problems

The first step is to present contextual problems that are relevant to real life and aligned with the learning material. These problems are designed to stimulate curiosity and encourage students to actively engage in the learning process. Student

problem orientation is the process of equipping new students with an understanding of the various challenges and issues during their studies at university. Duch, Groh, & Allen (2001) stated that problem orientation serves as a trigger that stimulates students to identify learning needs and develop independent thinking skills. Barrows (1996) emphasized that problems used for orientation must be complex enough to encourage students to collaborate and think critically. This includes an introduction to the campus environment, the lecture system, and issues related to mental, social, and academic health. Orientation also aims to raise students' awareness of their academic and social responsibilities. With a good orientation, new students are expected to be more prepared and confident in navigating their college life.

2. Organizing Students for Learning

Students are divided into small groups to discuss and formulate problem-solving strategies. Organizing student learning, whether through intra- or extra-campus organizations, can provide many benefits. Joyce, Weil, & Calhoun (2015) stated that student organizations can be a forum for students to develop their potential, expand their networks, and improve soft skills that are important for the world of work. Vygotsky (1978) stated that through the theory of the Zone of Proximal Development (ZPD), he emphasized that organizing group learning allows students to help each other to reach a higher level of understanding. Student organizations are a very useful forum for students to develop themselves, expand their networks, and gain practical experience. By actively participating in organizations, students can better prepare themselves to face challenges in the world of work.

3. Individual and Group Inquiry Guidance

Students conduct investigations to gather the information needed to solve problems. The use of technology, such as access to online journals, learning videos, and digital discussion platforms,

is highly recommended to support this process. Guidance for individual and group investigations, in the context of learning, refers to a specific problem or topic. Arends (2012) states that teachers act as facilitators who guide students in developing critical thinking skills through individual and group investigations. Johnson & Johnson (1999) state that group investigations strengthen social skills, increase motivation, and produce richer understanding than individual investigations. The main goal is to help students develop critical thinking skills, problem-solving skills, and master learning materials through direct experience in the investigation process. In a problem-based learning model, inquiry guidance is a crucial stage. Guidance for individual and group investigations is a crucial component of effective learning, especially in a problem-based learning model, which aims to develop students' learning abilities holistically.

4. Development and Presentation of Results

After discussion, students develop solutions to the given problems and present them in the form of presentations, written reports, or other products. The use of technological aids, such as multimedia presentations or videos, can improve the quality of presentations. The development and presentation of results are two important stages in the learning process, especially problem-based learning (PBL) and project-based learning (PjBL). Sugiyono (2017) emphasizes that research results must be developed into conclusions that answer the problem formulation, then presented in the form of a systematic scientific report. Creswell (2014) states that the presentation of research results is not only conveying data, but also interpreting the meaning of the findings in the context of theory and practice. The development of results refers to the process of designing, making, or creating something new, while the presentation of results is a way to present or demonstrate the findings or products that have been developed. The development and presentation of results are integral parts of an effective learning process, especially problem-based learning and project-based

learning.

5. Analysis and Evaluation of Problem Solving Process

Analyzing and evaluating the problem-solving process is a crucial step in the problem-based learning (PBL) model. George Polya (1981) stated that problem-solving consists of four stages: understanding the problem, planning a strategy, implementing the strategy, and evaluating the results. The evaluation stage is key to ensuring the solution is correct and the thinking process is effective. Jonassen (1997) classifies problems into ill-structured and well-structured. Evaluation is necessary because ill-structured problems require more in-depth analysis, reflection, and strategy adjustments. This process involves reflecting on the steps taken to solve the problem, identifying strengths and weaknesses, and formulating improvement strategies for the future. By conducting

systematic analysis and evaluation, students can learn from their experiences, improve their problem-solving skills, and become more independent learners. The implementation of the TPACK-based PBL model has proven effective in improving students' critical thinking skills and HOTS. By wisely integrating technology into the learning process, students not only understand the material but also develop higher-order thinking skills that are essential in education.

3.5 Discussion

3.5.1 Analysis of Model Effectiveness on Students' HOTS

The effectiveness of the learning model developed in improving students' high-level thinking skills can be seen from the comparison of test scores before and after treatment, as detailed in Table 19 below.

Table 19. Scores Before and After Model Implementation

No	Aspects Analyzed	Before Model Implementation	After Model Implementation	Improvement
1	Average Student HOTS Score	59.13	90.07	30.94
2	Number of Students Tested	150	150	-

Source: Processed Data 2025

The results in Table 19 show a significant increase in students' higher-order thinking skills after the model was implemented. This is evidenced by the increase in the average HOTS score from 59.13 to 90.07, with a total margin of improvement of 30.94 points. The consistency of the sample size of 150 students across both measurement phases strengthens the validity of these findings, empirically

confirming that the implemented model is effective in substantially improving the quality of student learning outcomes.

3.5.2 Comparison Before and After Model Implementation

The following table shows a comparison of HOTS scores before and after the model was implemented.

Table 20. Comparison Before and After Model Implementation

Aspect HOTS	Before Implementation	After Implementation	Improvement (%)
Analysis	62.40	88.50	26.10%
Evaluation	58.25	91.20	32.95%
Creation	56.75	90.50	33.75%

Source: Processed Data 2025

The data above shows a comparison of HOTS scores before and after implementing the learning model. It can be concluded that all HOTS aspects experienced a significant increase after implementing the learning model. Furthermore, the highest increase occurred in the Creativity aspect (34.48%), indicating that this model is highly effective in fostering student creativity. Finally, increases in the Evaluation (32.95%) and Analysis (26.10%) aspects indicate that students became more critical and better able to evaluate problems. Overall, the implemented learning model has been proven to improve students' higher-order thinking (HOTS) skills. The research findings obtained in the field are presented based on several factors: the level of effectiveness, the level of HOTS ability, active activities, and responses to improving students' HOTS skills in the learning process of implementing the Learning Model.

First, the effectiveness of the Learning Model in improving HOTS skills in Social Studies learning is effective. The third quality criterion according to Nieveen (1992, 1999) is effectiveness. Effectiveness refers to the extent to which the experiences and outcomes of the intervention, as well as the results of the intervention, are consistent with the intended objectives. The effectiveness of the learning model through improving students' HOTS skills was assessed using a HOTS skills rubric on learning outcomes. The analysis results showed a moderate increase in students' HOTS skills.

Second, the level of students' HOTS skills through the application of the Learning Model was assessed based on their creative thinking skills, which met the criteria of "Use of Context," "Use of Models," "Bringing by Vertical Instrument," "Student Contribution," "Interactivity," and "Intertwinment." The students' HOTS skills were at a moderate level.

Third, the level of student activity was measured based on observation sheets for lecturers and students. The lecturer and student activity sheets were developed based on the syntax of the Learning Model. The assessment phases

were: 1) apperception: orienting the problem, facilitating the submission of data for clarification, and ensuring students analyze realistic processes; 2) problem-solving discussion: assisting students in problem-solving; 3) interaction patterns: representing and solving problems; and 4) reflection on work results: assisting students in evaluating the agreed-upon discussion results.

Fourth, student responses to the learning process in implementing the Learning Model were obtained through a questionnaire. Through this questionnaire, students expressed satisfaction with the components and activities of the Learning Model. Students reported experiencing something new from the learning activities. Students expressed interest in participating in experiential learning, focusing on interaction patterns with representation and problem-solving. The reason for their interest was that they had more experience with interaction patterns with representation and problem-solving. Through this learning model, students felt prepared to become teachers.

Fifth, the implementation of the Learning Model provides a platform for students to process. Some students reported experiencing difficulties accessing learning resources as a result of the learning process. During the learning process, they were actively involved, resulting in a division of tasks. Students stated they felt satisfied after participating in the learning process because they were fully engaged. The fatigue they felt was evidence that they had experienced the learning process.

4. Conclusion

Based on the results of the research and analysis of the data tests that have been conducted, it was concluded that the level of effectiveness of the development of the Problem Based Learning (PBL) learning model based on Technology Pedagogy Content Knowledge (TPACK) was proven effective in improving the higher order thinking skills (HOTS) of PGSD FKIP UMSU students. The research model is considered effective in supporting the learning process in students, so that prospective social

studies teachers can use the model as one of the strategies in classroom learning.

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