Implementation of TPACK-based problem-based learning model on social studies learning outcomes of elementary school students

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ABSTRACT

This study aims to determine Social Studies (IPS) learning outcomes with a problem-based learning model based on Technological Pedagogical Content Knowledge (TPACK) in elementary school students. The research method used is descriptive quantitative with quasi-experiment. The implementation was carried out in stages with the theory of Borg and Gall, and the main stages are (1) preliminary studies in the form of preparation and needs analysis; (2) preparation of model design and prototype model products in a participatory manner; (3) analysis of trials by learning technology experts; (4) operational trials carried out repeatedly / cycles accompanied by refinement of model products; (5) validation tests using pre-experimental design; and (6) dissemination of results. Data collection in this study was done using objective tests. Observations using observation guideline instruments on activities during the operational test process and pre-experimental tests. Questionnaires and performance assessments were used in the operational and model validation tests. The observation results were analyzed descriptively quantitatively, finding the mean, median, mode, standard deviation, and variance of each variable studied. Data analysis techniques used (1) descriptive analysis, (2) requirements test analysis, and (3) hypothesis testing. The findings of the research showed that elementary school students were motivated to learn by using TPACK-based problem-based learning models and had a high understanding of using ICT learning. The analysis of research results could affect the learning outcomes of social studies based on technological pedagogical content knowledge in elementary schools with an average score of 79.42. So, this research uses classroom action research conducted in 3 (three) cycles. The results obtained up to the third cycle stage (three) were declared complete.

INTRODUCTION

Learning involves joint activities between educators, students, and learning resources (Yurinda & Widyasari, 2022). Learning is carried out with various activities with the characteristics of doing, interaction, evaluation, and reflection, by improving the quality of creativity of students, learning is adapted to the development and psychology of students (Mustika & Temarwut, 2022). Social studies lessons in primary schools aim to prepare students to master knowledge, skills, attitudes and values that can be used as an ability to solve personal, social problems, and be able to make their own decisions (Amini et al., 2023; Azizah, 2021; Putri et al., 2019; Wiguna et al., 2023). This emphasis on problem-solving is a powerful inspiration for policymakers in the field of education.

National Education Regulation (Permendiknas) of the Republic of Indonesia Number 22 Year 2006, explains that the orientation of social studies education in primary schools, among others, (1) as a concept related to the life of society and its environment, (2) the ability to think logically and critically, (3) have a commitment and awareness of social values and humanity, (4) have the ability to communicate effectively. One indicator of the achievement of social studies learning objectives in primary schools, which is a problem in this study, is the low social studies learning outcomes (Aningsih et al., 2023; Mintarwati, 2020; Trisna et al., 2022).

Based on the results of pre-surveys and interviews with one of the fourth-grade social studies teachers at SDN Ciangsana 04 Bogor, it was found that social studies learning outcomes on the material of social issues are still low, still below KKM, teachers are still conventional in their application in learning, and as the root of the problem is the technological devices in schools there are still teachers who have not used ICT, or Technology Pedagogical Content Knowledge (TPACK).

TPACK is a framework that holds immense potential for modernizing pedagogical practices. It helps teachers understand and integrate technology into their teaching, creating a modernized learning environment. The Problem-based learning model, based on constructivism learning theory, further enhances this modernization by fostering collaborative problem-solving among students (Andriyani et al., 2021).

This research is very important because it presents an innovative solution to improve the quality of social studies education in primary schools, especially in Indonesia. Based on the results of a pre-survey at SDN Ciangsana 04 Bogor, it is known that student learning outcomes in social studies subjects still need to be higher and have yet to reach the expected standards. This condition requires pedagogical intervention that can significantly improve student learning outcomes. In this digital era, the use of technology in learning is an urgent need, but in reality, many teachers have yet to be able to utilize technology effectively (Bećirović, 2023; Dhakal, 2023; Pylypenko & Shuliak, 2023). The Technological Pedagogical Content Knowledge (TPACK) framework offers an approach that can help teachers integrate technology in ways that optimally support pedagogy and subject content (Durusoy & Karamete, 2023; Galindo, 2023; Rahayu et al., 2023).

The problem-based learning model integrated with TPACK is relevant to the national curriculum objectives listed in Permendiknas No. 22 in the Year 2006 and supports the development of 21st-century skills such as critical thinking, creativity, collaboration, and communication. This research will provide empirical evidence on how the TPACK-based PBL approach can improve social studies learning outcomes and other important skills students need to face future challenges. Thus, this research adds to the academic literature on the integration of TPACK and PBL and provides practical solutions for teachers and policymakers to advance education in Indonesia. In addition, the focus on the local context at SDN Ciangsana 04 Bogor provides relevant and applicable insights that can be applied in other schools across Indonesia, making this research invaluable for developing basic education in the country.

This research offers several significant novelties in the field of education. Firstly, it combines the problem-based learning (PBL) model with the technological pedagogical content knowledge (TPACK) framework. It is effective separately but has yet to be studied in the primary school context. This integrative approach is expected to provide new insights into how combining the two can comprehensively improve student learning outcomes. Secondly, this study is specific to social studies at the primary school level, which has yet to be widely explored in previous academic literature. Most research on TPACK tends to focus on higher levels of education, so this study fills an important gap in the study of primary education (Colón et al., 2023).

In addition, this research also focuses on the local context in Indonesia, specifically at SDN Ciangsana 04 Bogor. This makes an important contribution to education development in Indonesia by providing contextually relevant data and findings. This approach enables a more appropriate and effective adaptation of the problem-based learning model integrated with TPACK according to local needs and challenges (Waluyo & Nuraini, 2021a, 2021b). Thus, this study not only enriches the academic literature by providing new empirical evidence but also offers an innovative learning model that can be widely applied to improve the quality of education in primary schools in Indonesia.

Combining a Problem-Based Learning (PBL) model with a Technology Pedagogical Content Knowledge (TPACK) framework has been a rare occurrence in basic education research

Implementation of TPACK-based problem-based learning model ...
Desak Made Darmawati et al.

3

(Durusoy & Karamete, 2023; Witarsa & Siregar, 2023). While studies individually highlight the benefits of PBL and TPACK in improving student cognition and teacher readiness, integrating both approaches in a single study still needs to be improved. Research has shown that TPACK significantly influences student cognition and teacher practice, especially in subjects such as Civics (Dahnial et al., 2023). In addition, using TPACK in teacher education programs has been found to improve teaching practices and student learning outcomes, emphasizing the importance of integrating technology with pedagogy and content knowledge (Sofyan et al., 2023). Further exploration into the combined effects of PBL and TPACK in primary education may provide valuable insights into optimizing teaching strategies and student learning experiences.

This study's formulation of the problem is "Can the application of TPACK-based PBL affect student learning outcomes at SDN Ciangsana 04 Cikeas Cilengsi Bogor?" This study aims to determine the learning outcomes of social science by using a problem-based learning model approach based on Technological Pedagogical Content Knowledge (TPACK). This research is expected to contribute significantly by providing an innovative learning model that combines PBL and TPACK to improve social studies learning outcomes in primary schools, providing empirical evidence on the effectiveness of TPACK integration, offering insights for policymakers, as well as adding to the academic literature related to the application of TPACK-based PBL in the context of primary education in Indonesia. Finally, the focus on the local context at SDN Ciangsana 04 Bogor provides contextually relevant and applicable insights, which can be applied in other schools across Indonesia, thus improving the quality of basic education in the country.

METHOD

This research method uses a quasi-experimental design, a type of non-equivalent posttest-only control group design, or pseudo experiment, where all variables can be strictly controlled, and this research is only applied and carried out in a short time. This design uses 2 (two) classes, namely the experimental and control classes (Arikunto, 2009). In this study, there are 2 (two) groups, each of which is randomly selected (R). The first group is given treatment (X), and the other is not. The treated group is the experimental group, and the untreated group is the control group. The effect of treatment (treatment) is (O1: O2). This research was conducted at Ciangsana 04 Bogor State Elementary School, with a sample size of 53 students, class IV A, and class IV B as the experimental and control classes.

The method used in collecting data in this study is to use tests (objective tests), namely data on social studies learning outcomes with the problem-based learning (PBL) model. Data collection obtained through social studies learning outcomes with a problem-based learning model was analyzed descriptively and quantitatively, namely by looking for the price of mean, median, mode, and standard deviation variance of each variable studied (Santoso et al., 2023). The data analysis technique used (1) descriptive analysis, (2) testing of analytical requirements, and (3) hypothesis testing by systematically collecting factual data regarding the relationship between facts and phenomena being investigated (Prihatiningsih, 2018). The research sample distribution table can be seen in Table 1.

Table 1. Sample Distribution

No.	Class Population	Group	Number of Classes
1	Class IV A	Experiment	28
2	Class IV B	Control	25
	Total		53

This design uses 2 (two) classes, namely the experimental and control classes (Arikunto, 2009). The implementation was carried out in stages with the theory of Borg and Gall (1983). The main stages are (1) preliminary studies, in the form of preparation and needs analysis; (2) preparation of design models and prototype model products in a participatory manner; (3) analytical tests with technology learning, together with craftsmen/business people; (4) operational tests carried out

repeatedly/cyclically accompanied by refinement of model products; (5) validation tests using pre-experimental design; and (6) dissemination of results. Schematically visualized in Figure 1.
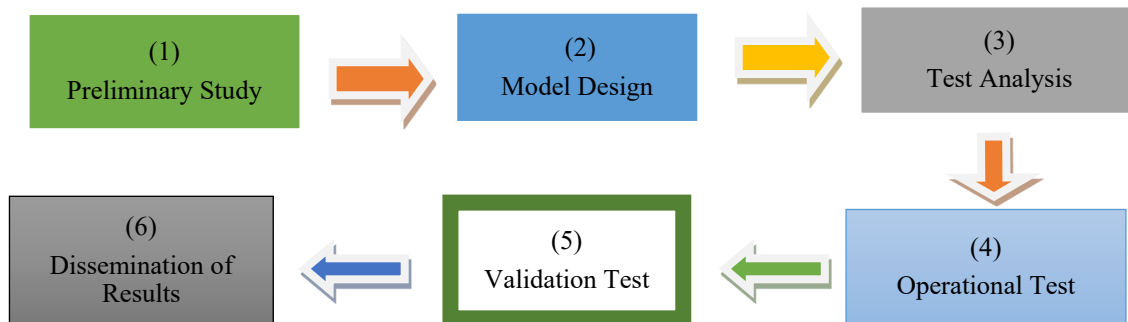

Figure 1. Model Implementation Steps (Borg & Gall, 1983)

Data collection involved interviews, FGD (Forum Group Discussion), document review, observation, questionnaires, and vocational skills performance tests. The questionnaire used in the operational test and model validation test was adapted from an instrument developed by Shapornnanon, et al (Detregiachi & Altran, 2023). The adaptation process involved [specific steps or considerations], ensuring the validity and reliability of the instrument.

Data analysis of research on the implementation of TPACK-based PBL learning, the results of the evaluation validation test showed that the overall instrument had an average score of 4.3 with a very good/acceptable category. To test the reliability of the instrument using suggestions from Gronlund and Waugh (2008), namely by comparing the results of research on the vocational skills of learning citizens showed a high correlation coefficient (correlation coefficient of the cycle I of 0.888, cycle 2 of 0.652, and pre-experiment of 0.768, which also means the instrument is reliable, then the data was analyzed using quantitative descriptive techniques and paired sample t-test.

RESULT AND DISCUSSION

Result

The social studies learning outcomes of students in class IV A and B obtained a reliability result of 0.908, the range criteria obtained are $0.80 \leq r11 < 1.00$, then the calculation data based on experimental trials using the TPACK-based PBL model, the calculation data can be described that the data on the social science learning outcomes of class IV A students after taking part in learning with the experimental class treatment with a median value of 78.96, mode value of 75.30, average value of 79.42 and standard deviation value of 10.25 with details as can be seen in Table 2.

Table 2. Frequency Distribution List of Social Studies Learning Outcomes (Experiment Class)

No.	Class Interval	Mark Middle (xi)	Law Real	Frequency		
				Absolutely	**Cumulative**	**Relatively**
1	60 - 66	63	59.5 - 66.5	3	3	10.7%
2	67 - 73	70	66.5 - 73.5	6	9	21.4 %
3	74 - 80	77	73.5 - 80.5	7	16	25%
4	81 - 87	84	80.5 - 87.5	4	20	14.3%
5	88 - 94	91	87.5 - 94.5	6	26	21.4
6	95 - 101	98	94.5 - 101.5	2	28	7.1%
	Total			28		

Based on the results of the frequency distribution table in Table 2, the learning outcomes data can be made into histograms and bar charts as in Figure 2. Based on the experimental class's frequency distribution table, histogram graph, and bar chart, the smallest value is 60, and the largest value is 100; more students scored in the 74-80 range, as many as seven students or 25 percent.
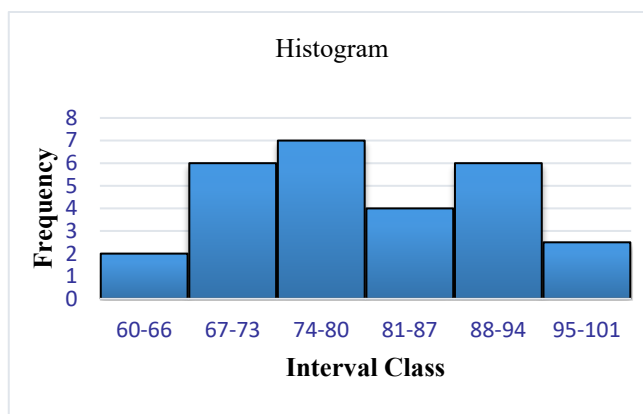
Implementation of TPACK-based problem-based learning model ...
Desak Made Darmawati et al.

5

Figure 2. Histogram of Social Studies Learning Outcomes (Experimental Class)

Learning outcomes without applying ICT media (control class) were conducted on respondents of class IV/B students. Based on the results of trials conducted by researchers in the control class, the median value was 71.80, the mode value was 69, the average value was 73.28, and the standard deviation value was 10.24. Table 3 shows the frequency distribution of social studies learning outcomes in the control class.

Table 3. Frequency Distribution List of Social Studies Learning Outcomes (Control Class)

No.	Class Interval	Mark Middle (xi)	Law Real	Frequency		
				Absolutely	Cumulative	Relatively
1	52 - 58	55	51.5 - 58.5	2	2	8%
2	59 - 65	62	58.5 - 65.5	4	6	16%
3	66 - 72	69	65.5 - 72.5	7	13	28%
4	73 - 79	76	72.5 - 79.5	4	17	16%
5	80 - 86	83	79.5 - 86.5	5	22	20%
6	87 - 93	90	86.5 - 93.5	3	25	12%
	Total			28		

Based on the frequency distribution table in Table 3, the histogram graph in the control class obtained the smallest value of 52 and the most significant value of 92, with a range of 66-72, as many as seven students or 28 percent.
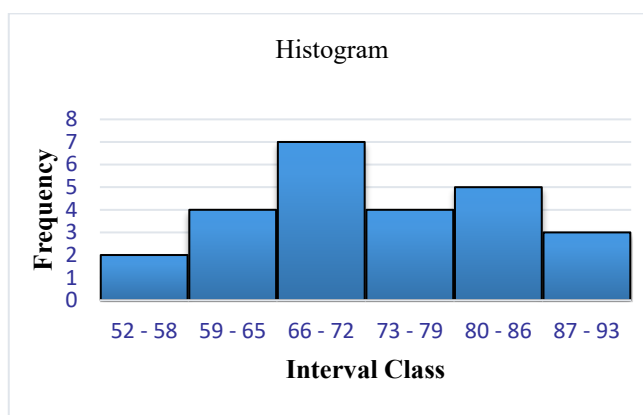

Figure 3. Histogram of Social Studies Learning Outcomes (Control Class)

In the normality test using the Liliefors test with a significance level of 5% (0.05). From the calculation results based on the normality test table after that the highest absolute price value between the difference between F (Zi) and S (Zi) is taken, which is referred to as L0 (L_{count}). This test is carried out to see whether the data tested is normally distributed or not. At the critical value for the Liliefors test at the 5% significance level (0.05) with n experimental class of 28, the Ltabel is 0.161 and n control class is 25, the L_{count} is 0.173.

Hypothesis testing states that H0 is normally distributed data, and H1 is not normally distributed data. With testing criteria: Accept H0 if $L_{count} < L_{table}$, then the data is normally distributed, and reject H1 if $L_{count} > L_{table}$, then the data is not normally distributed. In the calculation of the normality test of social studies learning outcomes in the experimental class using the PBL learning model based on TPACK obtained $L_{count} < L_{table}$, which is 0.085 < 0.161 and the significance level is 0.05 with n number 28, then H0 is accepted, and the sample used comes from a normally distributed population.

Reiterating the results, the normality test of social studies learning outcomes in the control class, conducted without the PBL model with the TPACK approach, yielded a result of $L_{count} < L_{table}$, specifically 0.074 < 0.173. With a significance level of 0.05 and a sample size of 25, H0 is accepted. This confirms that the sample used is from a normally distributed population, a key finding in our research. Reiterating the results, the normality test of social studies learning outcomes in the control class, conducted without the PBL model with the TPACK approach, yielded a result of $L_{count} < L_{table}$, specifically 0.074 < 0.173. With a significance level of 0.05 and a sample size of 25, H0 is accepted. This confirms that the sample used is from a normally distributed population, a key finding in our research.

Table 4. Normality Test of Social Studies Learning Outcomes in Experimental and Control Classes

Group	n	L_{count}	L_{table}	Criteria	Information
Class Experiment	28	0.085	0.161	$L_{count} < L_{table}$	Normal distributed data
Control Class	25	0.074	0.173		

Test the homogeneity of the two groups using Fisher's Test. Fisher's test uses the formula $S^2 = \frac{n.\Sigma FX^4 - (\Sigma FX)4}{n\,(n-1)}$ in the experimental class the variance was 105.14 and in the control class the variance was 104.96. After knowing the variance in the two groups, then the results $Fcount = \frac{Largest\ variance}{Smallest\ variance} = \frac{105.14}{104.96} = 1.001$ the results of F_{count}, the comparison of Ftable with F_{table} is 1.95. The results of the homogeneity test obtained $F_{count} < F_{table}$, namely 1.001 < 1.95, so it can be concluded that the two data groups were declared homogeneous.

Table 5. Homogeneity Test Calculation Results

Group	Variance (S^2)	F_{count}	F_{table}	Criteria	Information
Experiment	105.14	1.001	1.95	$Fcount < Ftable$	Homogeneous
Control	104.96				

Normality test and homogeneity test were conducted to determine whether social studies learning outcomes can be improved by using TPACK-based PBL learning model. Hypothesis testing was carried out by conducting a t-test. The calculation of this t-test is carried out to determine whether there is an effect after treatment. If the calculation of the data has an effect then the tcount must be greater than the ttable. Where H0: there is no effect of PBL model with TPACK approach to social studies learning outcomes of grade IV students of SDN Ciangsana 04 Bogor, and H1: there is an effect of PBL learning model with TPACK approach to social studies learning outcomes in grade IV students at SDN Ciangsana 04 Bogor.

Based on the calculation results t_{count} of 2.224 and ttable at the significance level α = 0.05 with dk = 51 it is obtained at 2.007. so, tcount > t_{table} diproleh of 2.224 > 2.007. For this it can be seen that, H0 rejected, then H1 accepted. The results of this study, "There is an influence on social studies

Implementation of TPACK-based problem-based learning model ...
Desak Made Darmawati et al.

7

learning outcomes for class IV between the experimental class using the PBL learning model based on TPACK SDN Ciangsana 04 Bogor with an average value of 79.42".

Table 6. Calculation Results of Hypothesis Test with t-test

t_{count}	t_{table}	Criteria	Information
2.224	2.007	$t_{count} > t_{table}$	There is the influence of the TPACK-based PBL model on social studies learning outcomes for fourth grade students at SDN Ciangsana 04 Bogor,with an average value of 79.42.

Discussion

Researchers analyzed social studies subjects using economic activity material and the TPACK-based PBL model. The material consists of one Basic Competency (KD) and three indicators. The research was conducted in 2 meetings, each class 1 meeting. We will meet in class IV A, which is the experimental class. Based on the calculation of learning outcomes that have been carried out, the highest score in the experimental class was 100 for one student, and the lowest score was 60 for one student. According to the observations of researchers, students who get a score of 100 or the highest score and students who are active and motivated by using ICT media.

Based on the calculations in the experimental class by applying the TPACK-based PBL learning model, the average score is 79.42, and the standard deviation is 10.25. Furthermore, the research continued in class IV B, the same as in class IV A. Based on the calculations that have been carried out in the control class, the average value is 73.28, and the standard deviation is 10.24.

In the control class, it was found that students who got the highest score of 92 were one student, and students who got the lowest score of 52 were one. It can be seen from the average of the experimental class using the PBL learning model with the TPACK approach, where the average value is greater than the control class. The atmosphere in the classroom that uses the TPACK-based PBL model is more conducive and active than the control class that uses conventional methods.

From this description, it can be proven by the evaluation test results and statistical test analysis obtained count of 2.224 and table at the significance level $\alpha = 0.05$ with dk = 51 obtained by 2.007, $t_{count} > t_{table}$ obtained by 2.224 > 2.007, and it can be seen that H0 is rejected and H1 is accepted, which means there is a difference or there is an influence on social studies learning outcomes in class IV between the experimental class using the TPACK-based PBL model and the control class at SDN Ciangsana 04 Bogor.

Implementing learning by using a problem-based learning (PBL) model that applies ICT can help students actively seek answers to problems given by the teacher. In calculating the normality test of social studies learning outcomes in the experimental class using the TPACK-based PBL learning model obtained $L_{count} < L_{table}$, namely 0.085 < 0.161 and a significance level of 0.05 with n of 28, then H0 is accepted. The effectiveness of the problem-based learning (PBL) learning model in research conducted based on TPACK can be produced in accordance with the achievement of the acquisition of an average class score of 79.42.

The TPACK-based problem-based learning model on Social Studies Learning Outcomes has a significant effect on the results obtained, seen from the effect size of the difference in the experimental group has a more significant change in value than the control group in the application of the PBL model, there is an increase in students' creative thinking. In accordance with the characteristics of the problem-based learning model, namely, the problems used are daily life problems experienced by students (real problems), problem-solving makes students gain knowledge, students learn more actively with very varied learning resources, so teachers must be creative, design classes with a pleasant atmosphere (Purba et al., 2023; Simangunsong et al., 2023).

As for the source of research on the problem-based learning model to improve student learning outcomes conducted by researchers (Superman & Husen, 2015), the results of this study indicate that applying the problem-based learning model can improve student learning outcomes in cycles I and Cycle II, and is very influential on learning tools and facilities with ICT technology,

related to the research we conducted using TPACK-based PBL there is a novelty in modernizing learning that is charged with technological knowledge which is very influential on social studies learning outcomes, proven to be able to improve children's ability to achieve results by student KKM as seen from the increase in results in each learning cycle.

Researchers have conducted several studies on the effectiveness of problem-based learning models in improving student learning outcomes in various subjects and grade levels. Studies by Pratama et al. (2023), Cahyaningsih et al. (2023), Santoso et al. (2023), Sukma et al. (2023), and Hima et al. (2023) all show positive results in improving student learning outcomes through the implementation of PBL. These studies were conducted in various educational settings, including primary and secondary schools, focusing on subjects such as Pancasila education, civic education, linear equations, and science. Consistent findings across these research papers highlight the effectiveness of the PBL model in improving student learning outcomes, making it a valuable approach for educators to consider in their teaching practices.

Related to the research that researchers conducted using TPACK-based PBL, there is a novelty in modernising learning that is charged with technological knowledge which is very influential on social studies learning outcomes, proven to be able to improve children's ability to achieve results according to student KKM as seen from the increase in results in each learning cycle.

This study has several limitations that need to be considered. Firstly, the research subjects were limited to primary school students in one school, namely SDN Ciangsana 04 Bogor. This specificity may limit the generalisation of the results to the entire population of primary school students in Indonesia. Secondly, the method used was a quasi-experiment with a pre-experiment design, which did not involve a control group for direct comparison, thus limiting the ability to determine the causal effect of the intervention. The study duration limited to a few cycles may also not be long enough to measure the long-term impact of implementing the TPACK-based problem-based learning model, potentially underestimating its effectiveness.

While this study mainly focuses on social studies learning outcomes and students' learning motivation, it should be noted that it does not explore the impact on other aspects such as social skills, creativity or affective aspects that are also important in learning. The measurement instruments used, such as objective tests, observations, questionnaires and performance assessments, were selected with great care and rigour to ensure the reliability of the findings within the scope of the study.

Limited resources such as time, experts, and technological support available in schools may also affect the implementation and results of the research. The successful implementation of the TPACK-based problem-based learning model relies heavily on the active participation of teachers and students (Safitri & Setiyawati, 2023). Variations in the level of participation and technological readiness from one class to another may affect the results of the study (Jariwala et al., 2018). Finally, the findings of this study are highly contextualised and specific to the educational environment at SDN Ciangsana 04 Bogor, so implementation in other schools with different contexts may require additional adaptations, such as modifying the intervention to suit the needs and resources of the school.

While recognising these limitations, it is important to note that the results of this study, despite the constraints, offer valuable insights. The results of this study pave the way for future research, inspiring us to further explore and implement these findings in diverse educational contexts.

The implications of this study underscore the effectiveness of the TPACK problem-based learning model in improving social studies learning outcomes in primary schools, providing crucial directions for future research. Future studies could explore the applicability of this model to different subjects and education levels to ensure the consistency of its effects and extend the duration of the intervention to observe the long-term impact.

In addition, research can measure the impact on students' social skills, creativity, and affective aspects. Recognizing the importance of active participation from teachers and students, it is essential to develop and evaluate effective teacher training programs for implementing TPACK. The constructivist learning theory underlying PBL (Reigeluth, 2013) and the TPACK concept introduced by Mishra and Koehler (2006) emphasize the urgency of technology integration in pedagogy to improve learning quality. Further research could explore how technological support and

Implementation of TPACK-based problem-based learning model ...
Desak Made Darmawati et al.

9

infrastructure could be improved to support the wider application of this model (Mishra & Koehler, 2006; Reigeluth, 2013).

CONCLUSION

This study concluded that the Technological Pedagogical Content Knowledge (TPACK)-based problem-based learning model effectively improves social studies learning outcomes in primary schools, with an average score of 79.42 showing a significant increase. However, this study has limitations, such as limited subject coverage in one school and the absence of a control group. Therefore, for future research, it is recommended that the research subjects be expanded to various schools with different socio-economic backgrounds and that an experimental research design with a control group be used for stronger validity of the results. In addition, the duration of the intervention can be extended to observe the long-term impact, and research can explore the influence of this model on students' social skills, creativity, and affective aspects. It is also important to develop training programs for teachers to be more effective in implementing TPACK and improve technological support and infrastructure in schools. Thus, this study provides practical insights to improve social studies learning outcomes and opens up opportunities for further research that can strengthen and extend these findings in various educational contexts.

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Implementation of TPACK-based problem-based learning model ...
Desak Made Darmawati et al.

11

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