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The Practicality of the Problem Based Learning (PBL) with the Integration Pattern of Science, Technology, and Society (STS) Education for Grade 4 Elementary School Students

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Abstract

This study aimed to describe the practicality of the Problem-based Learning (PBL) with the integration pattern of Science, Technology, and Society (STS) education for fourth-grade elementary school students. In this study, the development research model was used, referring to Borg and Gall's, a process carried out to produce and test an educational product. The results of the study showed (1) the total mean implementation of the PBL-STS model obtained a score of 1.7 and was declared implemented based on the implementation criteria of the PBL-STS model; (2) The total percentage of learning implementation obtained a value of 89.1% and was declared good based on the learning implementation criteria; and (3) the total percentage of student activity obtained a value of 86.3% and was declared good based on student activity criteria. Based on these results, it can be concluded that the PBL-STS Model is practical for fourth-grade elementary school students.

Keywords: Practicality, Models, Problem-based Learning, Science, Technology, Society

INTRODUCTION

The success of education cannot be separated from the implementation of learning in it. Therefore, teachers who have a role as learning executors must have adequate skills to develop good learning. These skills are related to how the teacher's efforts in making learning can be carried out easily (practically). This is in line with what was stated by Nieveen that the second characteristic of good quality material is that experts (and also practitioners) consider that the material can be implemented and is easy for teachers and students to apply the material based on the method set by the developer (1999).

Based on the Teacher Professional Development Program assessment instrument at one state university in Surabaya, Indonesia, it is known that one aspect of mastery of the material, namely applying the concept of learning material in life, still needs improvement. Teachers tend to prioritize knowledge or skills that students gain through real examples and their relationship with the latest information but do not connect them with science, environment, technology, and society. For instance, on one occasion, the teacher wants students to master the concept of alternative energy, and the teacher conducts a question-and-answer activity to students regarding examples of alternative energy. When students don't know or are stuck, the teacher immediately tells students through real examples and their relationship to the latest information, for example, the use of sunlight as alternative energy for solar panel lights which are often found on the streets. Next, students are asked to name other examples. Teachers should also guide students so they can make connections between the material being taught and science, the environment, technology, and society. This is in accordance with the dimensions of knowledge in the competency standards for graduates of primary and secondary education based on the Decree of Indonesian Ministry of Education Number 20 of 2016, which is to make students individuals who understand science, technology, arts, and culture and have a human, national, state and civilized perspective. However, teachers are also not allowed to do things that should be done so that they are relevant to the Decree of Indonesian Ministry of Education Number 20 of 2016 (Ministry of Education, 2016). More than that, teachers must also do it easily (practically). Learning will be difficult without being able to do it easily, so the expected learning objectives may not be achieved. Therefore, control or supervision is needed through observation to ensure that learning can really be carried out easily.

The ideal learning conditions in teaching material to students are by providing real examples and their relationship to the latest information. In addition, the teacher must also guide students to make connections between the material being taught and science, technology, and society in the context of contextual problem-solving. The students have the knowledge to make informed decisions about the role or impact of science and technology in Public. This is to be in line with Permendikbud Number 20 of 2016, which the researchers alluded to above regarding the dimensions of knowledge in the competency standards for graduates of primary and secondary education.

There is a learning model close to the above conditions: Problem-based Learning (PBL). Kilbane and Milman stated, "Solving problems is a part of everyday life … quality of life is influenced by our ability to solve problems" (2014). Problem-solving is part of everyday life, so the quality of human life is influenced by the ability to solve problems. Meanwhile, Tan (2006) states that schools in the United States often use PBL in learning for several reasons, namely the use of real-world problems involving student activity, interdisciplinary learning, students can make choices in learning, and collaborative learning. PBL can help improve the quality of education with an emphasis on problem-solving and thinking. Tan (2006) further explained that PBL includes several characteristics, namely the starting point of learning begins with a problem, the use of real-world problems, the use of cross-disciplines, provides challenges to students, and students have the responsibility for independent learning, utilization of various resources, collaborative learning, developing problem-solving skills, closing activities include synthesis and integration of learning, and ends with evaluation and review of learning experiences. From some of the characteristics of

PBL, we do not see an emphasis on aspects of science, technology, and society in contextual problem-solving. This is very important, considering that problem-solving can be done with science as a process of scientific discovery. The results of this knowledge are then manifested in the form of technology, both in the form of tools, ideas, and ideas that are later used to solve societal problems. This is in line with what Tan stated, namely that breakthroughs in science and technology are often the result of being linked to problems. Ziman (1980) states that valid science is taught as if it has no relationship with the world about it. In fact, it is related in many ways to society, especially through its technological applications. Based on this study, we sparked the idea of integrating the PBL model so that it fits the ideal learning conditions that the researchers mentioned above, namely learning. We guide students so they can make connections to the material being taught with science, technology, and society in a contextual problem-solving context. This is where the basis or foundation for researchers integrates the PBL model with Science, Technology, and Society (STS) education so that it becomes the PBL-STS model.

The purpose of STS education itself is to present an objective view of the world which tends to be dominated by science and technology, to students and to use science and technology issues that involve students in it to carry out critical analysis regarding the impact it has on society (Kumar & Chubin, 2010). Meanwhile, Ziman (1980) stated, "The STS theme has both descriptive and analytical aspects, it is open-ended, it can arouse interest and feeling, it can exercise hard thinking and thoughtful action". That is, the STS theme has descriptive and analytical aspects, is open, can generate interest and attention, and can train hard thinking and wise action. Therefore, with the development of the PBL-STS model, it is hoped that it will be able to train students to think critically so that they can act wisely based on information about the role or impact of science and technology in society.

Nieveen (1999) suggests that the second characteristic of good quality material is that experts (and practitioners) consider that the material can be implemented, and it is easy for teachers and students to apply the material based on the method set by the developer. The second characteristic is related to one of the operational forms of the PBL-STS model, namely RPP (Lesson Plan). RPP guide for implementation of the PBL-STS model and the implementation of learning carried out by the teacher, as well as the activities of students in implementing the PBL-STS model. Previous study show the practical application of the PBL in learning activities, one of which is the results of research from Hye-Young et al. (2020), which explains that students' responses to the statement "I am actively participating in this class" from a survey about learning experiences using the PBL indicate a level of satisfaction which is high or 91.4%. The results of this study are relevant to the researchers' idea of developing a practical PBL-STS model and a differentiator from research conducted by Hye-Young et al. (2020), namely that there is a pattern of integration of STS education into PBL. In developing the practical PBL-STS model, we seek to arrange its operational form so that it can be used easily by teachers and students according to the method that the researchers have determined. One is to provide opportunities for teachers to be more creative and inspire students to learn more actively by developing their mindset through questions and arguments so that students can practice their critical thinking skills. This is where what researchers mean is relevant between the research results of Hye-Young et al. (2020) and what researchers are doing, one of which is to make students more initiative (proactive/active). With active students, it can be interpreted that students easily (practically) implement the PBL-STS model because it is impossible for students to easily (practically) implement the PBL-STS model if students are not active.

Based on the background described above, researchers will conduct research that aims to describe the practicality of the Problem-based Learning (PBL) model with an integration pattern of Science, Technology, and Society (STS) education for fourth-grade elementary school students.

METHOD

This research aims to describe the practicality of the PBL-STS model for fourth-grade elementary school students. The PBL-STS model in this study is of the development type commonly referred to as R & D (Research and Development) with a quantitative and qualitative approach. The products produced in this development research include the PBL-STS model along with its syntax or steps and learning tools consisting of lesson plans.

In this development research, a development research model is used, which refers to the property of Borg and Gall. According to Borg and Gall (2003), educational research and development (R & D) is a process of producing and testing an educational product. However, the purpose of academic research is not only the development of a product but also an effort to discover new knowledge (using basic research) or to find answers to specific questions related to practical problems (using applied research).

The following are the stages in which this development research will be carried out by referring to Dick and Carey's learning system development design model (Dick and Carey, 2003).

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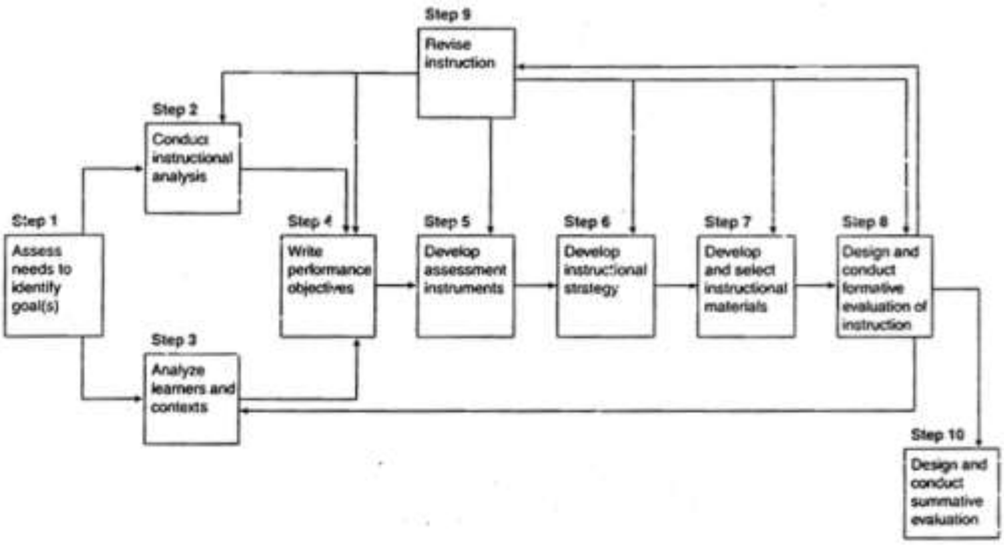

Figure 6. The Systematic Design of Instruction (Dick dan Carey, 2003)

The subjects of this study were fourth-grade students of School X in the Surabaya area. The selection of subjects and test locations was based on theoretical and practical considerations, namely (1) the cognitive development of fourth-grade students who were in the concrete operational stage, making it possible to teach high-level (critical) thinking skills; (2) Class IV students of School X in the Surabaya area come from diverse backgrounds, thus allowing for interaction from students with different characters; (3) The open attitude of the stakeholders of School X in the Surabaya area in the context of improving the quality of learning; and (4) School X in the Surabaya area implements the 2013 Curriculum so that it is in line with the development of the PBL-STS model that the researchers did.

In this study, the data collection technique used by the researcher is observation, which is a data collection technique that provides the opportunity for researchers to go directly into the field to observe the situation. This is in line with what was stated by Cohen et al. (2007), namely that this technique offers researchers to collect data directly from situations that occur naturally. In this study, researchers used this technique to collect data on the practicality of the PBL-STS model by observing aspects of the implementation of the PBL-STS model, learning implementation, and student activities. The assessment instruments used were the observation sheet for implementing the PBL-STS model, the observation sheet for implementing learning, and the student activity observation sheet. The data collected on the practicality of the PBL-STS model will be carried out for three meetings based on the time and theme that the researcher has determined.

Data on the implementation of the PBL-STS model were analyzed using the following formula.

$$P = \frac{\text{Total score achieved}}{\text{The total number of aspects of the implementation of the PBL-STS model}}$$

Information:

P = Implementation of PBL-STS model

The criteria for measuring the implementation of the PBL-STS model use parameters from Nurdin (2007) which in more detail can be seen in Table 1.

Table 1. The criteria of PBL-STS model Implementation

Grade	Criteria
$1.5 \leq M \leq 2$	Implemented
$0.5 \leq M < 1.5$	Partially implemented
$0.0 \leq M < 0.5$	Not done

Data on the implementation of the PBL-STS model were analyzed using the following formula.

$$P = \frac{\text{Total score achieved}}{\text{The total score of all aspects of the implementation of learning}}$$

Information:

P = Percentage of learning implementation.

The criteria for measuring the implementation of learning use parameters from Hinton (2004) which can be seen in Table 2.

Table 2. Learning Implementation Criteria

Percentagae (%)	Criteria
90.00 - 100.00	Very good
70.00 - 89.99	Good
50.00 - 69.99	Enough
00.00 - 49.99	Not good

Student activities in the implementation of learning using the PBL-STS model are analyzed using the following formula.

$$P = \frac{\text{Number of students doing certain observation categories}}{\text{Number of all students}}$$

Information:

P = Percentage of student activities

The criteria for measuring student activity use parameters from Hinton (2004) which in more detail can be seen in Table 3

Table 3. Student Activities Criteria

Percentagae (%)	Criteria
90.00 - 100.00	Very good
70.00 - 89.99	Good
50.00 - 69.99	Enough
00.00 - 49.99	Not good

Based on the parameters that the researchers used as a reference above, the PBL-STS model was concluded to be practical with interpretation, namely (1) The implementation aspect of the PBL-STS model obtained a value of 1.5 M 2 or was in the implemented criteria, (2) Aspects of minimum learning implementation get a percentage of 70.00 - 89.99 or are in good criteria, and (3) Aspects of student activity at least get a percentage of 70.00 - 89.99 or are in good criteria.

RESULTS AND DISCUSSION

We conducted a practicality test after the PBL-STS model books, RPP, and assessment instruments (PBL-STS model implementation observation sheets, learning implementation observation sheets, and student activity observation sheets) met the eligibility criteria (valid) and were revised.

The following are the research results on aspects of the implementation of the PBL-STS model, which were observed by two observers using the instrument sheet for observing the implementation of the PBL-STS model, which can be seen in Table 4.

Table 4. Observation Results of the PBL-STS Model Implementation

Phases	Meeting			Average	Criteria
	1	2	3		
Phase 1: *Meeting the problem.*	1,6	1,7	1,8	1,7	Implemented
Phase 2: *Problem analysis and learning issues.*	1,8	2	1,5	1,8	Implemented
Phase 3: *Discovery and reporting.*	1,5	1,5	1,8	1,6	Implemented
Phase 4: *Solution presentation and reflection.*	1,8	2	1,8	1,9	Implemented
Phase 5: *Overview, integration and evaluation.*	1,8	1,6	1,8	1,7	Implemented
Average	1,7	1,8	1,7	1,7	Implemented

**The score of each meeting is the average score of observers one and observer two obtained from each phase observed. While the average score in the bottom row is obtained from the average score of all phases in each column*

The following are the research results on aspects of the implementation of learning observed by two observers using the learning implementation observation sheet instrument, which can be seen in Table 5.

Table 5. Observation Results of Learning Implementation

Aspect	Meeting			Percentage	Criteria
	1	2	3		
Phase 1: *Meeting the problem.*					
Ask each group to read the problems presented in the student worksheets.	4	4	4	100	Very Good
Provide a stimulus by asking philosophical questions to the problems presented.	3.5	3.5	3.5	87.5	Good
Directing students to the focus of the problem from the questions or arguments (ideas) made.	3.5	3.5	3.5	87.5	Good
Phase 2: *Problem analysis and learning issues.*					
Request and monitor the involvement of students independently in finding information that is relevant to the questions or arguments (ideas) made, as well as confirming the credibility of the sources used.	3.5	3.5	3	82.5	Good
Phase 3: *Discovery and reporting.*					
Confirm to students the validity, accuracy, and reliability of the information obtained.	3.5	3.5	3.5	87.5	Good
Phase 4: *Solution presentation and reflection.*					
Providing understanding or stabilization to students by clarifying doubts, gaps and misunderstandings or excessive generalizations, so that the group is ready to present the results of the discussion.	3.5	3.5	4	92.5	Very Good
Phase 5: *Overview, integration and evaluation.*					
Provide input and awards to students.	3.5	3.5	3.5	87.5	Good
Together with students summarize or conclude the material, and provide feedback.	3.5	3.5	3.5	87.5	Good
Percentage	89.1	89.1	89.1	89.1	Good

** The score for each meeting is the average score of the first and second observers obtained from the aspects observed in each phase. While the percentage score on the bottom row is obtained from the average acquisition score of all aspects observed in each phase in each meeting column divided by the maximum score, then multiplied by 100%.*

The following are the research results on aspects of student activity observed by two observers using the instrument observation sheet of student activity can be seen in Table 6.

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Table 6. Observation Results of Student Activities

Aspect	Meeting			Percentage	Criteria
	1	2	3		
Phase 1: *Meeting the problem.*					
Read the problems presented in the student worksheets.	27.5	27.5	28.5	92.7	Very Good
Make questions or arguments (ideas) from the problems presented.	24.5	25.5	24.5	82.7	Good
Determine the focus of the problem from questions and arguments (ideas) made through question and answer activities with group members.	25.5	25	25.5	84.3	Good
Phase 2: *Problem analysis and learning issues.*					
Construct knowledge independently in seeking information (external input) by utilizing various learning resources, such as: ➢ Reading student books; ➢ Interviewing characters; and ➢ Browsing. All of this is done by expressing opinions and analyzing problems in the form of deductions/inductions or decisions.	27.5	27.5	28	92.3	Very Good
Phase 3: *Discovery and reporting.*					
Discuss by reporting the information students have obtained to each group member. And conduct investigations by providing further explanation of the deduction/induction or decisions given by finding terms and assumptions (opinions), as well as considering the definitions (limitations) used, as well as determining the	25.5	26.5	25.5	86	Good

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Aspect	Meeting			Percentage	Criteria
	1	2	3		
relationship of the problems presented with science and technology (actions/technology applications), and society (interaction).					
Phase 4: *Solution presentation and reflection.*					
Presenting the results of the discussion by rearranging the knowledge gained (problems of exploiting natural resources in Indonesia) and demonstrating new knowledge (relationships of the problems presented with science, technology (actions/technological applications), and society (interaction)) in a short, clear, and use good and correct language, and based on the results of analysis either orally, in writing, or using other media.	24.5	26.5	25.5	85	Good
Phase 5: *Overview, integration and evaluation.*					
Provide input on the learning resources used.	24.5	25.5	24.5	82.7	Good
Reflect on newly acquired knowledge and evaluate what they do as problem solvers, independent learners, and team members.	25.5	24.5	25.5	84	Good
Percentage	85.5	86.9	86.5	86.3	Good

** The score for each meeting is the average score of observer one and observer two, which is obtained from the number of students who carry out activities based on the aspects observed in each phase. While the percentage score on the bottom row is obtained from the average acquisition score of all aspects observed in each phase in each meeting column divided by the maximum score, then multiplied by 100%.*

Based on the data on the implementation aspects of the PBL-STS model, the implementation of learning, and student activities above, the researcher will discuss them as follows.

The Implementation of PBL-STS Model

Based on Table 4 above, the average implementation of the PBL-STS model at meetings 1, 2, and 3, respectively, was 1.7, 1.8, and 1.7. The mean total implementation of the PBL-STS model obtained a score of 1.7 and was declared implemented based on the criteria for implementing the PBL-STS model.

After being declared feasible by learning product design experts and material experts, the PBL-STS model was then implemented and measured using the PBL-STS model implementation sheet instrument to determine the practicality of the PBL-STS model from the aspect of the implementability of the PBL-STS model. These eligibility criteria can be interpreted if the validator thinks the PBL-STS model can be used easily by teachers. This can be seen in Table 4, which shows the average implementation of the PBL-STS model at meetings 1, 2, and 3, respectively were 1.7, 1.8, and 1.7. The mean total implementation of the PBL-STS model obtained a score of 1.7 and was declared implemented based on the criteria for implementing the PBL-STS model. The implemented criteria obtained show that the teacher, as one of the executors, can easily apply the PBL-STS model based on the method the researcher has determined. The research results at the same time, reinforce the theory put forward by Nieveen (1999), that the second characteristic of good quality material is that experts (and practitioners) consider that the material can be implemented. It is easy for teachers and students to apply the material based on predetermined methods by the developer.

Learning Implementation

Based on Table 5 above, the percentage of learning implementation at meetings 1, 2, and 3 was 89.1%, 89.1%, and 89.1%, respectively. The total percentage of learning implementation obtained a value of 89.1% and was declared good based on the learning implementation criteria.

After being declared feasible by learning product design experts and learning material experts, the PBL-STS model was then implemented and measured using the learning implementation sheet instrument to determine the practicality of the PBL-STS model from the aspect of learning implementation. These eligibility criteria can be interpreted if the validator thinks the PBL-STS model can be used easily by teachers. This can be seen in Table 5, which shows the average implementation of learning at meetings 1, 2, and 3, respectively 89.1%, 89.1%, and 89.1%. The total percentage of learning implementation obtained a value of 89.1% and was declared good based on the learning implementation criteria. The good criteria obtained indicate that the teacher, as one of the executors, can easily apply the PBL-STS model based on the method the researcher has determined. The research results, at the same time, reinforce the theory put forward by Nieveen (1999) that the second characteristic of good quality material is that experts (and practitioners) consider that the material can be implemented and it is easy for teachers and students to apply the material based on predetermined methods by the developer.

Students Activities

Based on Table 6 above, the percentage of student activity at meetings 1, 2, and 3, respectively, is 85.5%, 86.9%, and 86.5%. The total percentage of learning implementation obtained a value of 86.3% and was declared good based on student activity criteria.

After being declared feasible by learning product design experts and learning material experts, the PBL-STS model was then implemented and measured using the student activity observation sheet instrument to find out the practicality of the PBL-STS model from the aspect of student activity. These eligibility criteria can be interpreted if the validator thinks the PBL-STS model can be used easily by students. This can be seen in Table 6, which shows the average activity of students at meetings 1, 2, and 3, respectively 85.5%, 86.9%, and 86.5%. The percentage of total student activity obtained a value of 86.3% and was declared good based on student activity criteria. The good criteria obtained show that students, as one the executors, can easily apply the PBL-STS model based on the method that the researcher has determined. The research results at the same time reinforce the theory put forward by Nieveen (1999), that the second characteristic of good quality material is that experts (and practitioners) consider that the material can be implemented and is easy for teachers and students to apply the material based on predetermined methods by the developer.

In addition to reinforcing the theory put forward by Nieveen, the research results obtained also confirmed the research conducted by Hye-Young et al (2020) which explained that students' responses to the statement "I actively participate in this class" from a survey about learning experiences using the PBL model show a high level of satisfaction or 91.4%. The results of this study are relevant to our efforts to develop a practical PBL-STS model as well as a differentiator from the research conducted by Hye-Young et al (2020), namely the integration pattern of STS education into the PBL model. In developing the practical PBL-STS model, the researcher seeks to arrange its operational form in such a way that it can be used easily by teachers and students according to the method that has been determined by the researchers, one of which is to provide opportunities for teachers to be more creative and inspire students to learn more active by developing their mindset through questions and arguments so that students can practice their critical thinking skills. This is where what researchers mean is relevant between the results of Hye-Young et al's research and what researchers are doing, one of which is to make students more initiative (proactive/active). With active students, it can be interpreted that students easily (practically) use the PBL-STS model because it is impossible for students to easily (practically) use the PBL-STS model if students are not active.

CONCLUSION

Based on the research results and discussion of the practicality of the PBL-STS model for fourth-grade elementary school students, which refers to the implementation aspects of the PBL-STS model, the implementation of learning, and student activities, we concluded that the PBL-STS model is said to be practical. Thus the PBL-STS model that we developed can be used as alternative learning for other teachers by taking into account the situation and condition of the class, the characteristics of the students, and the availability of facilities and infrastructure in schools.

SUGGESTIONS

Based on the conclusions above, we recommend other researchers to further develop this research in the context of knowing the effectiveness of the PBL-STS model on student learning outcomes.

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