International Journal of Social Learning
August 2023, Vol. 3 (3), 293-307
e-ISSN 2774-4426 and p-ISSN 2774-8359
DOI: https://doi.org/10.47134/ijsl.v3i3.193

The PBL-STS Model for Achieving Critical Thinking Skills in Elementary School Students

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ABSTRACT

The research was motivated by the low learning outcomes of students, where as many as 57% of thirty students still needed to achieve the minimum completeness criteria (KKM). Moreover, in practice, the assessment of learning outcomes developed by teachers needs to be oriented toward measuring critical thinking skills. This study aims to describe the effectiveness of the Problem-based Learning (PBL) model with the integrated pattern of Science, Technology, and Society (STS) education in fourth-grade elementary school students. In this study, Borg and Gall's development research model was used, a process carried out to produce and test an educational product. The results showed (1) Each statement, both positive and negative statements, obtained an average percentage of 85.4% and was declared good; and (2) the average pretest score was only 32.7 and increased after the PBL-STS model was applied with a posttest score of 83.3. The average n-gain value obtained is 0.75 and is included in the high category. In addition, the significance value (2-tailed) is 0.00 <0.05, so the application of the PBL-STS model has a significant effect on the achievement of learning objectives (students' critical thinking skills learning outcomes), or H_1 is accepted.

***Keywords**:*

Problem-based Learning (PBL), Science, Technology, Society (STS), Critical Thinking

ABSTRAK

Penelitian dilatarbelakangi rendahnya hasil belajar peserta didik, di mana sebanyak 57% dari total tiga puluh peserta didik tidak mencapai kriteria ketuntasan minimal (KKM). Apalagi dalam pelaksanaannya, penilaian hasil belajar yang dikembangkan guru tidak diorientasikan untuk mengukur keterampilan berpikir kritis. Penelitian ini bertujuan mendeskripsikan keefektifan model Problem-based Learning (PBL) dengan pola integrasi pendidikan Sains, Teknologi, dan Masyarakat (STS) pada siswa kelas IV

Submitted: 2022-08-08; Accepted: 2023-07-31; Published: 2023-08-27
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Sekolah Dasar. Dalam penelitian ini digunakan model penelitian pengembangan milik Borg dan Gall, yaitu suatu proses yang dilakukan untuk menghasilkan dan menguji suatu produk pendidikan. Hasil penelitian menunjukkan (1) Setiap pernyataan baik pernyataan positif maupun pernyataan negatif memperoleh rata-rata persentase sebesar 85,4% dan dinyatakan baik; dan (2) rata-rata skor pretest hanya 32,7 dan meningkat setelah diterapkan model PBL-STS dengan skor posttest 83,3. Nilai rata-rata n-gain yang diperoleh adalah 0,75 dan termasuk dalam kategori tinggi. Selain itu, nilai signifikansi (2-tailed) adalah 0,00 < 0,05, sehingga penerapan model PBL-STS berpengaruh signifikan terhadap pencapaian tujuan pembelajaran (hasil belajar keterampilan berpikir kritis siswa) atau H_1 diterima.

***Kata Kunci**:*

Problem-based Learning (PBL), Science, Technology, Society (STS), Berpikir Kritis

1. Introduction

Based on a preliminary study conducted by researchers in grade IV SD Muhammadiyah 3 Surabaya using learning assessment instruments belonging to the Unesa Professional Development Program (PPG), it is known that in one aspect of material mastery, namely applying the concept of learning materials in life, it is still not good. The teacher prioritized the knowledge or skills gained by the participants through real examples and up-to-date information but did not relate them to science, the environment, technology, and society. For example, one occasion, the teacher wants students to master the material being studied, and the teacher conducts question-and-answer activities for students. When students do not know, the teacher immediately tells students through real examples and knows the latest information, then asks students to mention other examples. Teachers should also guide students so that they can make connections with the material being taught with science, the environment, technology, and society. This is so that it follows the dimensions of knowledge in the competency standards for graduates of primary and secondary education Permendikbud Number 20 of 2016, which makes students individuals who understand science, technology, arts, and culture and have a humane, national, state, and civilized perspective.

Meanwhile, one aspect of the model/approach/strategy, which reflects active or scientific learning, still needs improvement. Based on the theory, learning media is a tool to help understand and teach (Puspitasari, 2022). According to Permendikbud Number 103 of 2014 concerning Learning in Basic Education and Secondary Education, learning is carried out with a scientific approach or a science-based approach which includes several stages, namely (1) observing activities, (2) questioning activities, (3) trying activities (gathering information), (4) reasoning or associating activities, and (5) communicating activities. At the questioning stage in the scientific approach, the teacher does not provide a stimulus that can encourage students to dare to ask and argue through philosophical questions on the material being studied (related to one aspect of the

model/approach/strategy, namely fostering positive habits). This is where the opportunity should be for teachers to be more creative and inspire students to be more active in learning by developing their mindset through questions and arguments so that students can practice their critical thinking skills. In other words, it is not surprising that the necessary thinking skills possessed by students are still low. When conducting interviews with classroom teachers, the researchers found out related to critical thinking skills indicators, namely where the teacher stated that most of his students had problems presenting alternative ideas, ideas, or reasonable (logical) opinions while implementing learning. Thus, it is necessary to have positive habits carried out by teachers through stimuli that can encourage students to dare to ask questions and argue through philosophical questions about the material being studied is very important to do. This is in line with the results of research from Rahdar et al., which states that teaching philosophy through asking questions and using argumentation as the primary methodology positively impacts increasing critical thinking. Critical reflection is learning from and reworking experience (Arrieta, 2021).

In addition to the practical problems above, researchers also see the need for innovation in learning. In other words, someone who has chosen a career path as an educator must be able to spawn updates through research conducted as part of self-development.

Based on the problems described above, the ideal learning conditions researchers expect are as follows. In teaching material to students, in addition to providing real examples and their relationship to the latest information, the teacher must also guide students so that they can make connections with the material being taught with science, technology, and society in the context of contextual problem solving so that students have the provision of knowledge in making informed decisions about the role or impact of science and technology in society. Then in implementing the scientific approach, especially at the questioning stage, the teacher must be more creative and inspire students to want to learn more actively by developing their mindset through questions and arguments to practice their critical thinking skills.

In the researcher's view, there is a learning model close to the above conditions, namely 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, p. 280). Solving problems is part of everyday life, so the quality of human life is influenced by its ability to solve problems. Meanwhile, Tan stated 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. And most importantly, PBL can help improve the quality of education by emphasizing problem-solving and thinking. PBL comes with the idea that learning achievement can be realized if schooling is focused on authentic, relevant issues and provides new experiences. This must be done so students experience what they will face in real life (Zarvianti & Sahida, 2020). The PBL model can absorb the knowledge gained by students well (Permatasari *et al*., 2019). In addition, the PBL model can also encourage students' interest in learning through interaction and cooperation among group members. PBL begins with solving problems in such a way that students need new knowledge to be able to solve these problems (Batlolona & Souisa,

2020). Through PBL, students are facilitated to make learning more meaningful (Suryawati *et al*., 2020).

Meanwhile, Nuswowati et al. stated that scientific concepts and principles could be applied and are suitable for study in the PBL model (2017). Implementing the PBL model can strengthen the inquiry competence of prospective teachers (Aryulina & Riyanto, 2016). In the PBL model, a thought process is needed to solve the problems students face during learning. These problems can be in the form of material concepts being taught to stimulate students' thinking processes in a higher direction in solving these problems (Marzuki & Basariah, 2017).

Furthermore, Tan explained that PBL includes several characteristics, namely the starting point of learning starting with a problem, the use of real-world problems, the use of cross-disciplines, providing challenges to students, students having the responsibility to learn independently, utilizing various resources, and learning independently. Collaborative, 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, researchers need to see more emphasis on aspects of science, technology, and society in contextual problem-solving. According to the researcher, this emphasis is significant, 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 will later be used to solve societal problems. This is in line with what Tan put forward, namely that breakthroughs in science and technology are often the result of being linked to issues. Meanwhile, Ziman stated that valid science is taught as if it has no relation to the world about it. It is related in many ways to society, primarily through its technological applications (Ziman, 1980).

Based on the explanation above, it is considered necessary to integrate the PBL model to fit the ideal learning conditions that the researchers mentioned above, namely learning that can guide students to be able to make connections with the material being taught with science, technology, and society in a contextual problem-solving context. This is the basis for researchers to integrate the PBL model with Science, Technology, and Society (STS) education into the PBL-STS model.

Kumar and Chubin stated that another goal of STS is to present an objective view of the world dominated by science and technology to students and use science and technology problems that involve students to conduct a critical analysis of the impact it has on society. Meanwhile, Ziman 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" (Ziman, 1980). The STS theme has descriptive and analytical aspects, is open, can arouse interest and attention, and can train hard thinking and wise actions. Based on this explanation, STS education is expected to prepare students to think critically to act wisely based on information about the role or impact of science and technology in society. Based on this statement, integrating the PBL-STS model is considered appropriate to achieve students' critical thinking skills.

According to Kallet (2014), critical thinking is a method that aims to improve thinking beyond everyday automatic thinking. So, when one thinks critically, one is thinking differently or unusually. In other words, when one thinks critically, one has done the most challenging "work" to make a situation more transparent and enduring. After that, the person only needs to conclude his thoughts. Meanwhile, Arrieta stated that critical thinking is an essential extension of reflection, a review of ideas that asks individuals to step back to test their opinions by asking investigative questions (Arrieta, 2021).

Critical thinking is the ability to analyze arguments logically and involves broader necessary thinking skills in various domains (Huber & Kuncel, 2016). Acquiring essential skills in thinking is now as crucial as acquiring conceptual understanding (Marthaliakirana *et al*., 2022). Pramasdyahsari explained that critical thinking skills are a need for students, so learning needs to be facilitated to support the 21st century (2023). Essential thinking skills make students sensitive to sustainability issues and skills that must be mastered by students in the 21st century (Khoiri *et al*., 2022). One of the higher-order thinking skills needed in society is critical thinking skills. Problems constantly confront humans, so logical thinking is necessary to make decisions (Nazwar *et al*., 2023).

Concerning the development of the PBL-STS model, Nieveen suggests that the third characteristic of suitable quality materials is if students appreciate the learning provided and the desired learning objectives can be achieved (Akker, 1999). The third characteristic is related to one of the operational forms of the PBL-STS model, namely THB. Because THB is what is used to see the achievement of the learning objectives that have been set, in this case, the learning outcomes of students in the form of critical thinking skills. In addition, student appreciation is also needed in the form of student responses to the PBL-STS model. Several research results examine the effectiveness of the PBL model on students' critical thinking skills. First, the research conducted by Anugraheni and Indri with the title "A Meta-analysis of Problem-based Learning Models in Increasing Critical Thinking Skills in Elementary Schools" states that based on the results of the meta-analysis, it turns out that the PBL model can improve students' critical thinking skills ranging from the lowest 2.87% to the highest 33.56% with an average of 12.73% (2018). Second, the research conducted by Triswahyono et al. with the title "Improving Critical Thinking of Elementary School Students Using Problem-based Learning Models" states that based on data on critical thinking skills obtained by fourth-grade students at SDN Sawunggaling VIII/389 Surabaya City through the application of the PBL model in Social studies learning experienced an increase in classical completeness by 14.74% (2019). Third, the research conducted by Utomo et al. with the title "Influence of Problem-based Learning Models (PBL) and Learning Motivation to Learn Outcomes and Student's Critical Thinking Skills Themes of Caring for Life in Class IV Primary School No 026609 Pujidadi Binjai" stated that the application of the model PBL has a significant effect (0.006) on students' critical thinking skills than the expository learning model.

The average necessary thinking skills of students who apply the PBL model is higher (80.86) than the critical thinking skills of students who use the expository model (76.67) (2020). All of the results of these studies are relevant to the researchers' efforts in developing an effective PBL-STS

model as well as being a differentiator from the research conducted by Anugraheni and Indri, Triswahyono et al., and Utomo et al., namely the existence of a pattern of integration of STS education into the PBL model. In developing an effective PBL-STS model, researchers refer to indicators of achieving the desired learning objectives: students' critical thinking skills. This is where the researcher intends to be relevant between the results of the research by Anugraheni and Indri, Triswahyono et al., and Utomo et al. and what the researchers did; namely, the implementation of the PBL-STS model is expected to help students achieve critical thinking skills.

The learning conditions above certainly affect the achievement of learning outcomes obtained by students. The end of semester one assessment data for the 2021/2022 academic year that the researchers received showed that as many as 57% of 30 students still needed to reach the minimum completeness criteria (KKM). Moreover, in practice, teachers' assessment of learning outcomes needs to be oriented toward measuring one of the higher-order thinking skills (HOTS), namely critical thinking skills. So it is essential for further treatment, considering that necessary thinking skills are crucial to train students because they are one of the four skills needed in the 21st century: critical, creative, communicative, and collaborative. This is as stated by Trilling and Fadel (2009:49), the first focus of skills sets in the 21st century is critical and innovative learning skills, namely critical thinking and problem-solving (expert thinking), communication and collaborative (complex communication), creativity and innovation (application of imagination and invention).

Based on what has been described above, this study aims to describe the effectiveness of the Problem-based Learning (PBL) model with the integration pattern of Science, Technology, and Society (STS) education to achieve critical thinking skills in elementary school students.

2. Methods

2.1 Research Design

The research to be carried out is a type of development research commonly referred to as R & D (Research and Development) with quantitative and qualitative approaches. This is because this research focuses on developing a product and testing the product, namely the Problem-based Learning (PBL) model with the Science, Technology, and Society (STS) Education Integration Pattern or the PBL-STS model. The products produced in this development research include (1) the PBL-STS model and its syntax or steps; and (2) learning tools consisting of lesson plans (RPP), student worksheets (LKPD), and learning outcomes tests (THB).

In this development research, a development research model design was used, which refers to Borg and Galls. According to Borg and Gall (2003, p. 569), educational research and development (R&D) is a process to produce and test an educational product. However, the purpose of academic research is not only product development but also an attempt to discover new knowledge (using basic research) or seek answers to specific questions related to practical problems (using applied research).

2.2 Population and Sample

The subjects of this study were fourth-grade elementary school students located at Muhammadiyah 3 Elementary School Surabaya. The selection of topics 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) The fourth-grade students of SD Muhammadiyah 3 Surabaya come from various backgrounds, thus allowing for interaction from students with different characters; (3) The open attitude of the stakeholders of SD Muhammadiyah 3 Surabaya in the context of improving the quality of learning; and (4) SD Muhammadiyah 3 Surabaya implements the 2013 Curriculum so that it is in line with the development of the PBL-STS model that the researchers did.

2.3 Data Collection

In this study, the data collection technique used by the researcher is a questionnaire or commonly referred to as a questionnaire, which is a technique that is quite often used in survey research on information by providing structured and numerical data. Questionnaires can also be administered without the researcher's presence in the field and are easy to analyze (Cohen *et al*., 2007). In this study, the researcher gave the students a questionnaire instrument to find out the students' response data to a series of learning activities using the PBL-STS model.

In addition to using questionnaires, researchers also used data collection techniques in the form of tests. One of the most powerful data collection methods in educational research is the test technique used to collect numerical data. In this study, the researcher gave students a test instrument for learning critical thinking skills after carrying out a series of learning activities using the PBL-STS model. The provision of learning outcomes tests is carried out to determine the achievement of critical thinking skills of students.

2.4 Data Analysis

Data analysis of student responses to the implementation of learning using the PBL-STS model was analyzed using the following formula.

$$P = \frac{\text{The number of students who respond to certain aspects}}{\text{a total number of students}} \text{ x } 100\%$$

Information:

P = Percentage of student responses.

The student response criteria adapted from Hinton (2004) in more detail can be seen in the following table.

Table 1. Student Response Criteria

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

Learning outcomes data in the form of critical thinking skills tests were analyzed from the scores obtained by students based on indicators of necessary thinking skills as outlined in the assessment rubric with the following formula.

$$P_{\text{individual}} = \frac{\text{Earning score}}{\text{maximum score}} \text{ x } 100$$

Then to find out the category of improving student learning outcomes, the critical thinking skills test scores were analyzed using the n-gain formula, which refers to Hake (2002), namely:

$$\langle g \rangle = \frac{\langle S_{post} \rangle - \langle S_{pre} \rangle}{100\% - \langle S_{pre} \rangle}$$

The n-gain category adapted from Hake (Akker, 1999) in more detail can be seen in the following table.

Table 2. Category N-Gain Value

N-Gain Value	Category
g > 0,7	High
0,3 ≤ g ≤ 0,7	Medium
g < 0,3	Low

In addition, researchers also conducted paired t-tests with the help of SPSS software to determine the significance value of increasing student learning outcomes. But before that, it is necessary to do a prerequisite test in the form of a normality test to find out whether the test items are typically distributed (probability value > 0.05) or not (probability value < 0.05). The significance value used for paired t-test (paired t-test) is = 0.05 with the basis, namely H_0 = No. There is a significant effect of increasing learning outcomes (critical thinking skills) for students who apply the PBL-STS model, and H_1 = There is a significant effect of improving learning outcomes (essential skills of thinking) for students who use the PBL-STS model.

3. Results and Discussion

The effectiveness test was carried out after the PBL-STS model book, learning tools (RPP, LKPD, and THB), and assessment instruments (student response questionnaire sheets) met the eligibility criteria (valid) and were revised by the researcher. The results of the student response questionnaire can be seen in the following Table 3.

Based on Table 3, it can be explained that (1) In terms of learning statements like this that make me interested and fun, the majority of students answered strongly agree (SS) with a percentage of 83% (good); (2) On items such as learning statements are not interesting and boring, the majority of students answered strongly disagree (STS) with a percentage of 87% (good); (3) In the statement item I prefer learning like this than the previous learning, the majority of students answered strongly agree (SS) with a percentage of 80% (good); (4) In the statement of learning items like this, there is no difference from the previous learning, the majority of students answered strongly disagree (STS) with a percentage of 87% (good); (5) In the statement item I am more motivated after participating in this kind of learning, the majority of students answered strongly agree (SS) with a percentage of 80% (good); (6) In this learning statement item, it does not provide benefits for me, the majority of students answered strongly disagree (STS) with a percentage of 90% (very good); (7) Learning statement items like this make me dare to ask questions and arguments, the majority of students answered strongly agree (SS) with a percentage of 87% (good); (8) In the statement item I feel pressured and tense during this kind of learning, the majority of students answered strongly disagree (STS) with a percentage of 83% (good); (9) In learning statement items like this it makes it easier for me to understand the material (making connections with the material being taught with science, technology, and society in the context of contextual problem solving), the majority of students answered strongly agree (SS) with a percentage of 90% (very good); and (10) In learning statement items like this, it makes me lazy to listen to the material (making connections with the material being taught with science, technology, and society in the context of contextual problem solving), the majority of students answered strongly disagree (STS) with a percentage 87% (good).

After being declared feasible by learning product design experts and learning material experts, the PBL-STS model was implemented and measured using a student response questionnaire sheet instrument to determine the effectiveness of the PBL-STS model based on student responses. The appropriate criteria can be interpreted if the validator considers that students will give an upbeat assessment of the PBL-STS model. This can be seen in Table 3, which shows that each positive and negative statement obtained an average percentage of 85.4% and was declared good based on the student response criteria. The reasonable measures indicate that students, as one of the implementers, respond well to the PBL-STS model. The results obtained simultaneously reinforce the theory put forward by Nieveen that the third characteristic of suitable quality materials is if students appreciate the learning provided and the desired learning objectives can be achieved (Akker, 1999).

Learning outcomes data in the form of students' critical thinking skills tests analyzed using the n-gain formula can be seen in the following table.

Based on Table 4 , it can be seen that the average value of n-gain obtained is 0.75 and is included in the high category. Then the normality test was conducted to determine whether the test items were normally distributed or not. The results can be seen in the following table.

Table 3. Student Response Questionnaire Results

Statement	Number of Students (Percentage)			
	SS	S	TS	STS
Learning like this makes me interested and fun.	25 (83%)	3 (10%)	2 (7%)	
Learning like this could be more exciting and exciting.		1 (3%)	3 (10%)	26 (87%)
I prefer learning like this to previous learning.	24 (80%)	4 (13%)	2 (7%)	
This kind of learning is similar to previous knowledge.		1 (3%)	3 (10%)	26 (87%)
I am more motivated after taking lessons like this.	24 (80%)	5 (17%)	1 (3%)	
Learning like this does not benefit me.		1 (3%)	2 (7%)	27 (90%)
Learning like this makes me dare to ask questions and arguments.	26 (87%)	4 (13%)		
I feel pressured and tense during this kind of learning.			5 (17%)	25 (83%)
Learning like this makes it easier for me to understand the material (connect the material taught with science, technology, and society in contextual problem-solving).	27 (90%)	2 (7%)	1 (3%)	
This kind of learning makes me lazy to listen to the material (making connections with the material being taught with science, technology, and society in the context of contextual problem solving).		1 (3%)	3 (10%)	26 (87%)

Based on Table 5 above, it can be seen if the Kolmogorov-Smirnov probability value for pretest and posttest data is more significant than 0.05 or normally distributed. With the fulfillment of these prerequisite tests, a paired t-test is carried out to determine the significance of increasing student learning outcomes. The results can be seen in the Table 5.

Based on Table 6, it can be seen that the significance value (2-tailed) is 0.00 < 0.05, so it can be concluded that there is a significant effect on increasing learning outcomes (critical thinking skills) for students who apply the PBL-STS model or H_1 received

After being declared feasible by learning product design experts, learning material experts, and education practitioners, the PBL-STS model is then implemented and measured using a learning outcomes test instrument to determine the effectiveness of the PBL-STS model based on the achievement of learning objectives (students' critical thinking skills learning outcomes). The appropriate criteria can be interpreted if the validator considers that implementing the PBL-STS model can achieve the desired learning objectives (students' critical thinking skills learning outcomes). This can be seen in Table 4, which shows that the average pretest score is only 32.7 and has increased after implementing the PBL-STS model with a posttest score of 83.3. The mean value of n-gain obtained is 0.75 and is included in the high category. In addition, Table 5 also shows that the significance value (2-tailed) is 0.00 < 0.05, so the implementation of the PBL-STS model has a significant effect on the achievement of learning objectives (students' critical thinking skills learning

outcomes), or H_1 is accepted. The results obtained simultaneously reinforce the theory put forward by Nieveen that the third characteristic of suitable quality materials is if students appreciate the learning provided and the desired learning objectives can be achieved (Akker, 1999). These results are understandable, considering that the learning outcomes test instrument is used to see the achievement of the learning objectives that have been set; in the context of this study, the student learning outcomes are in the form of critical thinking skills.

Table 4. Category Improving Student Learning Outcomes

Code Learners	*Pretest*	*Posttest*	N-Gain	Category
X1	43,3	91,7	0,85	High
X2	33,3	90	0,85	High
X3	31,7	88,3	0,83	High
X4	21,7	75	0,68	Medium
X5	41,7	93,3	0,89	High
X6	33,3	76,7	0,65	Medium
X7	33,3	80	0,70	Medium
X8	23,3	73,3	0,65	Medium
X9	45	91,7	0,85	High
X10	21,7	76,7	0,70	Medium
X11	33,3	83,3	0,75	High
X12	21,7	76,7	0,70	Medium
X13	43,3	93,3	0,88	High
X14	41,7	91,7	0,86	High
X15	23,3	73,3	0,65	Medium
X16	21,7	75	0,68	Medium
X17	41,7	93,3	0,89	High
X18	23,3	76,7	0,70	Medium
X19	31,7	80	0,71	High
X20	33,3	81,7	0,73	High
X21	21,7	80	0,74	High
X22	45	91,7	0,85	High
X23	31,7	81,7	0,73	High
X24	23,3	80	0,74	High
X25	41,7	90	0,83	High
X26	23,3	75	0,67	Medium
X27	33,3	73,3	0,60	Medium
X28	33,3	78,3	0,67	Medium
X29	43,3	93,3	0.88	High
X30	41,7	91,7	0,86	High
Rerata	32,7	83,2	0,75	High

** The pretest and posttest scores are average from meetings 1, 2, and 3.*

Table 5. Normality Test Results of Learning Outcomes Test Items

Test Data	Kolmogorov-Smirnov	Shapiro-Wilk
Pretest	0,200	0,249
Posttest	0,164	0,41

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Table 6. Paired T-Test Results

Class	T	Df	*Sig. (2-tailed)*
IV	-38,844	30	0,000

In addition to confirming the theory put forward by Nieveen, the research results obtained above also ensure several relevant studies, including (1) Research conducted by Anugraheni and Indri with the title "A Meta-analysis of Problem-based Learning Models in Increasing Critical Thinking Skills. in Elementary Schools" stated that based on the results of the meta-analysis, it turned out that the PBL model was able to improve student's critical thinking skills starting from the lowest 2.87% to the highest 33.56% with an average of 12.73% (2018). The meta-analysis used as a method in this research is a type of research that is carried out by summarizing, reviewing, and analyzing research data from several previous research results. The purpose of meta-analysis is to combine and synthesize findings from various studies that are relevant to a particular field. By conducting a meta-analysis, researchers can identify general patterns, measure an intervention's or treatment's effects, and provide more robust conclusions based on available evidence. Therefore, the findings in this study are in line with and strengthen the results of previous studies that state students' critical thinking skills can be improved through the PBL model; (2) Research conducted by Triswahyono et al. with the title "Improving Critical Thinking of Elementary School Students Using Problem-based Learning Models" states that based on data on critical thinking skills obtained by fourth-grade students at SDN Sawunggaling VIII/389 Surabaya City through the application of the PBL model in social studies learning experienced an increase in classical completeness by 14.74% (2019). The method in this research is classroom action research, which teachers or education practitioners carry out in the classroom to improve learning practices and student learning outcomes. This research involves an action cycle of planning, implementing, observing, evaluating, analyzing, and reflecting. The primary purpose of classroom action research is to identify problems, design and implement corrective actions, and monitor and assess the impact of these actions. The results of classroom action research can be used to inform and improve classroom practice, leading to significant improvements in learning and student learning outcomes.

The stages carried out in the analysis were also carried out in this study, although in a different context, and the results at the same time confirm the findings in this study if the PBL model can improve critical thinking skills in elementary school students.; and (3) The research conducted by Utomo et al. with the title "Influence of Problem-based Learning Models (PBL) and Learning Motivation to Learn Outcomes and Student's Critical Thinking Skills Themes of Caring for Life in Class IV Primary School No 026609 Pujidadi Binjai" stated that the application of the PBL model has a significant effect (0.006) on students' critical thinking skills than the expository learning model. The average necessary thinking skills of students who apply the PBL model is higher (80.86) than the critical thinking skills of students who apply the expository model (76.67) (2020). In this study, a quasi-experimental method was used, namely a research method used to determine whether there was an effect of a treatment given to research subjects, in this case, students. This method is used when it is not possible or practical to carry out randomization or randomization in the distribution of

the treatment and control groups. This study used a quasi-experimental method to compare the effect of the problem-based learning model (PBL) and expository learning on students' learning outcomes and critical thinking skills in science, considering high and low learning motivation. The quasi-experimental method used in this study was the same as that used by researchers in this study, and the results of this study simultaneously strengthened the results of Utomo et al.'s research that the PBL model affected critical thinking skills in elementary school students.

All of the results of these studies are relevant to the researchers' efforts in developing an effective PBL-STS model as well as being a differentiator from the research conducted by Anugraheni and Indri, Triswahyono et al., and Utomo et al., namely the existence of a pattern of integration of STS education into the PBL model. In developing an effective PBL-STS model, researchers refer to indicators of achieving the desired learning objectives: students' critical thinking skills. This is where the researcher intends to be relevant between the results of the research (Anugraheni and Indri; 2018, Triswahyono *et al*.; 2019 Utomo *et al*.; 2020) and what the researchers did. Namely, implementing the PBL-STS model is expected to help students achieve critical thinking skills.

4. Conclusion

Based on the results of research and discussion on the effectiveness of the Problem-based Learning (PBL) model with the integration pattern of Science, Technology, and Society (STS) education to achieve critical thinking skills in elementary school students, it can be concluded that the PBL-STS model is said to be effective, with details (1) Each statement, both positive and negative statements, received an average percentage of 85.4% and was declared good; and (2) the average pretest score was only 32.7 and increased after implementing the PBL-STS model with a posttest score of 83.3. The mean value of n-gain obtained is 0.75 and is included in the high category. In addition, the significance value (2-tailed) is 0.00 < 0.05, so the implementation of the PBL-STS model has a significant effect on the achievement of learning objectives (students' critical thinking skills learning outcomes), or H_1 is accepted. Based on these conclusions, the essence of this research is that the PBL-STS model that the researchers developed is effective in achieving the critical thinking skills of elementary school students.

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