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The Student Worksheet Based on PBL Model to Develop Critical Thinking Skills in Phase A

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Abstrak
Matematika merupakan mata pelajaran yang menggunakan kemampuan berpikir kritis dalam penalaran logis. Penelitian ini dilakukan pada siswa kelas II SDN 1 Sukaraja, kelas kontrol 24 siswa dan kelas eksperimen 27 siswa. Penelitian Research and Development (R&D) ini mengadopsi model 4D dan baru mencapai tahap ketiga (define, design, devide). Produk yang dikembangkan adalah lembar kerja siswa berbasis model Problem Based Learning (PBL). Tujuannya untuk melatih kemampuan berpikir kritis siswa. Lembar kerja siswa berbasis model PBL yang dikembangkan terbukti "Sangat Valid" berdasarkan penilaian validator dan "Sangat Praktis" berdasarkan hasil evaluasi kepraktisan, sehingga dapat digunakan sebagai bahan ajar penunjang proses pembelajaran untuk melatih kemampuan berpikir kritis siswa.

Kata Kunci: *Berpikir Kritis; Pembelajaran Berbasis Masalah; Lembar Kerja Peserta didik*

Abstract
Mathematics is a subject that uses critical thinking skills in logical reasoning. This research was conducted on grade II students of SDN 1 Sukaraja, control class 24 students and experimental class 27 students. This research and development (R&D) study adopted the 4D model and reached only the third stage (define, design, develop). The product that was developed is a student worksheet that is based on the Problem-Based Learning (PBL) model. The goal is to train students' critical thinking skills. The developed student worksheet based on PBL model is proven to be "Very Valid" based on validator's evaluation and "Very Practical" based on practicality evaluation results, so it can be used as teaching material to support learning process to train students' critical thinking skills.

Keywords: *Critical thinking; problem based learning; Student worksheet*

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INTRODUCTION

The 21st century learning directs students to have 4C skills (Critical Thinking, Communication, Creative and Collaborative) so that learning is directed towards Student Centered Learning (SCL) (Azzahra, et.al., 2023; Brush & Saye, 2000; O'Connell et al., 2022). Conventional learning is considered difficult to improve 4C skills, especially critical thinking skills (Supena et al., 2021; Saptikasari & Rendi Nugraha Frasandy, 2020). Critical thinking skills are the ability to analyze, implement, and make decisions on a matter (Supena et al., 2021; Rohman, et.al, 2023). Critical thinking skills applied to learning help students understand material presented by teachers, including in mathematics (Maharani et al., 2021; Fitriani & Kowiyah, 2022; Pramudiyanti, et.al, 2023).

Mathematics is seen as a science that requires logic to understand, remember and know all things related (Nurfitriyani, 2016). The purpose of mathematics is to provide experience, based on logical thinking, in solving the problems that exist in our daily lives (Nurhanurawati, 2019). Mathematics can be mentally challenging for learners because it involves critical thinking in understanding, interpreting, and applying information about abstract objects and developing reasoning based on the level of cognitive development of the learner (Shelly Morin & Tatang Herman, 2022).

Educators are tasked with facilitating learning that can improve students' critical thinking skills, including in math subjects, especially when discussing fractions (Muharram et al., 2019). Students have a lack of basic knowledge of rational numbers, including fractions and decimals (Svecova, et al., 2022). Students experience many barriers to learning fractions, as evidenced by the following student responses (Kalra et al., 2020).

Ontogenic barriers, based on the mental readiness of the students in the reception of fraction material, limitations in the determination of the value of the fractions in a picture. Students focus only on the size of the image without paying attention to the shaded parts of the image, so they tend to incorrectly express the value of (Fauzi dan Suryadi, 2020).

Epistemological barriers related to limited knowledge of certain contexts, such as the use of symbols in fractions (Kazanidis et al., 2018). Didactic barriers, the cause of which is the use of strategies or methods provided by educators when delivering fraction material (Afriansyah & Dahlan, 2017). Teachers only provide material directly based on books without involving students in the environment (Wulandari & Amir, 2022).

Educators are expected to be able to overcome students' barriers by creating or developing educational materials, such as student worksheets on fractions (Deswanti et al., 2023). Student worksheets are considered to be practical and effective teaching materials that can support learning and train students' thinking skills, because the problems in fraction material are based on problems that are around of student, so student worksheets based on the problem-based learning (PBL) model can support learning. (Mustari et al., 2023).

The characteristics of the PBL model are that it emphasizes problem solving, students are responsible for solving problems, while teachers support the problem solving process (Refnywidialistuti, 2018; Afridiani et al., 2020). The PBL model helps students to construct knowledge through cognitive processes, so that students are able to train their critical thinking skills (Rahmawati et al., 2022). The advantage of the PBL model in terms of thinking skills is that it challenges students' abilities by providing the satisfaction of discovering new knowledge, thus stimulating critical thinking skills (Maharani et al., 2021).

Based on Facione's theory (1990), there are six indicators of critical thinking, namely: interpretation, analysis, inference, evaluation, explanation, and self-regulation. The PBL model and the six indicators of critical thinking can be integrated because they have the same characteristics (Sanjaya & Ratnasari, 2021). The PBL syntax used by educators to teach PBL illustrates the relationship between PBL and critical thinking skills (Zuriatin et al., 2021).

The PBL model, when integrated with critical thinking indicators that discuss fraction material in Phase A, can lead to Student Centered Learning (SCL) (Riyati & Suparman, 2019; Nurkholis, 2019). Thus, the development of LKPD based on the problem-based learning (PBL) model to train students' critical thinking skills on fraction material in Phase A needs to be developed.

METODE

This product development was tested on the students of Class II at SDN 1 Sukaraja, on a control class with a total of 24 students and on an experimental class with a total of 27 students. The product, in the form of LKPD, is designed to train critical thinking skills based on Facione's theory, which includes six indicators (Seventika, 2022).

This product development adopted the 4D model (define, design, develop, disseminate) of Thiagarajan and Sammel (1974), but this research only reached the development stage (Pribadi et al., 2021). The researchers chose the 4D model because the steps in its development are more concise, yet detailed.

1. The define phase, in this phase is defined as each of the things that are needed in the product development, such as the analysis of problems in the field (Panwina et al., 2023). At this stage it is also necessary to analyze the needs of students and teachers, in addition to the need for theoretical studies related to student worksheets, such as analyzing learning outcomes to be able to describe them in the flow of learning objectives that are in accordance with the fraction material in Phase A. The define phase's very important because it is at this stage that the researcher determines the defining boundaries for each element involved in the development of student work sheets.

2. In the design phase, this research develops products in the form of student worksheets designed to train students' critical thinking skills through fraction material, so planning is needed to design student worksheets (Widodo, 2017). Activities to determine the application to be used, paper size, appearance, supporting images, and other relevant things to be presented in the learner worksheet must be considered as well as possible. This learner worksheet is based on the PBL model, so it needs to be designed in any existing syntax. In the development phase, when the student worksheet has gone through the planning phase, the development phase requires expert validation activities (Gunawan et al., 2019). The development of this student worksheet involves two validators (material, media, and language). The assessment results from the validators are analyzed using Aiken (1985) as a prototype feasibility test analysis. The purpose of Aiken's analysis is to achieve a more objective assessment, so the formula used is:

$$V = \frac{\sum_{i=1}^{n} s_n}{n(c-1)}$$

The level of validity can be determined on the basis of Table 1, which is the range of the Aiken index scale in the measurement of validity (Aiken, 1985).

Table 1. Interpretation of Validity Index Value

No	Aiken Index Scale Range	Description
1	$V > 0.84$	Very Valid
2	$V > 0.68 – 0.84$	Valid
3	$V > 0.52 – 0.68$	Enough
4	$V > 0.36 – 0.52$	Less Valid
5	$V \leq 0.36$	Invalid

Prototypes that pass the expert validity stage are then tested on a control class of 24 students. The results will go through a practicality test analysis of the prototypes that students and educators have used. This assessment is done by calculating a Likert scale then using the mean formula, the results of the calculation can determine the feasibility category according to Table 2 (Purwanto, 2013).

Table 2. Feasibility Category Based on Practicality Assessment

No	Feasibility Scale	Category
1	80%, x ≤ 100%	Very Practical
2	60%, x ≤ 80%	Practical
3	40%, x ≤ 60%	Enough
4	20%, x ≤ 40%	Less Practical
5	0%, x ≤ 20%	Not Practical

If the prototype has achieved its practical results, then the student worksheet is suitable for testing in an experimental class of 27 students. Student worksheets based on the PBL model to train critical thinking skills will be tested when it has been tested, the results will be assessed based on the student worksheet assessment rubric. This research was conducted on grade II students of SDN 1 Sukaraja, control class 24 students and experimental class 27 students. The subjects involved in this research can be presented on the table 3.

Tabel 3. Research Subjects

Name of School	Grade	Sample size	Dimension of Assessment
SDN 1 Sukaraja	Experiment class	27	Critical thinking skills
	Control class	24	

Implementation of student worksheets based on the PBL model to train critical thinking skills using the instrument of the observation rubric and the evaluation of the contents of the student worksheet. Dimension of Assessment critical thinking skills cover six aspects namely: 1) Interpretation; 2) Analysis; 3) Evaluation; 4) Inference; 5) Explanation; and 6) Self-Regulation.

RESULT AND DISCUSSION

The 21st century learning is leading to student-centered learning (SCL), where learners are expected to be active participants in the learning process (Wright, 2011; Sumantri et al., 2022). The use of student worksheets as a learning support is designed based on the model used, one of the models that can direct learning to SCL is the Problem Based Learning (PBL) model (Pertiwi et al., 2022; Yarman et al., 2021). The syntax of PBL can be integrated into the six indicators of critical thinking according to Facione's theory, and the product development of learner worksheets adopts the 4D model and reaches only the third phase (development).

The definition phase, based on the results of analyzing the needs of students and teachers, that teaching materials are needed in the form of student worksheets that can train the critical thinking skills. The student worksheets are based on the PBL model (Kaharuddin, 2019), which is described in Table 3:

Table 3. Syntax of PBL and Activities

Syntax of PBL	Kegiatan
Problem Orientation	Students have an in-depth understanding of the problem in the lesson; the problem is from an example that is relevant to the fractions material (Zulfaturrochmah et al., 2023).
Organizing Learners	Students will be able to classify the problems discussed in fraction material (Andeswari et al., 2021).
Group Investigation	Students conduct experiments in groups in an organized manner to understand and critique the problems presented and the solutions that can be taken to solve problems according to the fraction material (Afridiani et al., 2020).
Presenting the Result	Groups of learners will present their answers on the student worksheet provided, which will then be presented at the end of the lesson (Nasir, 2022).
Analyzing and Evaluation	Students can analyze and evaluate the problem solving they have done during group problem solving so that they can draw correct and accurate conclusions (Pribadi et al., 2021).

Learning activities based on the PBL model described in Table 3, each syntax can be integrated with critical thinking indicators aimed at learning outcomes in Phase A fraction material. The relationship between PBL and critical thinking skills can be seen in the PBL syntax used by educators when teaching (Zuriatin et al., 2021).

In the design phase, the worksheet was designed using the Canva Pro application, starting with determining the paper size, tamplate, color, typography, and supporting images appropriate for the fraction material, so it was produced as shown in Figure 1, but there were some changes that were made based on suggestions from the validators.

Figure 1. Result of Student Worksheet Design on PBL Model

In the development phase, when measuring feasibility based on the validator's assessment (Panwina et al., 2023), the results when analyzed using Aiken, with reference to Table 1 on the level of validity, are described in Table 4.

Table 4. Expert Judgment Test Results Using by Aiken

Aspect of Material Assesment	Aiken' V (Aspect of Material)	Aspect of Media Assesment	Aiken' V (Aspect of Media)	Aspect of Languange Assesment	Aiken' V (Aspect of Language)
Appropriateness of CP and ATP	0.8750	Design of Media	0.8436	Straighforward	0.8125
Up-to-date of Material	0.8750	Typography	0.8500	Communicative	0.8750
Relevance to PBL Model	0.8125	Grafic	0.8750	Conformity with Language Rules	0.8333
Presentatiom Feasibility	0.8393				
Coherence and Arrange	0.8750				
Assesment of Material (Holistic)	**0.8470**	**Assesment of Media (Holistic)**	**0.8563**	**Assesment of Language (Holistic)**	**0.8403**

Meanwhile, to see the practicality of using the student worksheet, student and teacher evaluations are needed, as shown in Table 5.

Table 5. Result of Practicality

No.	Aspect	Practicality		Category
		Teacher	Student	
1.	Display of student worksheet	82%	90%	Very Practical
2.	Suitability of Material	87.5%	88%	Very Practical
3.	Approriateness	83%	87.5%	Very Practical
Average of Holistic		**84.2%**	**88.5%**	**Very Practical**

Table 5 shows that the overall final result of the teacher's assessment is 84.2%, and for students it is 88.5%, if referring to table 2 then both results are in the "very practical" category, which means that the student worksheet in its use is very practical and can be used when discussing fraction material and is able to train students' thinking skills. This PBL model based student worksheet when integrated with critical thinking indicators is shown as Table 6.

Table 6. Syntactic Mapping of PBL Model Integrated with Critical Thinking Indicators

Syntax of PBL	Critical Thinking Indicators
Problem Orientation	Interpretation
Organizing Student	Analysis
Guiding Group Investigate	Evaluation
	Inference
Develop and Creat	Eksplanation
Analyzing and Evaluating Problem Solving of the Result	Self-Regulation

Table 6, illustrates briefly but in detail the relationship between PBL syntax and indicators of critical thinking, this relationship is used in developing student worksheets (Vera & Wardani, 2018). The first syntax, can explain that in the syntax of problem orientation, students are integrated with indicators of interpretation that occur through information as an initial stimulus (Muqorobin & Kartin, 2022). The syntax of organizing learners is integrated in the analysis indicator, which can be passed through the ability to analyze a concept. The syntax of leading group investigations expects learners to be able to evaluate and infer information from the data obtained (Nasir, 2022).

The syntax of developing and presenting results is integrated with the explanation indicator, meaning that students are expected to be able to explain their opinions in detail (Afridiani et al., 2020). The syntax of evaluating the results of problem solving is where students are able to self-regulate the opinions given in each syntax that has been passed (Andeswari et al., 2021). Based on the syntax mapping integrated with the critical thinking indicators, when the student worksheet was tested in the experimental class (27 students), the results were as shown in Table 7.

Teble 7. Result of Using Student Worksheet in Experimental Class

Critical Thinking Indicators	Group 1	Group 2	Group 3	Group 4
Interpretation	4	4	4	4
Analysis	4	4	4	4
Evaluation	3	4	3	4
Inference				
Explanation	4	3	4	4
Self-Regulation	4	3	3	3
Final Results	95	90	90	95

The results obtained from the implementation of the LKPD on the fraction material in Phase A showed a score of ≥ 90, which means that the score falls into the "high" category (Sitopu & Purba, 2021; Rizky et al., 2022; Hartati, 2022). It's just that the fifth PBL step, which is integrated with self-regulatory indicators (Fig. 2), is still difficult for groups 2, 3, and 4.

Figure 2. Integrated PBL Syntax on Self-Regulation Indicators

Three of the four groups scored three points in Step 5 (analyzing the problem-solving process). If you look at the results of group tasks 2, 3, and 4, which did not get perfect scores because the answers or reasons given were correct only less detailed and precise, there were some reasons that did not answer the question correctly, but the acquisition of scores in each group obtained a high score. Thus, the development of student worksheet based on the PBL model is able to train students' critical thinking skills (Zulfaturrochmah et al., 2023).

KESIMPULAN

The use of PBL-based student worksheets hones and develops students' critical thinking skills because they are able to use their critical thinking skills, fully engage in their learning, and connect the problems presented to real life. This makes it easier for students to learn and master important learning concepts. Based on the analysis of PBL-based fraction materials from the results of the validation evaluation of the learner worksheets developed by the researcher, it can be concluded that the learner worksheets are theoretically feasible.

Analysis of the results of validators using Aiken produces an average of 0.8478 including in the "Very Valid" category and the results of practicality are in the "Very Practical" category, so that it can be used as teaching material that can support the learning process, but it is still necessary to develop better student worksheets, and more in accordance with the Learning Outcomes (CP) and Flow of Learning Objectives (ATP), so that students' critical thinking skills are getting better. In addition, it is still necessary to develop critical thinking indicators that are more connected to the syntax of the PBL model for further research.

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