

Integrating flipped PDF professional to develop a PBL e-worksheet for students' critical thinking

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Abstract

Increasingly advanced and developing technology resulted in the rapid development of science. Students have used smartphones a lot with the help of the internet to learn and obtain information. The impact of the covid pandemic has affected the use of technology. Digital-based teaching materials are needed to support student learning activities. One of the schools that will be used as a research location is SMP Nurul Muttaqin. This study aims to develop a valid, practical and effective Problem Based Learning (PBL) based e-worksheet to improve students' critical thinking skills towards quadrilateral math material. In this study using qualitative methods with the development of 4-D (Four-D Models), namely define, design, develop and disseminate. The instruments used in the study were media expert and material expert validation sheets, student response questionnaires and questions to measure students' problem-solving abilities. PBL-based E-worksheet is said to be valid in terms of media 111.5 with good criteria, and material expert validation obtains an average score of 51 with good criteria. From these results the developed e-worksheet can be declared to meet the validity criteria for a teaching material. Based on the results of the questionnaire the responses of e-worksheet students were said to be practical by small groups and large groups. Based on the student response questionnaire, the small group obtained an average score of 49,2 with good criteria, and the large group obtained an average score of 51.3 with good criteria. In this study, the effectiveness of the e-worksheet was obtained through post-test questions from the treatment group and control group using the independent sample t test and obtained $t_{count} > t_{table}$, so h_0 was rejected, which means that learning with treatment groups using the pbl model assisted by eworksheet is effective. to increase the critical thinking of class VII students of smp nurul muttaqin compared to the control group that does not use e-worksheet.

Keywords: e-worksheet, problem based learning, and critical thinking

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INTRODUCTION

Every human being needs education, where education always undergoes changes, improvements and developments according to the development of time, science and technology. Changes, improvements and developments in education include various components involved in it, including teacher competence, the quality of teaching staff, the quality of education, curriculum, educational infrastructure, and the quality of education management. In addition, in education there are changes in models, methods and learning strategies that are more innovative (Pranata et al., 2021). Mathematics plays an important role in education and must be studied by all students from elementary school to university. Given the importance of mathematics education, learning mathematics is an important thing to pay attention to. Learning mathematics is expected to equip students to reason, think critically and be able to solve problems experienced in everyday life (Nainggolan, 2020).

TIMSS or Trends in Student Achievement in Mathematics and Science is an activity that aims to measure the math and science skills of students in several countries. In the 2019 research results with the method used is descriptive research of TIMSS results from 1999 to 2015, according to the 2019 survey results show that the skill of Indonesian students is still relatively low (Indonesian students are only able to solve simple math problems). Observing and commenting on the results of TIMSS, which is conducted every four years, should be used as an example or data for learning evaluation and government response to further advance education in Indonesia (Hadi & Novaliyosi, 2019). Students' thinking skills need to be developed in the learning process, especially in mathematics learning, one of which is critical thinking. According to Ennis (1996), critical thinking is reasoned and reflective thinking with an emphasis on making decisions about what to believe or do.

Based on the results of interviews with VII grade mathematics teachers at Nurul Muttaqin Junior High School, it was found that after the acceptance of students using the zoning system, there were various abilities of students. The skill of students in learning quadrilateral flat shapes is still lacking. In learning mathematics is still teacher-centered, where the material and questions focus on the teacher. In addition, teachers have difficulty in learning because students' learning was previously carried out online or in the network or also called online learning. Researchers chose class VII as the research subject because starting from class VII it is expected that students can solve problems by applying critical thinking to the next grade level. One of the learning models that can provide opportunities for students to be able to develop critical thinking skills is the Problem Based Learning (PBL) learning model. PBL is one of the most inspiring, appropriate, and creative learning models to improve students' critical thinking (Supriyadi & Suparman, 2019).

Learners need a medium of teaching materials and practice questions in the form of e-worksheet (Electronic Learner Worksheets) which are used to learn to solve math solving problems and improve critical thinking skills. E- worksheet is a learning model to support distance learning, to encourage students to actively find information and organize information independently, while being able to develop their skills in solving problems (Tunga et al., 2021). Following up on the problems faced in class VII of Nurul Muttaqin Junior High School in online learning where students must continue to learn even though they are not face-to-face. In this regard, researchers developed an e- worksheet on the mathematics material of rectangular flat shapes, based on PBL to improve students' critical thinking skills for the 2021/2022 academic year.

RESEARCH METHOD

In this study conducted at Nurul Muttaqin Junior High School, the development model used was the 4-D model. According to Thiagarayan (in Sugiyono, 2019) the stages of the 4-D model include: defining, designing, developing, and disseminating. The 4-D model is used in the development of e- worksheet which includes testing the feasibility of the product in terms of validity, practicality, and effectiveness. The outcomes of this study include learning resources in the form of PBL-based e- worksheet to improve students' critical thinking skills.

The procedure used in this research uses a sequential exploratory strategy with a Mixed Method design, namely Sequential Explanatory Design. Sequential Explanatory Design has five steps including collecting qualitative data, analyzing qualitative data, collecting quantitative data, analyzing quantitative data and interpretation of the overall analysis (Cresswell, 2014). Collecting and analyzing

qualitative data in this study was obtained from interviewing mathematics teachers. While collecting and analyzing quantitative data obtained from the results of the media expert validation questionnaire, material expert validation questionnaire, student response questionnaire and KPM test results for critical thinking of students. After obtaining the results of the analysis of qualitative and quantitative data, it is then evaluated as a whole and conclusions are drawn.

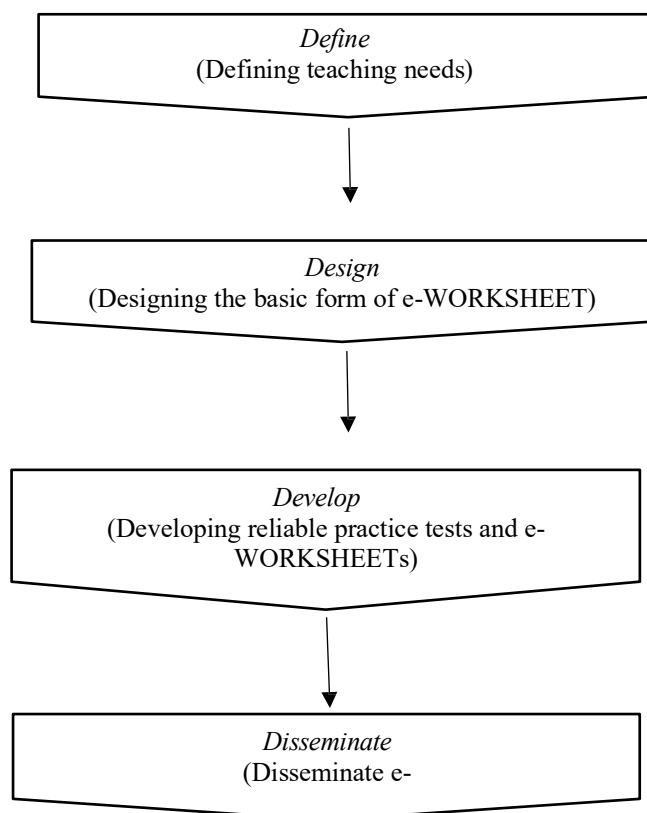


Figure 1. Schematic of the 4-D Model According to Thiagarayan (in Sugiyono, 2015)

The data collection techniques used in this study are as follows Non-test data collection is Teaching Material Validation Sheet for Media Experts and Material Experts e- worksheet assessment questionnaire by media experts and material experts. The questionnaire is used to determine the validity and practicality of e- worksheet. The questionnaire is used to determine the validity and practicality of e- worksheet and comments from media experts, material experts which will be used to complete the e- worksheet assessment form. In this case, mathematics teachers and expert lecturers work as media experts and material experts. The rules used in scoring the questionnaire use a Linkert scale as in Table 1.

Students' responses to the PBL-based e- worksheet components were collected through a student response questionnaire to determine the practicality of the product. The results of this questionnaire are used as material for revising e- worksheet. Learners are considered to have responded if they have given a positive response to the

material and materials in the e- worksheet. Learners are used as research samples to complete the answers of students.

Table 1. Scoring Rules on Questionnaires

Assessment Indicator Percentage	Score
$81\% < P \leq 100\%$	5
$61\% < P \leq 80\%$	4
$41\% < P \leq 60\%$	3
$21\% < P \leq 40\%$	2
$P \leq 20\%$	1

(Riduwan & Sunarto, 2017)

Documentation, observation, and interviews are advanced methods. The use of documentation is used to strengthen and complement the current data. Data and information can be collected through documentation. Documents used in this research to collect images and photographs. The observation sheet is used to monitor the teaching and learning process. Field notes served as the observation sheet for this investigation. The researcher used field notes to collect data regarding learning activities. The question sheet was used by the researcher to find out suggestions, input and interview results from informants (teachers and learners). The interview sheet includes questions asked to informants to find out more about learning. The interview process was conducted informally, and the researcher used a number of questions. The test technique is used to determine whether the e-worksheet PBL model to improve critical thinking of students is effective or useful in improving the critical thinking skills of students, by giving pretests and posttests on quadrilateral flat building material in mathematics lessons. The data collection techniques and instruments used are as follows:

For the non-test instruments, students' response questionnaires and assessment sheets or validation of teaching materials for media experts and material experts are non-test instruments and e-worksheet assessment sheet for media experts. E-worksheet is said to be valid if it meets the validity criteria based on media expert assessment. E-worksheet assessment sheet for material experts, in developing e-worksheet adapted to the subject matter of students, this subject matter affects the validity of e-worksheet so that material validation is needed in e-worksheet. The validity is obtained from the e-worksheet assessment in the form of content feasibility, presentation feasibility, and conformity to the process standards for students' critical thinking skills. The e-worksheet assessment grid for material experts comes from (Depdiknas, 2008), which can be seen in Table 2.

The results of the students' response questionnaire or students' responses to the components in the PBL-based e- worksheet are collected to determine the practicality of the product. The results of the students' assessment are taken into consideration for revisions to improve e- worksheet.

Table 2. Material Expert Assessment Questionnaire Grid

No	Aspects	Indicator	No Item
1	Content accuracy	a. Suitskill of material with KD	1
		b. Suitskill of the material	2,3
		c. Encourage students' interest	4,5
2	Present skill of Presentation	a. Accuracy of terms according to the context of the material and the development of learners	6
		b. The sub-materials in the e-worksheet are related	7,8
		c. The variety of language used is communicative in accordance with the language often used by students	9
3	Completeness of content	a. The detail of the e-WORKSHEET material according to the concept map design	10, 11
		b. WORKSHEET is presented systematically according to the PBL stages	12
		c. The suitskill of the material in the e-WORKSHEET is orderly and consistent	13,14

(Rusdi, 2018)

Learners are considered to have given a positive response if they have given a positive response to the relevance of the material, and the language in the e- worksheet. The learner response questionnaire grids can be seen in Table 3.

Table 3. Lattice of Learner Response Questionnaire

No.	Aspects	Assessment Indicator	No. Item
1	Content Feasibility	A. Suitskill with PBL learning model	1,2,3,4
		B. Interest	5,6,7
		C. Material and Presentation	8,9,10,11
		D. Use of Language	12,13,14
Number of questions			14

(Rusdi, 2018)

The test instrument used in this study is a person's assessment of problem solving. The problem solving process and testing of quadrilateral flat building material are used to create a problem skill test to improve students' critical thinking. The form of questions used in this study is a description question of 4 questions. By using this description question aims to find out how critical thinking of students to measure the effectiveness of e- worksheet. PBL-based e- worksheet is declared effective if the average posttest score is higher than the average pretest score, also the score obtained

by students exceeds the Minimum Completion Criteria (KKM) set by Nurul Muttaqin Junior High School.

Table 4. Grids of Problem Solving Skill Questions for Critical Thinking of Learners

Basic Competencies	Indicator
5.1 Solve problems and relate the perimeter and area formulas for different types of quadrilaterals (square, rectangle, rhombus, parallelogram, trapezoid and kite)	Solve contextual problems related to the area and perimeter of quadrilaterals (square, rectangle, rhombus, parallelogram, trapezoid, and kite)

RESULTS AND DISCUSSION

This research applies the 4-D development model (Define, Design, Development, Disseminate) to develop e- worksheet based on Problem-Based Learning (PBL). The main focus of the research is to improve students' critical thinking skills on quadrilateral flat material in class VII of Nurul Muttaqin Junior High School. This process begins with the Define stage, where researchers analyze the needs of students and schools. This analysis includes identifying student characteristics, materials, and tasks. The results showed the need for PBL-based e- worksheet to facilitate learning and increase student engagement and critical thinking skills.

At the Design stage, researchers designed e- worksheet that included a cover, introduction, table of contents, instructions, competencies, concept maps, materials, and evaluation questions. This design was adjusted to the results of the previous needs analysis, with the main objective of improving students' mathematical critical thinking skills. The indicators and structure of the e- worksheet were determined in detail at this stage.

The Development stage involves the development of e- worksheet as a whole, including the presentation of materials, questions, answer keys, the addition of PBL symbols, and critical thinking stages. After the e- worksheet was completed, it was validated by material and media experts. The validation results showed that the e- worksheet had good validity. At the Dissemination stage, e- worksheet that have been declared valid are tested on two groups of students: small groups and large groups. The questionnaire results show that the e- worksheet is practical and well received by students.

To test the effectiveness of e- worksheet, pretest and posttest tests were conducted on the treatment and control groups. The analysis showed that the use of PBL-based e- worksheet was effective in improving students' critical thinking and problem solving skills. Learning with e- worksheet involves more interactive and structured student activities compared to the PBL learning model without e- worksheet. The average posttest score of the treatment group was higher than the control group, indicating the effectiveness of e- worksheet in improving student learning outcomes.

This study supports previous findings that show that the utilization of technology in learning, especially e- worksheet, can improve students' critical thinking skills. This research also confirms that the PBL model is one of the inspiring and effective learning models to be used at the junior high school level, especially on quadrilateral flat building material.

CONCLUSION

The development of PBL-based e- worksheet to improve the critical thinking skills of seventh grade students of Nurul Muttaqin Junior High School on quadrilateral flat building material was carried out with the 4-D model (Define, Design, Development, and Dissemination) using Flip PDF Professional, PowerPoint, and Microsoft Word applications. E-worksheet meets valid criteria based on the assessment of media experts (111.5 with good criteria) and material experts (51 with good criteria), as well as practical criteria with an average score of 49.2 (small class) and 51.3 (large class) from the students' response questionnaire. In addition, this e- worksheet is effective based on the results of the independent sample t-test which shows $t_{\text{count}} > t_{\text{table}}$, so H_0 is rejected and learning with e- worksheet is more effective than control group learning. E-worksheet product is valid, practical, and effective, and can be used in learning, with the product results can be accessed at this link.

DECLARATION

Author Contribution

All authors contribute in the research process, such as collecting the data, analyzing the data, and writing the manuscript. All authors approved the final manuscript.

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This research did not receive any funding.

Conflict of Interest

Both authors declare that they have no competing interests.

Ethics Declaration

We as authors acknowledge that this work has been written based on ethical research that conforms with the regulations of our institutions and that we have obtained the permission from the relevant institutes when collecting data. We support the International Journal on Emerging Mathematics Education (IJEME) in maintaining high standards of personal conduct, practicing honesty in all our professional practices and endeavors.

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