

Development of an E-Worksheet Scientific Approach to Enhance Critical Thinking of 8th Grade Students

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Abstract

Probability is one of the materials that makes students find it challenging to engage with contextual problems. In fact, the critical thinking ability of students at Junior High School Muhammadiyah 1 Pundong on probability is relatively low; this is shown by the results of tests conducted by researchers. The cause of weak critical thinking is the learning model used by teachers during the learning process, namely the traditional learning model where teaching materials are not available which contain materials and exercises that students can use for independent learning. This research aims to develop an E-worksheet with a scientific approach to improve critical thinking skills. This research is research and development (R&D) using the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. The tools used in this research are validation tools from material and media experts, student response tools and pretest questions. Based on the validity test of E-worksheet products based on a scientific approach, it achieved an average of 4 in the competency category for media and 3.83 for material, while E-worksheet had an average of 94.18 in student responses in convenient terms. Based on the results of the comparative analysis of the averages presented, random E-worksheet material based on a scientific approach is effectively used in developing students' critical skills. Improving learning outcomes is supported by several features contained in the E-worksheet application. However, there are obstacles to using applications that are only used on Android phones rather than on other types of smartphones. However, this does not become an obstacle to the learning process.

Keywords: critical thinking, e-worksheet, scientific approach

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INTRODUCTION

Education plays an important role in improving the quality of human resources, so efforts need to be made to improve and improve the quality of educational services (Rusnilawati, 2016). One of the efforts made by the government to improve the quality of education services is by developing the curriculum. The curriculum in primary and secondary education must contain subjects, one of which is mathematics (Hernawati, 2016). Mathematics is one of the materials that must be studied at school (Wijayanti, 2016).

Based on the 2018 Program for International Student Assessment (PISA) test and evaluation results, the average achievement score of Indonesian students for mathematics was 379, placing Indonesia in 73rd place out of 79 countries evaluated (www.oecd.org). Based on these data, the learning achievements of students in Indonesia show that the mathematics abilities of Indonesian students are quite lower than those of students evaluated within the scope of PISA. One of the skills that students must have in the 21st century is the ability to think critically (Nursolekah & Suparman, 2019). Critical thinking skills are classifying, grouping, sorting, comparing,

differentiating, influencing, estimating, generalizing, specializing, predicting, validating, proving, connecting, analyzing, evaluating, making patterns and drawing conclusions (Siswono, 2018).

The paradigm shift in the learning process from students being told to finding out is nothing new, the Kurikulum Tingkat Satuan Pendidikan (KTSP) or 2006 curriculum in its concept also requires students to be more active in the classroom, but in practice the teacher still dominates the class. The 2013 curriculum really emphasizes balancing between cognitive (intellectual), psychomotor (movement) and affective (attitude) aspects, in contrast to KTSP which at the implementation stage tends to focus more on cognitive aspects. The government's policy in implementing the 2013 Curriculum is through a scientific approach (Lutfi, 2019).

The scientific approach is a learning process designed in such a way that students actively construct concepts, laws and principles through the stages of observing (to identify or find problems), formulating problems, proposing or formulating hypotheses, collecting data using various techniques, analyzing data, draw conclusions and communicate (Mahmudah, 2016).

According to Gerlach & Ely in Hamdani (2011), if broadly understood, media are people, materials, or events that create conditions that enable students to acquire knowledge, skills, or attitudes. More specifically, the definition of media in the teaching and learning process tends to be defined as graphic, photographic or electronic tools for capturing, processing and reconstructing visual or verbal information.

It is hoped that the use of media in mathematics learning can help the learning process be more effective and the learning objectives can be achieved and students can understand the concepts of the material that will be presented by the teacher. Student Worksheets (LKPD) are also an appropriate learning alternative for students because with worksheets students can be helped to add information about the concepts being studied through systematic learning activities, but in reality the worksheets used is less interesting and is considered not optimal. because students are less motivated to use worksheets (Prasetia & Suparman, 2019).

Based on the results of interviews with the Principal and Mathematics Teacher of Junior High School Muhammadiyah 1 Pundong, students still have difficulty understanding material concepts well, especially in class VIII regarding material probability. When making mistakes, students make mistakes in identifying contextual problems given by the teacher. Next, the researcher conducted an initial test on students by providing contextual problems to see the achievement of critical thinking indicators with test results as presented in Figure 1.

Based on Figure 1., the maximum score possessed by students is 40, with the maximum score on question number 1 being 50, while the average of students who answered question number 1 is 16, while on question number 2, the maximum score possessed by students is 30 with the maximum score on question number 2 being 50 and the average of students who answered question number 2 was 6. So, based on the results of students who answered questions number 1 and 2 was 22%, which indicates that students still needed to achieve minimum completeness. The minimum critical thinking completeness score is 70.

The results of interviews conducted with students at Junior High School Muhammadiyah 1 Pundong, with the aim of finding out the factors behind low critical thinking skills, show that low critical thinking skills are found in the learning model that teachers use. This learning model is a conventional one, where students only note down the material and formulas given.

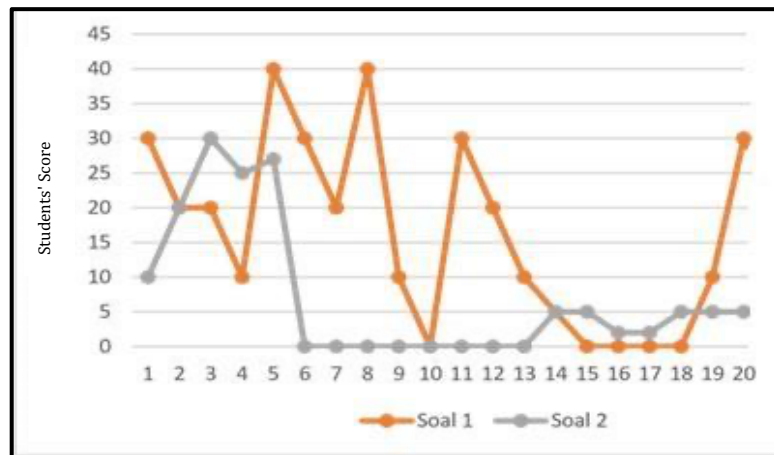


Figure 1. Recapitulation of Students' Scores

In the learning process, the teacher does $r_{Test 1}$ out $t_{Test 2}$ natics problems to be solved, so students are confused about solving the problems given. Students are also not given the opportunity to try independently the questions given, instead, the teacher answers the questions together with the students. This can be the cause of low critical thinking skills. Thus, Junior High School Muhammadiyah 1 Pundong requires a learning model that is oriented towards critical thinking skills.

Apart from the need for an orientation towards critical thinking skills, the learning conditions at Junior High School Muhammadiyah 1 Pundong also still use textbooks which students cannot study independently, besides, the learning books are monotonous and do not focus on one material with a short learning time making students unable to study independently, and cannot learn anytime, anywhere without a specified time limit (Florentina Turnip & Karyono, 2021; Maryam, Masykur & Andriani, 2019). In supporting the interview results, the researcher provided a needs analysis questionnaire, which can be seen in Figure 2.

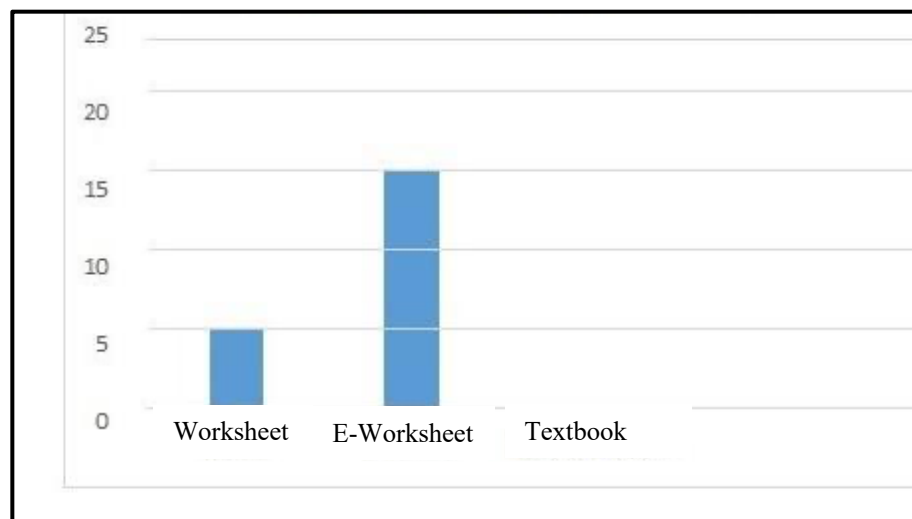


Figure 2. Results of analysis of E-worksheet needs at Junior High School Muhammadiyah 1 Pundong

Based on Figure 2, 25% of students chose a worksheet, 75% choose an E-worksheet, and 0% choose textbooks. This indicates that E-worksheet is an exciting teaching material for students. Apart from that, students also prefer to use cell phones in everyday life and tend to use cell phones more than books. E-worksheets can be a solution so that students can actively learn because the teaching materials are integrated using Android in the learning process.

RESEARCH METHOD

This research uses the research and development method using the ADDIE model (Analyze, Design, Development, Implementation, and Evaluation). Development research methods are used to produce certain products and test their effectiveness (Sugiyono, 2016).

In this research, researchers developed an e-worksheet as a learning media. The development of the E-worksheet is in terms of its form and content, which leads to a scientific approach. This research was carried out in class 8 of Junior High School Muhammadiyah 1 Pundong from March 2023 to June 2023 in the even semester of 2022/2023.

This research uses the concept of independent variables and dependent variables. The independent variable is a factor that influences the observed phenomenon, in this case, the E-worksheet. Meanwhile, the dependent variable is a factor that is observed to see the influence of the independent variable, namely learning achievement, on probability material. This research involved 20 grade 8 students at Junior High School Muhammadiyah 1 Pundong in field trials in the even semester of the 2022/2023 academic year. If any revisions are needed after the field trial, the revisions are carried out according to suggestions from the trial participants. If there are no revisions, the E-worksheet can proceed to the implementation stage. The research object is an E-worksheet as a learning media for junior high school students.

The method used in this research is the research and development method using the ADDIE model. The ADDIE development model consists of 5 main stages (Mulyatiningsih, 2011), namely: (1) Analysis; (2) Design (design); (3) Development (development); (4) Implementation (implementation); Evaluation (evaluation). To facilitate the research process, a research flow was prepared which contained research stages. The stages carried out in this research are (1) needs analysis, (2) product design, (3) product development, (4) product testing, and (5) product evaluation. The data in this research was collected through several techniques, namely, literature study, observation, lifting, interviews, and documentation.

The research instruments used in this research include (1) E-worksheet Validation Sheet: Used to validate E-worksheet media and materials by media expert lecturers and mathematics teachers before a limited trial is carried out. This sheet aims to ensure that E-worksheet meets quality standards and is relevant to a scientific approach. (2) Student Response Questionnaire Sheet: Used to collect student responses to learning using E-worksheet with a scientific approach. This questionnaire sheet helps in evaluating the effectiveness and success of using E-worksheet in the learning process.

The data obtained from this research is analyzed and then used to revise the developed E-worksheet so as to obtain an E-worksheet that is suitable as a learning medium in accordance with the specified criteria, namely appropriate. In general, the aspects assessed are content, language, design presentation and scientific approach. The data analysis technique used is a qualitative descriptive analysis technique measured by percentage (%) to test the level of product feasibility when implemented

in opportunity material. In this research, the questionnaire used uses a Likert scale. The data collected is processed by adding it up, comparing it with the expected number, and obtaining a percentage, which can be written using the following formula.

$$NP = \frac{R}{SM} \times 100\%$$

NP: The percent value sought

R: Score obtained

SM: Maximum score

The collected data was analyzed using qualitative descriptive analysis techniques expressed in score distributions and percentages. The next step was to describe and draw conclusions about each indicator. Table 1 shows the suitability of aspects in developing learning media.

Table 1. Product Feasibility Percentge Scale

Interval	Criteria
81%-100%	Highly feasible
61%-80%	Feasible
41%-60%	Moderately feasible
21%-40%	Less feasible
0%-20%	Not feasible

Adopted from Riduwan (2013)

The way to analyze the validity of E-worksheet is by giving the E-worksheet to the validator for validation. The E-worksheet is said to be valid if the validator states that the E-worksheet being developed is feasible for use in field trials with little or no revision, in the good category, namely $\geq 61\%$ (Riduwan, 2013). After the data is collected, the next step is to determine the validity value for each validator, material expert and media expert. The validity value of each material expert and media expert is calculated using the formula:

$$V_i = \frac{\text{Total score obtained}}{\text{Total score max}} \times 100\%$$

Note:

V_i : Validity value for each material and media expert validator

To analyze students' response, first calculate the total value of student responses through the answer choices for each question item. The student response value for each answer will be added up for each question item and the percentage will be found using the following formula.

$$\%NRS = \frac{\sum NRS}{NRS \max} \times 100\%$$

Note:

$\%NRS$: Percentage of student response score

$\sum NRS$: Total score of student responses obtained

NRS max: Maximum response value

To find out students' responses to E-worksheet, table 2. is presented as follows.

Table 2. Student Response Percentage Scale

Interval	Criteria
81%-100%	Highly practical
61%-80%	Practical
41%-60%	Moderately practical
21%-40%	Less practical
0%-20%	Not practical

Adopt from Riduwan (2013)

RESULTS AND DISCUSSION

At the beginning of the research, the researcher carried out a needs analysis of the curriculum and materials, conditions and situations and characteristics of students. This analysis will be discussed as follows.

Based on the curriculum and material analysis, as a result of observations and interviews conducted with mathematics teachers at Junior High School Muhammadiyah 1 Pundong, it is known that the school uses the K-13 curriculum as learning reference material, probability material refers to Core Competence (KI) and Basic Competence (KD) listed in the K-13 curriculum shown in table 3 below.

Table 3. Basic Competence (KD) of Knowledge and Skills

KD Knowledge	KD Skills
3.11 Explain the empirical and theoretical probability of an event from an experiment.	4.11 Solve problems related to the empirical and theoretical probability of an event from an experiment.

Next, the researchers interviewed about the extent to which mathematics teachers at Junior High School Muhammadiyah 1 Pundong provided probability material. The results of the interview are the probability material taught by the teacher during the learning process. The learning process is carried out with a time allocation of 2 hours per meeting and the learning process meeting time is carried out every 2 meetings a week.

This research was conducted at Junior High School Muhammadiyah 1 Pundong with the aim of developing E-worksheet based on a scientific approach to improve the critical thinking skills of grade 8th students. The results of the interviews showed that the learning model used was still conventional and did not facilitate discussion and collaboration between students. Students also have difficulty solving contextual mathematics problems and lack practical teaching materials that support learning.

Based on this analysis, the researcher decided to develop an E-worksheet based on a scientific approach. To understand the characteristics of students, interviews were conducted with mathematics teachers and written tests were given. The results show the low critical thinking abilities of students. Then, the researcher prepared an E-worksheet design which included observing, asking, trying, reasoning and communicating activities. The E-worksheet validation instrument was also prepared and tested for validity. Implementation was carried out in one class 8 in March. Evaluation is carried out with improvements based on problems encountered during

the learning process. Thus, this research aims to develop an E-worksheet based on a scientific approach that can improve the critical thinking skills of grade 8th students at Junior High School Muhammadiyah 1 Pundong.

At the design stage, researchers designed an E-worksheet based on a scientific approach for opportunity material at Junior High School Muhammadiyah 1 Pundong. The design includes several components: (1) Scientific Approach Syntax: The steps of the scientific approach are symbolized to guide students. These symbols include observing, asking, reasoning, trying, and communicating. (2) Critical Thinking Skills: Critical thinking indicators are included in the E-worksheet. This includes creating mathematical models, problem solving steps, applying the concept of opportunity, and evaluating work results. (3) Probability Material: Basic competencies and indicators of competency achievement are described in the E-worksheet. This material is arranged in a concept map to facilitate understanding. (4) Instructions for Using E-worksheet: The steps for using E-worksheet and scientific approach symbols are explained to guide users. (5) Critical Thinking Indicators: Critical thinking indicator symbols are included to guide students in the learning process. (6) Concept Map: The material is explained in a concept map to clarify the relationship between the concepts being taught. (7) Activities and Work Steps: Stages of activities and work steps in the learning process are described. (8) Assessment: Questions related to probability material are included to measure students' critical thinking skills. (9) Bibliography and Author Profile: The sources used in developing the E-worksheet are listed, and the author profile is included.

Apart from that, a validation instrument for media experts was also prepared and validated to ensure suitability from a media perspective. The validation results show that the instrument is suitable for use with several revisions. Validation instruments for media experts, material experts, student response questionnaires and pretest questions have been prepared to ensure feasibility and effectiveness in developing E-worksheet teaching materials. After being verified by experts, these instruments were declared suitable for use with several suggestions for improvement. Furthermore, the lesson plan (RPP) has also been prepared taking into account various aspects related to the curriculum and learning process.

In the development stage, E-worksheet was developed using Microsoft Word 2010, then converted into PDF format. After that, use the Flip PDF Corporate Edition application to convert the file into HTML format, making it E-worksheet. This e-worksheet is enriched with additional features through the FAPA book extender application, making it more interactive. Revisions to the E-worksheet were carried out based on input from material experts and media experts, which were then validated again.

Material expert validation was carried out by two validators, with the total score in the very decent category. Input from material experts includes improvements to the cover, adjustments to critical thinking ability achievements, adding page numbers, and adjusting assignments to critical thinking ability indicators. Media expert validation was carried out by one validator, with the total score of the category being very feasible and feasible. Input from media experts included improvements to the cover, adjustments to symbols to represent critical thinking skills, and consistency in font size. Next, a practicality test was carried out on E-worksheet with grade 8th students at Junior High School Muhammadiyah 1 Pundong. The results show that E-worksheet is considered very practical with a score of 94.18%. Evaluation is carried out by identifying deficiencies in the E-worksheet implementation process, which are then corrected. The

results show that E- worksheet can improve students' critical thinking skills and make the learning process more enjoyable

CONCLUSION

Based on this research, the development of E-worksheet with a scientific approach on probability material for grade 8th students at Junior High School Muhammadiyah 1 Pundong for the 2022/2023 academic year includes several processes. The first one is analysis process. During this process, field observations show that the use of learning media is not optimal, students have difficulty understanding probability material, and the learning approach used is a scientific approach. The second one is design. The E-worksheet development plan is prepared based on needs and scientific approach steps, with probability material as the main focus. The third one is development. E-worksheet was validated by media experts and material experts, the results showed the feasibility of E-worksheet with a scientific approach for grade 8th junior high school students. The fourth one is implementation. E-worksheet is implemented through field trials, both small trials and field trials to ensure its effectiveness. The last one is evaluation. Evaluation is carried out based on the results of validation and trials, as well as student achievement tests. The feasibility of E-worksheet was assessed as suitable for use according to media experts, material experts, and student responses.

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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