



## Development of Student Worksheets Based on An Open-Ended Approach to Facilitate Mathematical Critical Thinking Abilities of Junior High School Students

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### **Article Info:**

Received 16 Dec 2025  
Revised 2 Jan 2026  
Accepted 25 Jan 2026

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### *How to Cite:*

Rahmatti, D., Sunanti, T., & Kintoko, K. (2026). Development of Student Worksheets Based on An Open-Ended Approach to Facilitate Mathematical Critical Thinking Abilities of Junior High School Students. *Jurnal Theorems (The Original Research of Mathematics)*, 11(1), 50-57

### ABSTRACT

This study aims to develop and evaluate the quality of a Student Worksheet (LKPD) based on the open-ended approach for the topic of statistics, intended for Grade VIII B students at SMP Masyithoh Kroya. The development of this learning media is designed to facilitate students' critical thinking skills by meeting the criteria of validity, practicality, and effectiveness. The research method used is Research and Development (R&D) with the ADDIE development model, which consists of the stages: Analysis, Design, Development, Implementation, and Evaluation. The validation results indicate that the media is considered "Very Valid," with a score of 86.34% from the material expert and 84% from the media expert. The practicality of the media, based on student response questionnaires, scored 71.65%, categorized as "Practical." The effectiveness of the media was determined through test results, showing a mastery level of 96.77%, categorized as "Very Effective." Therefore, the developed open-ended LKPD is proven to be feasible for use in teaching statistics and effective in enhancing students' critical thinking skills.

**Keywords:** Student Worksheet, Open-Ended, Critical Thinking Skills

## INTRODUCTION

Mathematics plays a crucial role in education as it contributes to the development of competent human resources (HR). Minister of Education and Culture Regulation Number 20 of 2016 concerning Graduate Competency Standards for Elementary and Secondary Education states that junior high school (SMP/MTs) graduates are expected to possess creative, productive, critical, independent, collaborative, and communicative thinking and acting skills. Critical thinking is one essential skill that needs to be developed. Syafitri, Astuti, and Firdaus (2022) state that critical thinking is an essential skill that students must possess. Hidayah et al. (2017) also emphasize that students will not be able to deeply understand lessons, including mathematics, without critical reading and thinking skills. Therefore, mathematics learning should be directed toward developing critical thinking skills so that students can optimally practice and transfer their understanding. Rahmawati (2016) adds that critical



thinking is a deeply reflective process in making decisions and solving problems by analyzing situations, evaluating arguments, and drawing appropriate conclusions.

The results of the critical thinking ability test of eighth-grade students at Masyithoh Kroya Middle School showed that almost half of the 310 students were in the low category, with critical thinking skills still lacking. This finding is in line with research by Lilis Nuryanti et al. (2018) which stated that the average critical thinking ability of junior high school students only reached 40.46%. This condition indicates the need for intervention in learning to improve students' critical thinking skills, one of which is through the use of appropriate teaching materials. Teaching materials are a set of learning materials systematically arranged to support the student learning process. According to Prastowo in Atika et al. (2020), teaching materials can be printed, audio, audiovisual, or interactive. One form of printed teaching material commonly used is the Student Worksheet (LKPD). LKPD is a teaching material that helps students understand concepts, guides the learning process, and encourages active involvement in learning (Utami, Sumarmi, Ruja, & Utaya, 2016).

However, based on interviews with eighth-grade mathematics teachers at Masyithoh Middle School, it was found that the use of student worksheets (LKPD) is still limited. Teachers only use textbooks and lecture methods, while the LKPD used only contains material and questions without clear directions or instructions. As a result, students tend to be passive and simply memorize the material. A more appropriate learning approach is needed so that students can learn actively and develop critical thinking skills. One approach that can be used is the Open-Ended approach. This approach involves students in solving open-ended problems that have many possible answers and solution strategies (Taufik, 2014). According to Rahmawati (2014), this approach allows students to develop mindsets according to their abilities and interests. The main focus is not on the final answer, but rather on the thought process used to reach the answer. Through non-routine and open-ended questions, students learn to think critically, explore various solutions, and understand the thinking of other students (Suandiro, Darmawiyjo, & Purwoko, 2013).

From the above explanation, it is clear that the open-ended approach has great potential to support the development of students' critical thinking skills. Therefore, this research was conducted to develop Student Worksheets (LKPD) based on the open-ended approach as teaching materials capable of facilitating eighth-grade students' critical mathematical thinking skills. This development focused on producing a product that meets the aspects of validity, practicality, and effectiveness, so that it can be optimally used in the mathematics learning process in the classroom.



## METHODS

This type of research is *Research and Development (R&D)* This research was designed using the ADDIE model (*Analysis, Design, Devolpment, Implementation, Evaluation*). This research was conducted at Masyithoh Kroya Junior High School, specifically on class VIII B students in the second semester of the 2024/2025 academic year. A small-scale trial was conducted on 5 students, while a large-scale trial was conducted on 31 class VIII B students. The instruments used in data collection in the development of this LKPD were a validation sheet, a student response questionnaire sheet, and a critical thinking ability test sheet.

This data analysis was conducted to determine the quality categories of the developed LKPD. Three analyses were conducted in this study: validity, practicality, and effectiveness. The analysis techniques used to categorize the quality of the developed LKPD are as follows:

Table 1. Questionnaire Scoring Guidelines

Score	Criteria
5	Very good
4	Good
3	Pretty good
2	Not good
1	Very Bad

Calculate the average number of scores obtained using the formula:

$$P = \frac{\sum S}{\sum S_{max}} \times 100\%$$

With :  $P$  = Percentage of Product Criteria (%)

$\sum S$  = jumlah skor yang diperoleh

$\sum S_{max}$  = jumlah skor maksimum

The calculation results are converted into qualitative data with the following assessment criteria:

Table 2. Criteria for Assessing the Validity, Practicality, and Effectiveness of LKPD

Average score (%)	Criteria
$p > 80$	Very good
$60 < p \leq 80$	Good
$40 < p \leq 60$	Pretty good
$20 < p \leq 40$	Not Good
$0 < p \leq 20$	Not good

(Widoyoko, 2017)

LKPD can be said to be valid if the results of the validity assessment are in the minimum good category, it can be said to be practical if the results of the student response questionnaire analysis are in the minimum good category, and it can be said to be effective if the results of the test analysis are in the minimum "effective" category.

## FINDINGS

This research produces a product in the form of a Student Worksheet (LKPD) based on a learning *open ended* approach which aims to facilitate critical thinking skills in statistics material for class VIII SMP semester 2. The development process is carried out using the ADDIE model which consists of five stages. In the analysis phase, a study was conducted on student needs, the curriculum, and the student worksheets used at Masyithoh Kroya Middle School. The analysis showed that students' critical thinking skills were low, and the student worksheets used did not support active learning and did not include activities that encourage critical thinking.

The design phase includes developing the student worksheet structure, learning outcomes and objectives in accordance with the Independent Curriculum, and designing validation instruments for validity, practicality, and effectiveness. The student worksheets were developed for two sub-topics: data centralization and data dissemination, with an emphasis on open-ended problem-solving activities. The development stage includes product creation using WPS and Canva, followed by validation by subject matter and media experts, and revisions. The following is a preview of the developed LKPD.



**Figure 1. Display of the LKPD resulting from the development**

After developing the LKPD, validation was conducted by material experts and media experts.

The following are the results of the validation analysis of the developed mathematics LKPD:

**Table 3. Results of the analysis of the assessment of LKPD by material experts**

<b>Total questionnaire scores obtained</b>	<b>177</b>
Maximum score	205
Validity Percentage	86,34%
Validity Criteria	Very Valid

Based on table 3, according to material experts, the percentage obtained was 86.34% with qualitative criteria. **“Very Valid”**.



Table 4. Results of the analysis of the assessment of the Media Expert's LKPD

<b>Total questionnaire scores obtained</b>	<b>42</b>
Maximum score	50
Validity Percentage	84%
Validity Criteria	Very Valid

Based on table 4, according to media experts, the percentage obtained was 84% with qualitative criteria. **“Very Valid”**. The implementation stage, carried out through a small-scale trial conducted on 5 students of SMP Masythoh Kroya to determine student responses regarding the interest, material, and language of the developed mathematics LKPD. A large-scale trial was conducted by all 31 students of class VIIIB of SMP Masyithoh Kroya. The trial process of the developed LKPD was carried out by researchers and accompanied by the class VIIIB mathematics teacher who taught the class. The implementation of the large-scale trial was carried out in 2 meetings, distribution of student response questionnaires, and implementation of critical thinking ability tests after using the developed LKPD.

Evaluation stage, conducted an analysis of the LKPD assessment questionnaire by material experts and media experts, the student response questionnaire to the LKPD, and the results of the critical thinking skills post-test. The following analysis results were obtained:

1. The validity analysis has been described in tables 3 and 4 which state that the LKPD is very valid with a percentage according to material experts of 86.34% with the criteria of "very valid" and according to media experts a percentage of 84% with the criteria of "very valid".
2. Practicality analysis, seen from the results of the analysis of student response questionnaire data, the following is a practicality analysis in small and large scale sizes:

Table 5. Results of the analysis of the small-scale LKPD student response questionnaire

Total questionnaire scores obtained	318
Maximum score	425
Practicality Presentation	74,82%
Practicality Criteria	Practical

Table 6. Results of the analysis of the large-scale LKPD student response questionnaire

Total questionnaire scores obtained	1888
Maximum score	2635
Practicality Presentation	71,65%
Practicality Criteria	Practical

Based on the results of the student response questionnaire analysis, a percentage of 71.65% was obtained in the "practical" category. Effectiveness analysis was obtained from a critical thinking skills test. The test consisted of three descriptive questions covering four indicators of critical thinking skills. The test was administered for 60 minutes. In this study, students were considered to have



completed the course if they met the minimum criteria of good by achieving a final score of more than 60.

Table 7. Results of analysis of critical thinking skills completion

Many students have completed	30
Many students do not complete	1
Percentage of students who completed	96,77%
Criteria for students' critical thinking abilities	Very effective

Based on the results of the analysis of the critical thinking ability test, the percentage of student completion was 96.77% with the qualification "**very effective**". This shows that student worksheets (LKPD based on the learning approach) *open ended* to facilitate the critical thinking skills of junior high school students has met the effective criteria.

## DISCUSSION

The findings of this study demonstrate that the developed open-ended student worksheets on Statistics for Grade VIII are valid, practical, and effective in facilitating students' mathematical critical thinking abilities. Beyond confirming effectiveness, the results provide deeper insights into how the open-ended approach supports the development of critical thinking processes in mathematics learning.

First, the validity results indicate that the student worksheets successfully integrate statistical content with open-ended task characteristics, such as multiple solution strategies, non-routine problems, and opportunities for justification. This aligns with the theoretical foundation of open-ended learning, which emphasizes divergent thinking and student-generated reasoning. Unlike conventional structured exercises that typically lead students toward a single procedural answer, the developed student worksheets encouraged students to construct arguments, interpret data, and justify conclusions based on statistical representations.

Second, the practicality findings suggest that both teachers and students were able to implement the student worksheets effectively within classroom settings. Observations revealed that students actively engaged in discussions, compared solution strategies, and negotiated meaning during group work. This collaborative environment is crucial in nurturing critical thinking, as students are required not only to produce answers but also to evaluate and defend their reasoning. These classroom dynamics confirm that open-ended tasks can shift learning from teacher-centered explanation toward student-centered exploration.

Third, regarding effectiveness, the improvement in students' critical thinking abilities can be interpreted through several cognitive mechanisms. Open-ended statistical problems require students to interpret data, identify relevant information, consider alternative representations, and evaluate the reasonableness of conclusions. These processes correspond to key indicators of mathematical critical



thinking, including analysis, inference, evaluation, and explanation. The data suggest that when students are given autonomy to explore multiple strategies, they become more reflective and analytical in constructing mathematical arguments.

This finding is consistent with previous research by Purnamasari et al. (2019), Sari & Herman (2021), and (Fitriya & Faizah, 2021), which demonstrated that open-ended approaches enhance higher-order thinking skills in various mathematical topics. However, this study extends previous findings by focusing specifically on statistical content within the context of the Independent Curriculum. Statistics, which inherently involves interpretation of data and contextual reasoning, appears particularly suitable for open-ended design. The flexibility of statistical representation (tables, graphs, and diagrams) provides rich opportunities for students to propose diverse interpretations and justifications.

Furthermore, the implementation of open ended student worksheets supports the pedagogical orientation of the Independent Curriculum, which emphasizes meaningful learning, critical reasoning, and student agency (Monrat, Phaksunchai, & Chonchaiya, 2022; Widodo, Hidayat, Ekawati, Irfan, & Maarif, 2025). The results suggest that well designed open ended worksheets can function as practical tools for translating curriculum ideals into classroom practice. Teachers are not required to drastically change their teaching philosophy; instead, the structured design of the student worksheets guides them in facilitating richer mathematical discussions (Abdurrahman et al., 2020).

Nevertheless, several challenges were identified during implementation. Some students initially struggled with the absence of single correct answers, as they were accustomed to procedural tasks. This indicates that transitioning toward open-ended learning requires gradual adaptation and teacher scaffolding. In addition, time management becomes an important consideration, since open-ended discussions often demand longer classroom interaction. These challenges highlight the importance of teacher preparedness and classroom culture in successfully implementing open-ended approaches.

Overall, this study contributes both practically and theoretically. Practically, it provides a validated student worksheet design that teachers can adopt or adapt in statistics learning. Theoretically, it strengthens the argument that open-ended approaches are not only effective in algebra or geometry but also highly relevant in statistics education. By demonstrating how open-ended student worksheets facilitate critical thinking processes, this research supports broader efforts to integrate higher-order thinking skills into mathematics instruction at the junior high school level.

## CONCLUSION

This study developed open-ended student worksheets designed to facilitate junior high school students' mathematical critical thinking skills in statistics. The development process followed the



ADDIE model, which consists of the stages of analysis, design, development, implementation, and evaluation. The findings indicate that the developed student worksheets met the criteria of validity (86.34%), practicality (71.65%), and effectiveness (96.77%). These results demonstrate that the worksheets are appropriate and feasible to be implemented as instructional materials in mathematics learning. Furthermore, the integration of open-ended tasks within statistical content provides meaningful opportunities for students to analyze data, construct arguments, and justify their reasoning, thereby supporting the development of higher-order thinking skills. Overall, the study confirms that open-ended student worksheets can serve as an effective pedagogical tool to promote critical thinking-oriented learning in junior high school mathematics classrooms.

## SUGGESTION

Based on the findings of this study, several suggestions can be proposed. First, teachers are encouraged to adopt and adapt open-ended student worksheets in teaching statistics or other mathematical topics to foster students' critical thinking abilities. However, adequate preparation and classroom management strategies are needed to facilitate meaningful discussions and maximize student engagement.

Second, future researchers are recommended to explore the implementation of open-ended student worksheets in different mathematical topics, grade levels, or educational contexts to examine their broader applicability. Further studies may also investigate additional variables such as students' mathematical reasoning, problem-solving skills, or learning motivation to enrich the understanding of the impact of open-ended learning approaches.

Finally, longitudinal research is suggested to examine the sustainability of students' critical thinking development over time when consistently exposed to open-ended instructional materials.

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