

# HOTS Critical Thinking and Math Problem-Solving Skills on Wordwall-Assisted Problem-Based Learning Model

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## ABSTRACT

To address the difficulties experienced by students when dealing with challenging HOTS math problems, the selection and use of appropriate learning models and media is essential. This study investigated the impact of Wordwall-assisted Problem-based learning (PBL) models with HOTS problems on students' critical thinking and problem-solving skills in mathematics. This type of qualitative analysis uses descriptive methods. The subjects of this research were 31 grade 8 junior high school students in Batu, consisting of 22 male and 9 female students. Data collection methods are through questionnaires and test methods. Data analysis related to the validation of responses from 31 students was obtained from questionnaire results based on the ratio of student responses to the media, and data analysis was related to tests of students' critical thinking and problem-solving abilities. Established on the results of data analysis through research instruments in the form of data collected from student response questionnaires about the use of knowledge media, HOTS test questions discussed by SPLDV related to students' critical thinking abilities and problem-solving abilities. Students' critical thinking and mathematical problem-solving skills are very high, with achievements of 80.27% and 80.20%, respectively. It is expected that teachers can use the PBL method and Wordwall learning media so that student compatibility becomes better.

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## 1. INTRODUCTION

In the national curriculum, mathematics is a lesson that can support the development of science and technology and also contribute to problem-solving abilities (Bature *et al.*, 2020; Trimurtini *et al.*, 2021). However, most teachers still teach mathematics monotonously, which makes students think that learning mathematics is boring. As a result, students become less active during learning (Fernández-Martín *et al.*, 2022; Vansadiya *et al.*, 2023). The emphasis on developing students' scientific, systematic, logical, critical, and creative thinking skills in mathematics education necessitates teachers' ability to create new learning media that may not yet be readily available in schools (Kinasih *et al.*, 2023; Maharani, 2018). Apart from that, to increase students' interest in learning, interesting learning media is needed (Afriansyah & Arwadi, 2021; Puhka *et al.*, 2023).

In the knowledge method, media contributes to enhancing the grade of learning and also provides added value in learning activities (Devega *et al.*, 2022; Hasanah Lubis *et al.*, 2023). Learning media can improve students' readiness for knowledge and help students understand knowledge material easier. Apart from that, learning media can also make it easier for teachers to convey learning information to students. So, it is necessary to implement interesting and interactive knowledge media for students (Afriansyah & Arwadi, 2021; Muhammad *et al.*, 2023; Puhka *et al.*, 2023). A teacher's implementation of media use must be balanced with planning, implementation, and strict supervision so that the resulting quality does not deviate from the teacher's aims and objectives in learning (Krida, 2021; Wani *et al.*, 2023). Apart from creating interesting learning media, teachers are also expected to have various abilities and skills in preparing and managing teaching materials, selecting appropriate learning models,



and being able to master the class and use different learning models (Gultom et al., 2020; Nor et al., 2022).

A knowledge model is a pattern or design of knowledge activities that teachers must carry out when planning classroom learning, starting from preparing learning tools to assessment tools to achieve effective and efficient learning (Norström & Hallström, 2023; Wantu et al., 2023). The results of the researcher's initial observations from previous discussions with teachers or mentors at Muhammadiyah 2 Batu Middle School show that the learning process that have taken place so far is still oriented towards conventional learning models. The conventional learning model is a learning method that is still widely criticized because it is considered learning that does not give students freedom of action, and therefore, the participation of students in learning is still not optimal (Dietrich & Evans, 2022; Leal Filho, 2021). As a result, it causes boredom and hinders the development of students' active participation in school (Khalaf & Zin, 2018). Apart from discussing with teachers, researchers also conducted Question-answer interactions with class VIII students at SMP Muhammadiyah 2 Batu and found that students still had difficulty dealing with mathematics questions in the HOTS category.

HOTS has a good influence on students, including students are better able to understand learning concepts, differentiate learning concepts or ideas, provide clear arguments, solve and understand complex problems more clearly, construct explanations, and formulate hypotheses (Fatthurrahma & Anas, 2023; Pratama & Pramesti, 2018). If related to the cognitive level of Bloom's taxonomy, HOTS is at the level of analyzing, evaluating, creating, remembering, understanding, applying, evaluating, and creating (Ariyanto et al., 2020; Ekalia et al., 2022).

Established on the description above, the comparison between mathematics learning that occurs now in schools and the expected mathematics learning in the future lies in the media and learning models. Media and learning models have an influential effect on student knowledge. The subject of this problem is that it is necessary to choose an appropriate learning model assisted by using interesting learning media. The appropriate learning model to overcome HOTS problems in mathematics learning is the PBL model. The PBL model is a constructivist knowledge model that requires students to play an active role in understanding information, developing reasoning, developing higher skills, increasing self-confidence, developing insight and providing ideas, and being more effective (Wandari & Fardillah, 2021). Some of the characteristics of PBL are as follow: First, student-paced learning. Second, learning in small groups, where learning is not only carried out individually but can be done in groups and discussing with each other. Third, the teacher serves as a facilitator or principal; fourth, PBL problem-based learning; finally, students develop and present the results of their work (Markula & Aksela, 2022).

Meanwhile, the learning media that is suitable for the PBL learning model is Wordwall. This word wall media is in the form of a gaming platform that can be played online, so this media is not only used at school, but students can also access it at home. This media can be an exciting and fun learning tool for students, so it can make learning

more interesting and help students concentrate and pay attention to learning well (Fakhruddin et al., 2021; Jannah & Syafryadin, 2022). Apart from that, this application is suitable for designing and reviewing learning assessments because it has assessment tools in the state of considerable selection questions (*quiz*), matching the correct answer (*find the match*), closed questions, and anagrams (Bilova, 2023).

Based on the description above, with changes in media and learning models in schools, it is hoped that students can develop critical thinking skills to solve problems that may appear during learning. Critical thinking skills are essential to use in every subject, especially mathematics (Maulidiya & Nurlaelah, 2019; Rohman et al., 2020). Mathematics learning also brings a strategic and systematic reasoning process that can be employed in problem-solving abilities (Rohman et al., 2020). Polya (1973)'s book entitled *How To Solve It* defines problem-solving as an effort to find a path out of a problem to achieve a plan that cannot be completed directly. According to Polya, in solving a problem, there are four indicators, scilicet: (1) comprehending the problem, (2) scheduling problem-solving, (3) determining the problem, and (4) checking the results obtained (Rahayu et al., 2023).

Previous research related to the PBL model on critical thinking skills has been widely carried out, including Fitria et al. (2020) examining the use of the PBL model on students' mathematical critical thinking skills. This analysis was completed at Luqman Al-Hakim Middle School. The material provided is about Social Arithmetic. The results of this research show that the PBL model can enhance students' critical thinking skills. Meanwhile, PBL research related to problem-solving abilities was carried out by Amin et al. (2021), examining the effectiveness of the *Problem-Based Learning* (PBL) model and *Mobile Blended Problem-based Learning* (MBPBL) on mathematical problem-solving abilities. The results of this analysis show that the MPBL learning model is more effective than the PBL model. The MBPBL model can enable teachers and students to learn anywhere on their mobile devices. This research suggests that if you only use the PBL model, it is recommended to use the PBL model and media so that learning can be done anywhere, even if it is done online. Nasution et al. (2019)' aimed to determine the significance of implementing the PBL model with the CRH method assisted by crossword puzzle media. The development of this study implies that the media is suitable for use in the PBL model. However, the media is still lacking in variety, so the researcher suggests looking for other media to use in the PBL model.

What differentiates the research that has been carried out previously from the research that the researchers will carry out lies in the use of learning media. Researchers use wordwall media. There has already been research related to wordwall media, namely research conducted by Elhefni et al. (2023) and Asri et al. (2024). Variables related to several Wordwall media research include learning outcomes, learning motivation, and increasing student vocabulary. However, Wordwall media is very varied, which can help teachers create interesting content. Wordwall media related to critical thinking skills and problem-solving abilities, as

well as those related to the PBL model, have not yet been implemented.

Based on the description above, this analysis aims to encourage researchers to research critical thinking skills and HOTS mathematical problem-solving abilities in students with the help of the PBL model and Wordwall media. With this research, it is hoped that it can help teachers to be more creative in using media and learning models in the classroom, and it is also hoped that it will improve student activity when in the classroom and also improve students' critical thinking abilities when solving mathematics problems, especially HOTS questions.

## 2. METHOD

### 2.1. Types and Approaches

This type of research is descriptive qualitative research. The data described is data regarding the application of the Wordwall-assisted PBL model to critical thinking abilities and problem-solving abilities.

### 2.2. Participants

The Participants in this research were 31 students consisting of 22 male students and 9 female students. This research was implemented at SMP Muhammadiyah 2 Batu class VIII offline (face-to-face). This research was carried out in the odd semester of the 2023/2024 academic year.

### 2.3. Instruments

The research instruments used for data collection are three different questionnaires and a test instrument. The first questionnaire is a media validation questionnaire. There are 10 statements given to media experts to test the media that has been created. The second questionnaire, namely the material expert validation questionnaire. There are 9 statements given to material experts to test the material and test questions that have been created. The third questionnaire is a questionnaire regarding the application of media to students. The questionnaire will be given to students directly (offline) with 10 statements.

The test instrument contains HOTS questions related to class VIII mathematics learning SPLDV material. The test questions given are in the form of 1 essay question to measure students' critical thinking abilities and to measure students' mathematical problem-solving abilities.

### 2.4. Data Analysis

Data analysis related to the validation of responses from 31 students was obtained from questionnaire results based on the percentage of students' responses to the media, and data analysis was related to tests of students' critical thinking and problem-solving abilities. The calculations were analyzed using Excel, which uses Eq. (1) (Kusumah et al., 2021):

$$P = \frac{x}{y} \times 100\% \quad (1)$$

where:

$P$ : percentage number,

$x$ : score from data collection,

TABLE I: VALIDATION QUESTIONNAIRE CRITERIA FOR STUDENT RESPONSES TO MEDIA

Score	Feasibility categories
3.01–4.00	Strongly agree
2.01–3.00	Agree
1.01–2.00	Don't agree
0.00–1.00	Strongly disagree

Source: Wahyuni et al. (2020).

TABLE II: CRITICAL THINKING ABILITY CATEGORIES

Score (%)	Category
90–100	Very critical
80–89	Critical
70–79	Quite critical
60–69	Less critical

Source: Riezandi and Nurita (2022).

TABLE III: CATEGORIES OF PROBLEM-SOLVING ABILITY

Score average	Criteria
Score < 60	Low
$60.0 \leq \text{Score} < 80.0$	Current
$80.0 \leq \text{Score} \leq 100$	High

Source: Sumarni and Kadarwati (2020).

$y$ : Ideal score (highest score for each item  $\times$  number of respondents  $\times$  number of items).

The percentage results of student response data collection from the media validation questionnaire were categorized using a 4-point Likert scale. The 4-point Likert scale ranges into four categories. This can be seen in Table I.

Data analysts use tests. The tests tested are critical thinking abilities and mathematical problem-solving abilities in the form of HOTS questions. Students' critical thinking abilities can be categorized into very critical, critical, quite critical, and less critical, as presented in Table II. In contrast, students' mathematical problem-solving abilities are categorized into high, current, and low, as presented in Table III.

### 2.5. Research Procedure

#### 2.5.1. Survey

This stage is the initial stage. At this stage, the researcher will conduct a location survey to determine which school will be used as a research site. The researcher determined SMP Muhammadiyah 2 Batu City as the research site, with the subjects being class VIII junior high school students. Researchers also held discussions with mathematics subject teachers regarding HOTS question material in class VIII learning. At this stage, the researcher also prepares research instruments. The instruments in this research are questionnaires and tests. The first questionnaire was a media validation questionnaire. There are 10 statements given to media experts to test the media that has been created. The second questionnaire, namely the material expert validation questionnaire. There are 9 statements given to material experts to test the material that has been created. The third questionnaire is a questionnaire about student responses to the media that has been implemented. The test being tested is the HOTS question in the form of

an essay question, which consists of 1 question on critical thinking skills and mathematical problem-solving skills.

### 2.5.2. Research Implementation

Carrying out research is the core activity. The research was carried out 2 times, namely on the first day, testing the PBL model and media on students, and on the second day, administering HOTS test questions and questionnaires on student responses to learning media. After students take the HOTS question test, students will fill out a questionnaire about learning media. The data obtained were the results of a questionnaire regarding the use of learning media and HOTS test questions, which were then analyzed.

### 2.5.3. Analysis

This stage is the final stage of research. Researchers create research reports containing analysis of student data results. The report is written descriptively and explained based on existing facts.

## 3. RESULTS AND DISCUSSION

### 3.1. Students' Critical Thinking Abilities Related to HOTS Mathematics Test Questions in the Wordwall-assisted PBL Model

HOTS test questions with SPLDV discussion are given after students have applied the PBL model assisted by Wordwall media. The critical thinking abilities of Muhammadiyah 2 Batu Middle School students are classified as critical. The average percentage obtained for the student score category was 82.45 (Critical) and resulted in the categories presented in Table IV.

The categorization results given in Table IV show that 1 student was taken from the average results, namely critical students.

#### 3.1.1. Analysis of Students' Critical Thinking Skills Using Critical Categories

The RRA answers are presented in Fig. 1.

The student's score in the critical category is 87.5. Based on Fig. 1, in indicator 1, students get a score of 2. Students only write what is asked without writing what is known. In indicator 2, students get a score of 4. Namely, students make mathematical models wholly and correctly. In indicator 3, students get a score of 4, namely, students use strategies. The correct one is using the elimination and substitution method and doing the calculations correctly; on indicator 4, the student gets a score of 4; namely, the student concludes correctly and in accordance with what is asked in the question. So, it can be concluded that RRA students understand the questions well.

TABLE IV: STUDENTS' CRITICAL THINKING ABILITY TEST RESULTS

Critical thinking ability	Frequency	Percentage	Average
Very critical	14	46%	82.45%
Critical	5	16%	
Quite critical	6	19%	
Less critical	6	19%	

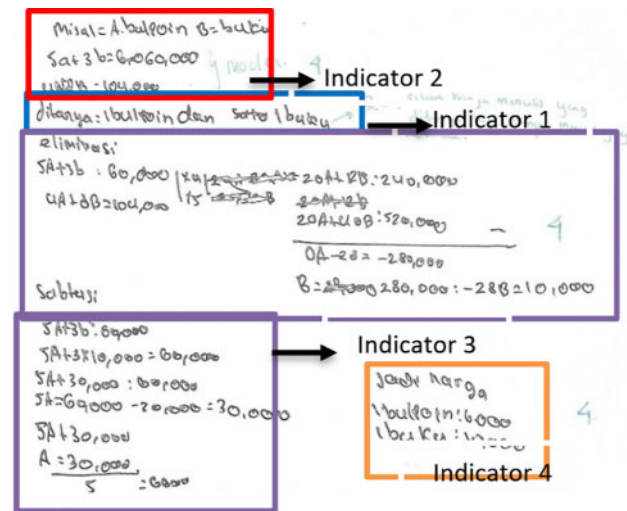


Fig. 1. Student answers in the critical category.

### 3.2. Students' Problem-solving Abilities Related to HOTS Mathematics Test Questions in the Wordwall-assisted PBL Model

HOTS test questions with SPLDV discussion are given after students have applied the PBL model assisted by Wordwall media. By implementing the PBL model and Wordwall media, the problem-solving abilities of Muhammadiyah 2 Batu Middle School students are relatively high. The average percentage for the student score category was 80.98 (High), which resulted in the categories presented in Table V.

From the categorization results in Table V, 1 student was taken from the average results, namely students who had high problem-solving abilities.

#### 3.2.1. Analysis of Students' Problem-solving Abilities in the High Category

The ANS answers are presented in Fig. 2.

Students who fall into the category of high problem-solving ability have a score of 100. Based on Fig. 2, in indicator 1 the student gets a score of 3; namely, the student shows a clear understanding of the context of the problem accurately and completely. In indicator 2 the student gets a score of 3. Namely, the student can consider new strategies. The strategy used is clear and precise, namely using the elimination and substitution method. In indicator 3, the student gets a score of 3, suggesting that the student states the solution or problem-solving steps, the solution taken is correct, and the calculations carried out are correct. In indicator 4, the student gets a score of 3. The student can apply the context of the problem when considering the solution, and the student can reflect on solutions so that the conclusions made are based on the context of the

TABLE V: RESULTS OF THE STUDENT PROBLEM-SOLVING ABILITY TESTS

Problem-solving skill	Frequency	Percentage	Average
Tall	19	62%	80.98
Currently	6	19%	
Low	6	19%	
Amount	31	100%	



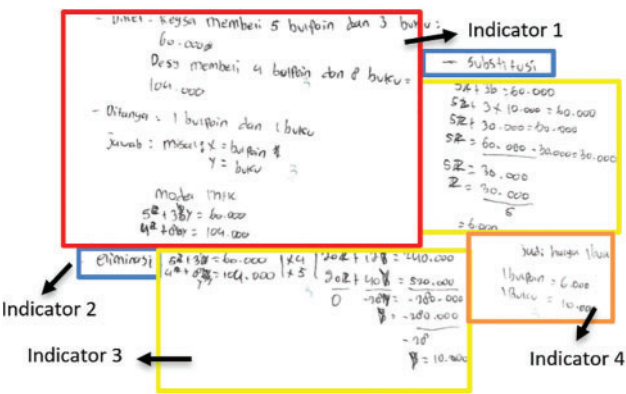


Fig. 2. Students' answers in the high category.

problem given by the teacher. So, it can be concluded that ANS students understand the questions well.

3.3. Student Responses to Media Questionnaires

Table VI shows students' responses to the media used during learning.

As suggested by Table VI, students' responses to the media used during learning showed that out of 31 respondents, after calculating the average of the results of the total number of respondents divided by the number of students, it is 3.02%. So, it falls into the strongly agree category. This means that most students are helped by the presence of media during learning.

The results of data analysis regarding students' critical thinking skills assisted by the PBL model and Wordwall media at SMP Muhammadiyah 2 Batu are classified as critical with the 80.27% category. This research was conducted on class VIII students using SPLDV discussion material. The use of the PBL model is very influential for

students. Students are faced with problems with mathematical concepts. Students are required to think more and discover for themselves the concepts of the problems they have studied. This is in line with research conducted by (Yolanda, 2019), which states that students' critical thinking abilities when applying the PBL model are classified as critical. This research was carried out at Bandung City Middle School with the subject of class VIII students, with material on relationships and functions. Research conducted by Patimah et al. (2023) regarding students' critical thinking abilities using Wordwall media stated that before using Wordwall media, students' critical thinking abilities were still relatively low. After implementing learning using Wordwall media, students' critical thinking abilities increased. It is proven that using learning media can improve students' critical thinking abilities. This research was carried out at the 5th grade Saban State Elementary School with thematic learning material. The results of data analysis regarding problem-solving abilities assisted by the PBL model and Wordwall media of Muhammadiyah 2 Batu Middle School students are classified as high with a category of 80.20%.

The results of data analysis regarding the use of Wordwall learning media for 31 female students produced an average of 3.02, which is in the strongly agree category. This aligns with research conducted by Asri et al. (2024). It can be seen that students like Wordwall as a learning medium. This research was carried out at SMA 10 Semarang with subjects in class XI, with English as the subject. Most students enjoy using this online game as their learning medium. Wordwall media can increase student learning motivation, build student interest in learning media, and make the use of media easy to understand.

Based on the results of the research conducted by researchers, it can be seen that each research conducted obtained different percentages of students' critical thinking

TABLE VI: RESULTS OF STUDENT RESPONSES TO MEDIA

No.	Statement	Percentage	Category
1.	Learning to use the Wordwall application media is a new experience for me	3.38	Agree
2.	It is easier for me to understand learning after using PPT and Wordwall learning media	3.32	Strongly agree
3.	I study more diligently when using PPT and Wordwall learning media	3.32	Strongly agree
4.	I am more enthusiastic about participating in learning that uses learning media	3.41	Strongly agree
5.	Learning using PPT and Wordwall media is very interesting and fun for me	3.25	Strongly agree
6.	The use of PPT and Wordwall media increases my motivation to study	3.09	Strongly agree
7.	The use of PPT and Wordwall media helps support my learning process	2.35	Agree
8.	The use of PPT and Wordwall media helps me to participate more actively in class	2.51	Agree
9.	The use of learning media is just a variation of teaching from the teacher so that you don't get bored easily, but in fact, the material I learned was the same as if I didn't use learning media	2.32	Agree
10.	I understand the questions better with the help of PPT and Wordwall media	3.29	Strongly agree
Average		3.02	Strongly agree

abilities and different results of students' problem-solving abilities. This is caused by internal factors and external factors of students (Mahanal et al., 2019). Internal and external factors can be overcome by increasing the use of media and learning models in schools. It is also recommended that teachers be more creative and innovative when teaching.

#### 4. CONCLUSION

This research investigated the PBL model and Wordwall media on critical thinking and problem-solving skills in solving SPLDV HOTS Mathematics questions among students at Muhammadiyah 2 Batu Middle School. The findings revealed that the intervention significantly enhanced students' critical thinking abilities to an average score of 80.27%, which is regarded as very critical, and the problem-solving abilities also improved considerably, reaching a high category with an average of 80.20%. Furthermore, the students who were classified in the very critical category exhibited superior critical thinking skills and analyzed mathematical issues effectively compared to those in lower categories. This pattern also occurred for the students in the moderately critical category who outperformed those in the less critical category. Hence, this notion also holds true for problem-solving. The students in the high category demonstrated better analytical and strategic skills than their counterparts in the medium category and outperformed those in the low category.

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#### CONFLICT OF INTEREST

The authors declare that they do not have any conflict of interest.

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