

## ANALYSIS OF STUDENTS' CRITICAL THINKING SKILLS IN DISCOVERY LEARNING SUPPORTED BY WORDWALL

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### Abstract :

This research utilizing Discovery Learning through Wordwall in order to examine students' critical thinking level in physics teaching, so that concerning the study of the work and energy. The study employed a quantitative methodology using a one-group pretest posttest design. A sample of 83 tenth graders was selected through purposeful sampling. Data was collected through an essay test developed with Ennis's critical thinking markers. Data were analyzed with descriptive statistics, N-gain, and the Wilcoxon signed-rank test. Results indicate that students' critical thinking skills fall in high to very high range across all variables. The highest achieved was 92.77% for set a strategy and tactics, while provide additional explanation has the lowest of 73.49%. The N gain showed that most of the students in the high (47%) and moderate (34%) categories. The Wilcoxon test confirms a statistical difference between the pretest and posttest data ( $p < 0.05$ ). The use of Wordwall to support Discovery Learning in class can improve critical thinking, which motivates students and provides more experience during learning. A case study demonstrating how a student centered learning methodology can embed interactive digital media within a more structured educational approach. The results also show that the use of this method can easily become a tool to enhance students' critical thinking skills in terms of physics learning.

**Keywords:** *Critical thinking skills; Discovery Learning; Wordwall*

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## INTRODUCTION

Challenges in the classrooms become complex and layered requiring educators to be prepared to tackle sophisticated challenges. In this regard, students are challenged not only to be able to master concepts but also higher-order thinking skills especially critical thinking (Ennis, 1993; Hryn et al., 2024; Ilmi et al., 2020; Irwan et al., 2025). With critical thinking, students are able to carefully evaluate arguments, analyze information systematically (Elhefni et al., 2020; Junina et al., 2020; Kasmiana et al., 2020; Ramadhan et al., 2020; Sari & Cahyo, 2020), and draw logical conclusions while solving the problems. Thus, the development of critical thinking skills also becomes an integral component when studying physics (Darwish, 2024; Rahma et al., 2023; Syamsidah et al., 2024).

Indeed, lectures and teacher-centered approach still dominate most of the classroom teaching. The problem here is that this limits students' opportunities to ask questions, to interrogate and explore

ideas not in the abstract but from their genesis. It also makes it harder for students themselves to sit in on classes. However, these results are generally low in the sense that critical thinking not only involves knowledge and understanding of theory but also applies skill to use what has been learned (Hartini et al., 2020; Siahaan et al., 2020; Wahidin & Romli, 2020; Wiwin et al., 2020). In physics this becomes a larger problem, because physics is not only about the concepts and how to understand them, but requires students to use scientific reasoning skills and transfer their knowledge into different contexts. From these conditions, one way we might conclude is that there is a greater need for learning approaches that can help accommodate twenty-first century competencies based on the perspective of students (Nenohai et al., 2022).

Discovery Learning is considered an effective approach because it directs students to actively construct their understanding through investigation and analysis. Several studies report that this model can improve critical thinking skills while also increasing student engagement during the learning process (Hariyanti et al., 2025; Ibrohim et al., 2024; Manurung & Pappachan, 2025; Setiaji et al., 2025). By adding interactive digital media, like Wordwall to the mix; it can reinforce this process in a more fun and responsive context. Interactive learning is an effective way to learn and makes students feel more motivated and engaged (Adiansha et al., 2025; Indriani et al., 2025; Oktavia et al., 2023; Olisna et al., 2022; Setiaji et al., 2025). Furthermore, the integration of student-centered learning models with digital media can create a more meaningful experience for students as they are encouraged to process and build upon what they learn (Chandra et al., 2024; Ibda et al., 2023; Kuron et al., 2025; Rezeki & Amelia, 2025).

So, digital technology in education promotes the development of interactive learning activities. One of the platforms utilized to create quizzes, games, and interactive activities is Wordwall (Ilham et al., 2022; Islami et al., 2021; Kurniawan, 2026; Samsudin et al., 2021). In previous studies, this sort of media were shown to significantly increase student engagement and lead to qualitatively deeper conceptual understandings (Alrizal et al., 2021; Gunawan et al., 2020; Oktalia et al., 2021; Vidyawati et al., 2020; Yana et al., 2020).

Previous studies have examined Discovery Learning, as well as digital media in their own right but there are few studies that integrate both methodologies especially related to physics education concerning work and energy. This study addresses these errors by combining Discovery Learning with Wordwall in class and testing students' critical thinking skills based on the Ennis indications.

This study is to evaluate students' critical thinking abilities prior to and during the use of Discovery Learning facilitated by Wordwall in physics education about the subject of work and energy. The results are anticipated to enhance the creation of more inventive and pertinent physics educational methodologies, especially in cultivating students' critical thinking abilities.

## **RESEARCH METHODS**

### **Research Design**

A quantitative method within a pre-experimental framework was used to collect data for this study. We tested students' critical thinking skills before and after they learned about force analysis with Wordwall. This allows the differences between before/after scores to be examined by group.

### **Time and Place of Research**

The research was performed in MAN 2 Pasuruan from January 27, until February 21, 2025 of the academic year of period year 2025–2026.

### **Research Target/Subject**

The sample of this study included 220 tenth-grade students. The sample was determined using purposive sampling, with the criteria of (1) no previous experience with Wordwall-based learning, (2) being taught by the same physics teacher, (3) showing relatively similar initial abilities based on previous academic achievements, and (4), availability during the research period. To ensure that the process goes well, a selection of prospective students is carried out based on these criteria, resulting in 83 selected students consisting of 26 from class X A Digital, 31 students from class X D Digital and 26 students from class X E Tahfidz.

### Research Procedure

Planning the study, giving the pretest, using Wordwall-supported Discovery Learning, giving the posttest, and analyzing the data were all part of the research process. Figure 1 depicts the entire study process.

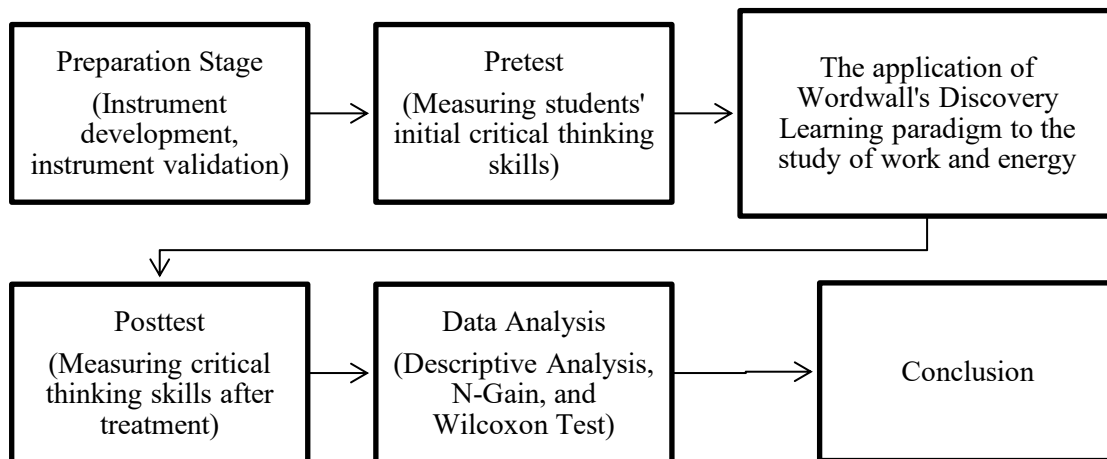


Figure 1. Procedure for research

### Instruments and Data Collection Techniques

A ten-item essay test was employed in this study to assess students' critical thinking skills. The test items were developed based on the critical thinking indicators proposed by (Ennis, 1993). Alignment with the learning objectives on the topic of work and energy was ensured. Each item was constructed to reflect specific indicators, namely providing simple explanations, building basic skills, drawing conclusions, providing further explanations, and setting strategies and tactics.

Each of these test items was designed to focus on targeted indicators such as simple explanations, basic building blocks, drawing conclusions, providing further explanation and strategy and tactics. Content rather than construct validity was confirmed by systematically aligned all three levels of the instrument (indicators, learning objectives and test items) in the development process.

The instrument was confirmed for content validity by expert judgment before testing empirically. 60 items using product-moment correlation for the first batch. A total of 60 items with test scores were analyzed and classified using  $r\text{-table} = 0.355$  as valid (26 items) and invalid (34 items). Out of the valid items, ten were selected based on their validity degree and adequate representation to each indicator.

Cronbach's alpha was used to evaluate the reliability of the instrument, which is performed on test items designed to measure the same construct. The value of 0.891 obtained indicates the high reliability of the instrument. This finding implies that the test has high internal consistency and can thus be used for measurement of students' critical thinking skills.

In order to evaluate students performance on each indicator we calculated the percentage of the correct answers based on Equation (1):

$$P = \frac{F}{N} \times 100\% \quad (1)$$

where  $N$  represents the total number of students,  $F$  denotes the number of correct responses for each indicator, and  $P$  indicates the percentage of critical thinking skills.

The relationship between the indicators, learning objectives and test items is presented in Table 1.

Table 1. Instrument design for exploration based on Ennis' critical thinking indicators

No	Critical Thinking Indicator (Ennis)	Learning Objectives	Item Number
1	Providing simple explanations	Students can articulate the definition of work and the direct variation between force and distance.	1, 2
2	Drawing conclusions	Students can also analyze the relationship between work and potential or kinetic energy.	3, 4, 6
3	Building basic skills	Students can determine variables and data necessary to find work and energy.	5, 8, 10
4	Providing further explanations	Students can now relate work to changes in kinetic energy.	7
5	Setting strategies and tactics	In work–energy analysis, students can identify variables and suitable experimental approaches.	9

### Data Analysis Technique

Data analysis was carried out using both descriptive and inferential statistical methods. The percentage of correct responses for each indicator was used to assess students' critical thinking skills using descriptive analysis. The improvement in students' critical thinking skills was measured using the N-gain score, which was derived from the difference between pretest and posttest results. The N-gain values were classified into three categories: low ( $g < 0.3$ ), medium ( $0.3 \leq g \leq 0.7$ ), and high ( $g > 0.7$ ).

Prior to hypothesis testing, data normality was examined using the Shapiro–Wilk test. A significance value (p-value) greater than 0.05 indicated that the data were normally distributed. The results revealed that both pretest ( $p = 0.000$ ) and posttest ( $p = 0.001$ ) data were not normally distributed ( $p < 0.05$ ).

For inferential analysis, the Wilcoxon signed-rank test was applied as a nonparametric test with a significance level of 0.05. The findings showed that a significant difference existed between the pretest and posttest scores ( $Z = -7.458$ ;  $p < 0.05$ ).

## RESULTS AND DISCUSSION

The assessment of students' critical thinking skills in physics learning on the topic of work and energy was conducted through the implementation of Discovery Learning supported by Wordwall. Measurements of students' critical thinking skills were carried out before and after the intervention through the administration of pretests and posttests.

### Analysis of Students' Critical Thinking Skills

The indicators developed by Ennis (1993), were used to evaluate students' critical thinking skills. These indicators include providing simple explanations, drawing conclusions, building basic skills, providing further explanations, and setting strategies and tactics. Table 2 presents the results of the investigation.

Table 2. Analysis of students' critical thinking skills based on indicators

No	Critical Thinking Indicator	Percentage	Category
1	Providing Simple Explanation	78.31	High
2	Drawing Conclusions	75.90	High
3	Building Basic Skills	82.73	Very High
4	Providing Further Explanation	73.49	High
5	Setting strategies and tactics	92.77	Very High

In Table 2, students' critical thinking skills are categorized as high to very high across all indicators. The highest score (92.77%) is shown in setting strategies and tactics, while the lowest (73.49%) is found in providing further explanations. The indicator of building basic skills is categorized as very high (82.73%). Meanwhile, providing simple explanations and drawing conclusions are classified as high, with percentages of 78.31% and 75.90%, respectively. These results indicate that variations in students' performance are observed across the indicators. The distribution of students' critical thinking skills across indicators is presented in Figure 2.

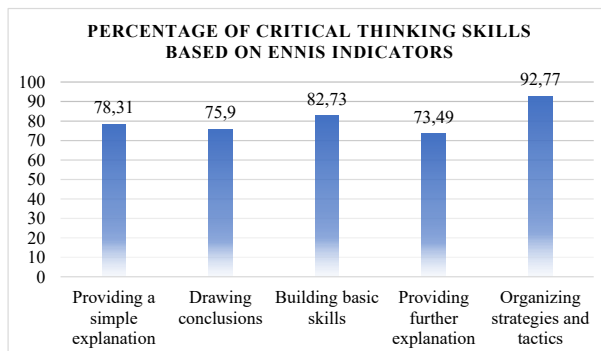


Figure 2. Critical thinking skills based on indicators

According to Figure 2, the largest percentage was obtained by setting strategies and tactics, whereas the lowest percentage was obtained by providing further explanations.

### Improving Students' Critical Thinking Skills

Based on the pretest and posttest results, the N-gain score was used to measure the improvement in students' critical thinking skills. Table 3 presents the results.

Table 3. Students' critical thinking abilities in the N-Gain category

N-Gain Category	Frequency	Percentage
High	39	47%
Moderate	28	34%
Low	16	19%
Total	83	100%

Based on Table 3, the majority of students are categorized in the high improvement group (47%), followed by the moderate category (34%) and the low category (19%). These results indicate that significant improvement was experienced by most students after the implementation of the learning model. The distribution of N-gain categories is shown in Figure 3.

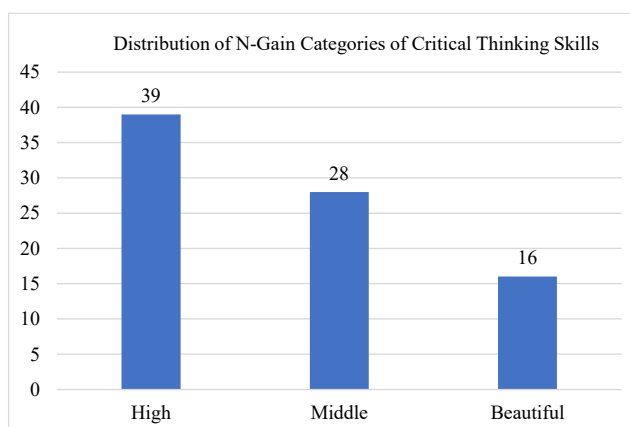


Figure 3. Distribution of N-Gain categories of critical thinking skills

According to Figure 3, the majority of students fall into the high and moderate improvement categories, while a smaller percentage remain in the low category.

### Hypothesis Testing

To examine whether a significant difference existed in students' critical thinking skills before and after the implementation of Discovery Learning supported by Wordwall, hypothesis testing was carried out. Since the data were not normally distributed, the Wilcoxon signed-rank test was applied. The results are displayed in Table 4.

Table 4. Wilcoxon signed rank test results

Compared Variables	Z	Sig. (2-tailed)	Decision
Posttest - Pretest	-7,458	0,000	Significant

A significant difference between the pretest and posttest scores is indicated by the Z value of -7.458 and the significance value of 0.000 ( $p < 0.05$ ). This finding suggests that an improvement in students' critical thinking skills was achieved through the use of Discovery Learning supported by Wordwall.

Based on Ennis (1993), students' critical thinking skills on the topic of work and energy are categorized as high to very high across all indicators. The best score (92.77%) is given for setting strategies and tactics. This means, known variables can be identified, correct formulas can be chosen and arranged step by step for solution. Decent development of procedural skill in physics problem solving.

Whereas the one with the least score (73.49%) is when giving further clarifications. This finding shows that students still find it difficult to provide more elaborate conceptual accounts. While the equations used regarding work and energy are seldom misapplied, it is common for students to rely on procedural steps without necessarily grasping the concepts that underlie them. The knowledge of physics contained in the analysis and interpretation stages, such as explaining a proposed model or describing qualitative relations expected to hold, reflects there are still questions to be answered about what the results mean physically.

According to N-gain analysis, students who experienced high improvement are 47%, moderate 34% and low 19%. The results indicate that in general an increase in students' critical thinking skills after the application of the learning model. But the students in the low improvement category show that the impact of the intervention is not homogenous. The variations would depend upon the prior knowledge, readiness and conceptual understanding of the student. Results of the Wilcoxon signed-rank test indicated significant differences between pretest and posttest scores ( $p < 0.05$ ), suggesting that the implemented instruction made a meaningful impact on students' critical thinking skills.

These results are in concordance with the study had been conducted by Hartini et al., (2020), where proven that procedural skills was better improved rather than conceptual understanding toward active and structured learning approaches. Thus, there should be an expectation for instructional strategies not only to highlight problem-solving procedures but also to devote greater focus on developing students' conceptual understanding (Ilmi et al., 2020; Irwan et al., 2025; Nenohai et al., 2022).

Reflected on such result is the potential of Discovery Learning, where students are placed as an active part of learning experiences. The students construct their understanding themselves through activities such as investigating, analyzing data and drawing conclusions. This process facilitates the development of analytical and evaluative thinking as hallmarks of critical thought. Gunawan (2020), corroborated this finding, in which students' critical thinking skills improved as a result of their active engagement in solving problems during inquiry learning.

Wordwall is also used in the learning process. Each of its interactive elements, from game-based quizzes to actionable feedback, bolsters student engagement and immediate scores. This encourages active engagement with the material and application of concepts in solving problems. As a consequence, students are more able to activate relevant procedural steps in the context of underlying concepts. This kittens with Vidyawati (2020), which revealing that the usage of digital learning tools could peak-up is engagements and helps develop conceptual understandings.

Wordwall is used both as an instructional tool and also as a one-test and Discover Learning helps them to support the practice of education. Integrating digital media into instructional strategies can help create a more organized and stimulating classroom atmosphere. This is regarded as unique because most previous studies have isolated each respective element, rather than integrating all three together.

We amalgamate a strong problem solving and conceptual comprehension to physics problems regarding work and energy as to why this integration is critical for the learning of physics. Wordwall is used to assign tasks, create exploration activities; and feedback is given empirically through Wordwall which helps support providing simple explanations, building basic skills, drawing conclusions, provides further explanations and setting strategies and tactics at different stages of Discovery Learning. This way the student can keep an active engagement and better grasp both processes and concepts.

The results of this study confirm that combining constructivist learning principles and interactive digital technology is significantly better than using either approach separately to enhance critical thinking skills. However, several limitations are identified. The lack of a control group trams the strength of causal interpretation in the one-group pretest–posttest design. The focus on a single institution sample, however, may limit generalizability of the findings. And essay-based instruments are also deemed inadequate to reflect the full spectrum of students' critical thinking processes. Thus, future studies will rely on more rigorous research designs, larger and more heterogeneous samples with better assessment methods yielding stronger results.

## **CONCLUSION**

The results showed an improvement in students' higher-order thinking skills for physics, especially on work and energy topics, after the implementation of Discovery Learning through Wordwall. Speech performance was classified as good and students demonstrated more amazing achievement in idea generation than providing further explanations. This pattern shows that procedural use is better developed than conceptual understanding. Results of the N-gain and Wilcoxon test confirmed that there was a significant increase in critical thinking skills. Fusion interactive media and student-centered learning are shown to impact better learning performance, especially in providing intuitive explanations, developing basic skills, making conclusions, explaining further, as well as setting strategies and tactics. Wordwall integrated with Discovery Learning as Teaching Approach and Assessment Method to Learning Work and Energy This method also helps keep students engaged by providing them with immediate feedback, which promotes critical thinking development. However, several limitations are identified. LimitationsThe lack of a control group leaves causes somewhat ambiguous as only an exploratory, pre-experimental design approach has been employed. Also, the results' generalizability may be altered by focusing on a single-institution sample. Future research is needed to utilize more robust research designs, engage larger and more diverse samples, and employ more thorough assessment methods.

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