

The Implementation of Interactive Learning Media Pear Deck on Work and Energy to Improve Junior High School Students' Critical Thinking Skills

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Abstract:

This study aims to determine the effect of implementing interactive learning media based on Pear Deck on the critical thinking skills of eighth grade students on the topic of work and energy. Critical thinking skills are one of the higher-order thinking skills that are important to improve in science learning, but are still relatively low due to monotonous, non-interactive science learning. Although interactive digital learning media have been widely developed, studies on the effect of Pear Deck on the critical thinking skills of junior high school students are still limited. The study used a quantitative approach with a quasi-experimental type and a post-test only control group design. The research sample consisted of class VIII.3 as the experimental class and class VIII.4 as the control class selected using a simple random sampling technique. The research instrument was a critical thinking skills test consisting of 15 multiple-choice questions arranged based on Ennis indicators. Data were analyzed using descriptive and inferential analysis. The results of the descriptive analysis showed that the average post-test score of critical thinking skills of the experimental class was 81.43 in the high category, while the control class was 71.92 in the medium category. The Mann-Whitney U test results showed a significance value of 0.036 ($p < 0.05$), which means there is a significant difference in critical thinking skills between the experimental class and the control class. Thus, it can be concluded that the application of Pear Deck interactive learning media has a positive and significant effect on improving students' critical thinking skills in the material of work and energy.

1. Introduction

Education is the primary means of developing human potential through the learning process. This aligns with Article 31 Paragraph (1) of the 1945 Constitution of the Republic of Indonesia, which states that every citizen has the right to education. Through education, it is hoped that quality human resources will be developed, possessing higher-order thinking skills, and capable of competing globally. However, this goal will not be optimally achieved if the learning process is not implemented effectively and oriented toward developing students' thinking skills (Fitri, 2021).

The quality of education in Indonesia remains a serious concern. The low quality of education occurs at various levels and is influenced by the suboptimal development of human resources with higher-order thinking skills and abilities. According to the 2017 Global Human Capital Report published by the World Economic Forum, Indonesia ranked 65th out of 130 countries in the field of education (Wahyudi et al., 2022). This situation indicates the need for ongoing efforts to improve the quality of learning, particularly learning that fosters students' critical thinking skills. One of the important higher-order thinking skills developed in science learning is critical thinking. This skill enables students to analyze information, evaluate arguments, and draw logical conclusions.

However, various international studies indicate that Indonesian students' critical thinking skills remain relatively low. This is demonstrated by the results of the 2015 Programme for International Student Assessment (PISA) survey, which ranked Indonesian students 69th out of 79 countries (Budiarti

& Airlanda, 2021). These results indicate that Indonesian students remain weak in solving questions that require Higher Order Thinking Skills (HOTS), particularly in problem-solving. One contributing factor to this situation is the continued dominance of teacher-centered learning and the limited use of interactive learning media.

Developments in educational technology actually open up opportunities to create more interactive and student-centered learning. Various digital learning media have been developed to increase student engagement in the learning process. One of the currently developing interactive learning media is Pear Deck, an interactive presentation platform that allows students to actively participate through questions, responses, and real-time feedback.

Several previous studies have shown that the use of digital learning media can increase student engagement and motivation. However, most of this research focuses on learning outcomes or student engagement, while studies specifically examining the effect of Pear Deck on students' critical thinking skills, particularly in physics topics such as work and energy at the junior high school level, are still limited. Furthermore, empirical research on the implementation of Pear Deck in the context of science learning in Indonesia is also relatively limited. This indicates a research gap regarding the use of Pear Deck-based interactive learning media to improve students' critical thinking skills in science learning.

Based on this description, this study aims to determine the effect of implementing Pear Deck-based interactive learning media on work and energy on the critical thinking skills of eighth-grade junior high school students. This research is expected to provide an empirical contribution to the development of science learning, particularly in the use of interactive learning media to improve students' critical thinking skills in the educational context in Indonesia.

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2. Theoretical Framework

2.1 *Pear Deck-Based Interactive Learning Media*

Interactive learning media is a learning tool designed to actively engage students through two-way interactions between teachers, students, and learning materials. One interactive learning media that has developed alongside the use of digital technology is Pear Deck. Pear Deck is an interactive presentation platform that allows teachers to present material accompanied by open-ended questions, multiple-choice questions, reflections, and real-time feedback, enabling students to act not only as recipients of information but also as active participants in the learning process (Solissa et al., 2024).

Conceptually, Pear Deck's features have the potential to support the cognitive processes required for critical thinking skills. The open-ended question feature encourages students to provide explanations and reasons for their answers, thus practicing the ability to provide both simple and advanced explanations. The real-time response feature allows teachers to provide immediate feedback, which can help students evaluate their understanding and correct reasoning errors. Furthermore, the active interaction created through Pear Deck encourages students to develop basic skills in interpreting information and drawing logical conclusions. Thus, Pear Deck functions not only as a medium for delivering material but also as a tool that can facilitate students' critical thinking processes.

2.2 *Critical Thinking Skills on the Material of Work and Energy*

Critical thinking skills are one of the higher-order thinking skills that are crucial in science learning. Critical thinking encompasses the ability to analyze information, evaluate arguments, draw conclusions, and make decisions logically and reflectively. In this study, critical thinking skills refer to the indicators

proposed by Ennis, which include the ability to provide simple explanations, build basic skills, draw conclusions, provide further explanations, and develop strategies and tactics for problem-solving (Ariadila et al., 2023).

In the context of science learning, critical thinking skills can be developed through learning activities that require students to observe phenomena, ask questions, analyze data, and relate concepts to real-world problems. Physics, particularly work and energy, has characteristics that require students to understand the relationships between variables, interpret concepts mathematically and conceptually, and evaluate the application of concepts in various situations.

In work and energy, critical thinking skills can be practiced through activities such as analyzing everyday events related to work and energy, comparing conditions before and after an event, drawing conclusions based on data or illustrations, and determining appropriate problem-solving strategies. Therefore, this material is highly relevant for developing critical thinking indicators according to Ennis, particularly in the aspects of analysis, inference, and decision-making.

However, in practical learning, work and energy materials are often presented procedurally through routine examples, resulting in students' lack of critical thinking skills. This situation highlights the need for learning media that can present contextual problems and encourage active student involvement in the thinking process.

2.3 The Relationship between Pear Deck and Critical Thinking Skills

The use of Pear Deck in science learning has a strong conceptual link to the development of critical thinking skills. Pear Deck's interactive questioning feature encourages students to provide simple explanations and express opinions based on their understanding. The real-time response and anonymous answer features enable students to think independently without fear of error, allowing for optimal analysis and evaluation.

Furthermore, the immediate feedback provided through Pear Deck helps students build foundational skills and quickly correct errors. Reflective activities embedded in the learning process also encourage students to draw conclusions and plan problem-solving strategies, which align with Ennis's critical thinking indicators. Thus, Pear Deck functions not only as an interactive medium but also as a pedagogical tool that theoretically facilitates students' critical thinking processes, particularly in the topic of work and energy, which demands conceptual understanding and analytical skills.

2.4 Previous Research

Several previous studies have shown that the use of Pear Deck-based interactive learning media has a positive effect on students' critical thinking skills. Islamiya & Romadhon (2022) reported that the use of Pear Deck in problem-based learning significantly improved students' critical thinking skills. Similar results were also found by Hanni (2022), who showed that students learning using Pear Deck demonstrated higher critical thinking skills compared to those using conventional learning.

However, most previous studies have focused on different contexts and materials and have not specifically examined critical thinking skills in the work and energy topic at the junior high school level. Furthermore, the relationship between Pear Deck features and Ennis' critical thinking indicators has rarely been discussed in depth. Therefore, this study offers a novel approach in examining the influence of Pear Deck interactive learning media on students' critical thinking skills in the work and energy topic in a more focused and theoretical manner.

Based on theoretical studies and previous research, it can be concluded that the use of Pear Deck-based interactive learning media in science learning, particularly in the work and energy topic, can increase

student active engagement and facilitate higher-order thinking processes. The interaction, immediate feedback, and reflective questions provided by Pear Deck encourage students to analyze, evaluate, and conclude information, thus positively impacting students' critical thinking skills.

3. Method

3.1 Type, Design, and Analysis of Research

This study used a quantitative approach with a quasi-experimental approach. The research design employed a post-test-only control group design, an experimental design involving two sample groups without a pre-test. The experimental group received treatment in the form of the interactive Pear Deck learning media, while the control group received conventional learning. This design was chosen to objectively determine the effect of the interactive Pear Deck learning media on students' critical thinking skills after the treatment (Rukminingsih et al., 2020).

Data analysis in this study was conducted through descriptive and inferential analysis. Descriptive analysis was used to determine the average and category of students' critical thinking skills in the experimental and control classes. Inferential analysis was conducted using the Mann–Whitney U test. The Mann–Whitney U test was used because the data were not normally distributed and the samples came from two independent groups. This test is a nonparametric test used to compare two independent groups when the assumption of normality is not met (Sugiyono, 2013). This test was used to determine differences in critical thinking skills between the experimental and control classes. All data analysis was carried out with the help of SPSS software version 24 with a significance level of 0.05 ($p < 0.05$).

3.2 Research Subjects, Place, and Time

This research was conducted at As-Shofa Islamic Junior High School, Pekanbaru, during the even semester of the 2025/2026 academic year, from October to November 2025. The study population consisted of all 91 eighth-grade students at As-Shofa Islamic Junior High School, divided into four classes. The sample was selected using a simple random sampling technique after conducting normality and homogeneity tests on students' daily test scores for the previous material, namely the human respiratory system and excretory system. The test results indicated that students' initial abilities were relatively homogeneous across classes. Based on these results, class VIII.3 was designated as the experimental class with 23 students, and class VIII.4 as the control class with 24 students.

This research was conducted with due regard for research ethics. Prior to the study, the researcher obtained official permission from the school, As-Shofa Islamic Junior High School, Pekanbaru. During the study, the science teacher and students were involved with the knowledge and consent of the relevant parties without any coercion. Data obtained from students was used solely for research purposes and kept confidential, so student identities were not included in the research report. Furthermore, all learning activities were conducted in accordance with the applicable curriculum and did not negatively impact students.

3.3 Learning Procedures

3.3.1 Experiment Class

Learning in the experimental class was conducted using interactive learning media based on Pear Deck combined with a scientific approach. The learning activities took place over three 80-minute sessions, each covering the topic of work and energy.

Each session began with the presentation of learning objectives and an apperception. Next, the teacher presented the material through Pear Deck slides containing conceptual explanations, illustrations

of contextual phenomena, and prompt questions. The Pear Deck feature was utilized to provide real-time interactive questions, such as multiple-choice, short-answer, and drag-response questions, which required students to analyze problems, connect concepts, and draw conclusions.

Learning activities are structured according to the stages of the scientific approach. The scientific approach utilizes scientific steps such as observing, asking questions, gathering information, reasoning, and communicating (Yuliastutik & Mahbubah, 2024) namely:

1. Observing: Students observe phenomena or illustrations presented through Pear Deck.
2. Questioning: Students respond to prompting questions and ask questions related to the material.
3. Gathering: Students work on interactive problems related to the concepts of work and energy.
4. Reasoning: Students analyze their answers and compare them with the responses of other students, which are displayed anonymously.
5. Communicating: Students convey their thoughts orally and in writing through class discussions.

Through these activities, students are trained to provide explanations, summarize concepts, and determine problem-solving strategies, thereby systematically developing their critical thinking skills. To clarify the implementation of the learning media used in the experimental class, several examples of Pear Deck slides are presented in Figure 1, Figure 2, and Figure 3.

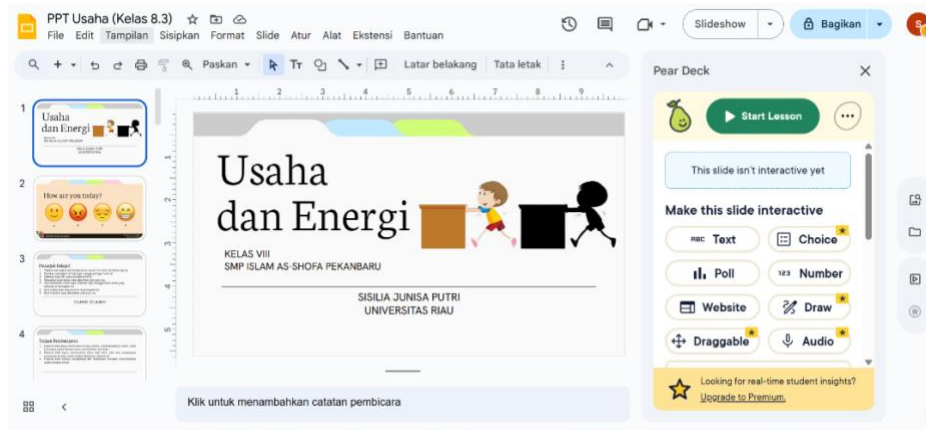


Figure 1. *Work and Energy Presentation on Pear Deck*

Figure 1. shows an example of a work and energy slide presented on Pear Deck. The slides explain the concepts of work, kinetic energy, and potential energy, complemented by illustrations of contextual phenomena to help students understand the connection between physics concepts and everyday events.

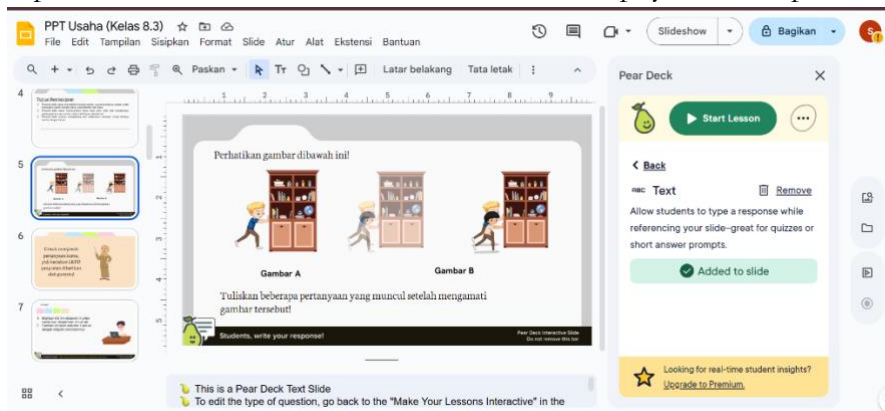


Figure 2. *Pear Deck Interactive Features Used*

Figure 2. displays the Pear Deck interactive features used during learning, such as multiple-choice questions, short answer questions, and drag-and-drop responses. These features are used to encourage

students to respond directly to questions, express their opinions, and connect concepts they have learned. This real-time interaction provides an initial glimpse into students' reasoning and understanding processes during the learning process.



Figure 3. Pear Deck Interactive Learning Display During Presentation

Figure 3. shows the learning environment when Pear Deck is used in class. Student responses are displayed in real time and anonymously, allowing for class discussion and comparison of answers between students. This display demonstrates active student engagement throughout the learning process. Student responses can be seen in Figure 4.

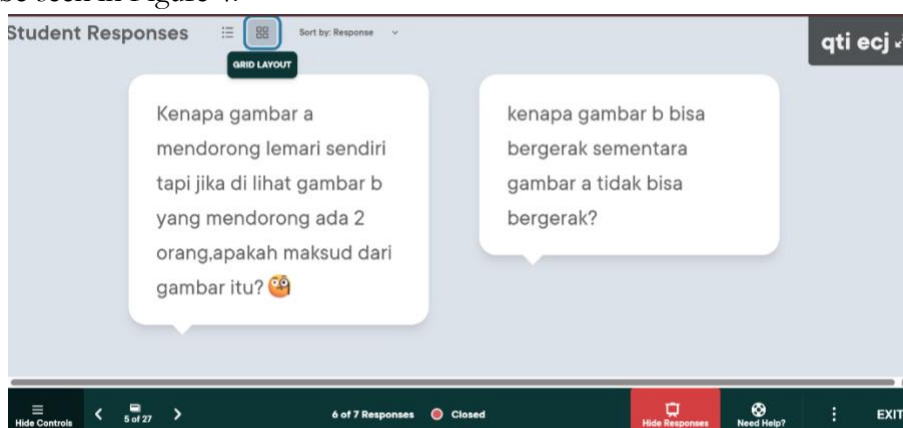


Figure 4. Example of Student Responses Using Pear Deck Media In the Learning Process

Figure 4. shows an example of student responses to interactive questions presented through Pear Deck. The prompt questions are accompanied by links to YouTube videos and virtual labs, which are used to help students contextually observe the phenomena of work and energy before providing answers. The summary of student answers was automatically saved in a Google Sheet. This data makes it easier for teachers to monitor student responses, identify answer patterns, and evaluate student understanding throughout the learning process.

The use of interactive features in Pear Deck, such as embedding YouTube video links as prompt questions and access to virtual laboratories, among other features, provides students with opportunities to observe and analyze work and energy phenomena in a more contextualized manner. Through multiple-choice, short-answer, and drag-and-drop response questions, students are encouraged to provide explanations, connect concepts, and draw conclusions before presenting their answers. Student

responses, displayed in real time, demonstrate the process of conceptual clarification and reasoning throughout the learning process.

The summary of student answers saved in a Google Sheets makes it easier for teachers to monitor student answer patterns and levels of understanding. These interactive activities align with the critical thinking skill indicators used in developing the post-test instrument. Thus, although critical thinking skills are measured through a post-test, the use of Pear Deck plays a role in facilitating students' thinking processes, supporting their readiness to answer questions based on the critical thinking skill indicators. Quantitative measurement of critical thinking skills in this study was still carried out through a post-test instrument that had been prepared based on critical thinking skills indicators.

3.3.2 Control Class

Learning in the control class was conducted using conventional learning without the aid of interactive digital learning media. The learning activities took place in three equal 80-minute sessions, covering the topic of work and energy. The lesson began with a lecture-based explanation by the teacher, followed by example questions and discussions from the textbook. Students took notes and completed written exercises in their exercise books. The learning interaction was dominated by the teacher's explanations, while active student involvement was limited to questions and answers and problem-solving.

The control class did not provide interactive, technology-based questions or direct feedback, as in the experimental class. Therefore, the difference in treatment between the experimental and control classes lies in the use of Pear Deck interactive learning media in the learning process.

3.4 Data Collection Techniques

Data collection was conducted after the entire learning process was completed. Prior to conducting the study, the researcher obtained official permission from the school and approval from subject teachers and students. The data collected consisted of post-test results on students' critical thinking skills in the work and energy topic.

3.5. Research Instruments

The research instrument used was a critical thinking skills test in the form of 15 multiple-choice questions arranged based on the critical thinking skills indicators according to Ennis, including: providing simple explanations, building basic skills, concluding, providing further explanations, and strategies and tactics. The instrument has gone through an expert validation process involving two competent experts in the field of physics education. The use of two validators in the content validity test with Aiken's V approach is considered adequate to assess the suitability of the items to the indicators being measured (Azwar, 2012).

Table 1. *Critical Thinking Skills Instrument Grid*

No	Aspects	Indicator	Question Number
1	<i>Elementary clarification</i>	Focusing Questions, Analyzing Arguments, Asking and Answering Challenging Questions	1,2,4,15
2	<i>Basic support</i>	Considering the credibility (criteria) of a source, Observing and considering the results of observations	6,7,14
3	<i>Inference</i>	Making deductions and considering a definition, Making considering results, Making and determining the results of considerations	5,8,9
4	<i>Advanced Clarification</i>	Defining terms and considering definitions, Identifying assumptions	3,10,13
5	<i>Strategies and Tactics</i>	Deciding on an action, Interacting with others	11,12

(Source: Ennis, 1985)

Validation was carried out to assess the suitability of the content, clarity of language, and the relevance of the questions to the critical thinking indicators. The instrument grid for the critical thinking skills aspect is shown in Table 1, and detailed questions are presented in Table 5 in Appendix A.

3.6 Data Analysis Techniques

Post-test scores were obtained from the results of a critical thinking skills test administered after the learning treatment. Each student's answer was assessed based on established scoring guidelines. Scoring was carried out with a correct answer given a score of 1 (one) and each incorrect answer given a score of 0 (zero). The total score was obtained by adding up the scores obtained from all questions. Each student's total score was then converted to a scale of 0–100 (Oktaviani et al., 2025). The average post-test score (\bar{X}) was calculated using the mean formula $\bar{X} = \frac{\sum X}{N}$, where $\sum X$ denotes the total score obtained by all students and N denotes the total number of students.

Data analysis was conducted in two stages: descriptive analysis and inferential analysis. Descriptive analysis was used to describe the average critical thinking skills of students in each class. Descriptive analysis was conducted on each aspect of critical thinking skills based on Ennis' indicators, which include elementary clarification, basic support, inference, advanced clarification, and strategies and tactics. The average scores for each aspect in the experimental and control classes were compared to determine differences in students' critical thinking skills.

The level of students' critical thinking skills was determined based on a percentage score range adjusted to the learning outcome assessment criteria. A score range of 90–100 was categorized as very high, 75–89 as high, 65–74 as moderate, 55–64 as low, and 0–54 as very low (Arikunto, 2018). This classification was used to facilitate the interpretation of students' critical thinking skills in the experimental and control classes, as well as to observe trends in the distribution of student abilities after implementing learning using Pear Deck media.

Furthermore, inferential analysis includes normality test using the Kolmogorov–Smirnov test, homogeneity test using the Levene test, and hypothesis test using the Mann-Whitney U test with the help of SPSS software version 24. The decision-making criteria were set at a significance level of 0.05 ($p < 0.05$) to determine the existence of differences in critical thinking skills between the experimental class and the control class.

4. Result

4.1 Research Result

This study aims to analyze the differences in critical thinking skills of eighth-grade students at As-Shofa Islamic Junior High School in Pekanbaru on the topic of work and energy between students who participated in learning using interactive learning media based on Pear Deck and students who participated in conventional learning. The study involved two groups: an experimental class that received treatment in the form of Pear Deck media and a control class that participated in learning without interactive learning media based on technology.

The independent variable in this study was the use of Pear Deck-based interactive learning media, while the dependent variable was students' critical thinking skills. The results of the study were presented in two forms of analysis: descriptive analysis and inferential analysis. Descriptive analysis was used to describe the profile of students' critical thinking skills based on critical thinking indicators and score achievement categories in each class. Furthermore, inferential analysis was used to determine whether

there was a significant difference in critical thinking skills between the experimental and control classes after the treatment was administered (Maswar, 2017).

4.2 Descriptive Statistical Analysis

Descriptive statistical analysis was conducted to describe the profile of students' critical thinking skills on the topic of work and energy based on the post-test results in the experimental and control classes (Maswar, 2017). This analysis focused on comparing the achievement of critical thinking skills between the two classes after the treatment was given. Critical thinking skills were analyzed based on five aspects: elementary clarification, basic support, inference, advanced clarification, and strategies and tactics. This aspect-by-aspect analysis aimed to see the tendency of strengths and weaknesses in students' critical thinking skills in each indicator.

The results of the analysis of the average post-test scores of students' critical thinking skills in the experimental and control classes for each aspect are presented in detail in tabular form. Presenting data in tables aims to facilitate reading, comparison, and interpretation of the research results. The data is then presented in Table 2.

Table 2. *Analysis of Critical Thinking Skills of Students in Experimental and Control Classes Per Aspect*

Aspects	Class			
	Experiment		Control	
	N	M	N	M
<i>Elementary Clarification</i>	23	3,09	24	2,71
<i>Basic Support</i>	23	2,52	24	2,21
<i>Inference</i>	23	2,61	24	2,41
<i>Advanced Clarification</i>	23	2,52	24	2,13
<i>Strategies and Tactics</i>	23	1,47	24	1,38

In general, Table 2 shows the average critical thinking skill scores for the experimental and control classes, arranged according to the critical thinking skill aspects. The experimental class's average post-test scores for each aspect tended to be higher than the control class's average post-test scores. Thus, differences in critical thinking skills were evident between the experimental class, which received treatment using interactive Pear Deck learning media with a scientific approach, and the control class, which used conventional learning methods for work and energy.

Table 3. *Results of Critical Thinking Skills of Students in the Experimental and Control Classes*

Levels	Category	Experimental Class		Control Class	
		n	Percentage (%)	n	Percentage (%)
90-100	Very High	7	30,4	3	12,5
75-89	High	4	17,4	6	25
65-74	Medium	11	47,9	8	33,3
55-64	Low	0	0	2	8,3
0-54	Very Low	1	4,34	5	20,8
Average		81,43		71,92	
Category		High		Medium	

Looking at each indicator, the aspects of providing simple and advanced explanations indicated that students were better able to focus on problems and develop concepts in depth, consistent with the findings of Fajiyusni (2017) and Sholihah et al. (2016). In terms of building basic skills, students in the experimental class were better able to consider the credibility of sources and use evidence in reasoning, consistent with Istiqomah (2012). The aspects of concluding and strategies and tactics demonstrated students' ability to reason, compare answers, and design more appropriate problem-solving steps, in line with Jaya Ims & G. (2020) and Saputra (2016).

Overall, the results of the analysis per aspect show that the experimental class had better critical thinking skills profiles than the control class after the treatment, but not all aspects developed optimally. The average scores for students' critical thinking skills across the two classes are shown in Table 3.

Based on Table 3, the experimental class had a higher proportion of students in the high and very high categories than the control class. However, there were still students in the experimental class in the medium and very low categories, indicating that the effectiveness of learning was not evenly distributed across all students. This finding suggests that although learning using interactive media produces better results than conventional learning, factors such as differences in students' initial abilities, the level of material difficulty, and limited learning time still pose challenges in optimizing the development of students' critical thinking skills comprehensively.

4.3 Inferential Analysis

Inferential statistical analysis was conducted to determine differences in students' critical thinking skills between the experimental and control classes after the treatment was administered. In accordance with the research design used, a post-test-only control group design, this analysis was not intended to measure student improvement from baseline, but rather to compare learning outcomes between the two groups after the learning process.

The significance test for normality showed that the post-test score for students' critical thinking skills on work and energy in the experimental class was 0.010 and the control class was 0.174. A significance value of $p \geq 0.05$ indicates a normal distribution of the data, whereas a significance value of $p < 0.05$ indicates a non-normal distribution of the data. Therefore, the experimental class data was not normally distributed, while the control class data was normally distributed. This difference may be influenced by differences in student response characteristics during the learning process. In the experimental class, learning using the interactive Pear Deck media required active participation, rapid response, and the ability to express opinions and reasons directly. These challenges led to greater variation in scores between students, resulting in a less normal distribution of the data. Meanwhile, in the control class, more structured, teacher-centered conventional learning tended to produce relatively uniform student responses, resulting in a closer distribution of data.

The homogeneity test results showed a difference in post-test scores for students' critical thinking skills on work and energy in the experimental and control classes of 0.345. A significance value of $p \geq 0.05$ indicates homogeneity of the data, whereas a significance value of $p < 0.05$ indicates heterogeneity. Therefore, the variance of the data for both groups is homogeneous, indicating that both classes have relatively comparable ability diversity.

Because the parametric test did not meet the requirements, a non-parametric test using the Mann-Whitney U test technique was used. The Mann-Whitney U test yielded a significance value of 0.036, indicating that if the p-value < 0.05 indicates a significant difference in students' critical thinking skills between the class using Pear Deck and the class using conventional learning on the topic of work and energy. However, if the p-value ≥ 0.05 indicates no significant difference in students' critical thinking skills between the class using Pear Deck and the class using conventional learning on the topic of work and energy. The significance value of $p < 0.05$ indicates a significant difference in critical thinking skills between students in the experimental and control classes after the treatment was administered. This finding indicates that students who participated in learning using Pear Deck-based interactive learning media achieved higher levels of critical thinking skills than students who participated in conventional learning.

This difference in achievement is not only influenced by the statistical analysis method used but can also be attributed to the learning context. In the experimental class, the use of Pear Deck enabled real-time two-way interaction, open-ended questions, and student engagement in reasoning and providing reasons for their answers. This encouraged students to be more active in processing information, constructing arguments, and making decisions based on the data presented. In contrast, in the control class, student engagement in higher-order thinking processes was relatively limited because learning focused more on delivering material and completing written exercises. These differences in interaction patterns and levels of engagement contributed to the differences in critical thinking skill achievement between the two classes.

However, the results of this study cannot be interpreted as an improvement in critical thinking skills from baseline, as the research design did not involve a pre-test. Therefore, the conclusions drawn from this inferential analysis are limited to differences in critical thinking skills between groups after the treatment, rather than to improvements in individual student abilities.

5. Discussion

5.1 Discussion Of Findings

Based on the research results, the average post-test score for critical thinking skills in the experimental class was in the high category, while the control class was in the medium category. This indicates a difference in critical thinking achievement between students learning using Pear Deck and conventional learning, reflecting the positive contribution of interactive media to critical thinking skills.

The higher achievement in the experimental class may be attributed to the characteristics of Pear Deck learning, which requires active student engagement. During learning, students respond directly to questions, express their opinions, and reflect on their understanding through interactive activities. This pattern allows for continuous analysis, evaluation, and reasoning, resulting in relatively optimal critical thinking achievement compared to the control class.

The elementary clarification aspect showed the highest score in the experimental class. This indicates that students in the experimental class were better able to identify problems, understand initial information, and formulate simple questions. This condition is suspected to be related to the learning characteristics that encourage active student participation, thus improving students' focus on the given problems. Furthermore, observations during learning showed that students responded more enthusiastically to learning stimuli than the control class. This is supported by research (Fajiyusni, 2017), which found that students are able to argue challenging issues in everyday life by analyzing all available information and providing simple explanations.

Conversely, the strategies and tactics aspect received the lowest scores in both classes. Low achievement in this indicator indicates that students' ability to determine problem-solving strategies and make decisions is still limited. This may be influenced by the complexity of the work and energy material, which requires high-level analytical skills, as well as students' learning habits, which rarely involve developing independent problem-solving strategies in everyday learning contexts. This is supported by research (Saputra, 2016), which suggests that students' low mastery of material concepts can lead to hesitation and uncertainty in making decisions, resulting in low critical thinking skills in junior high school students.

In the basic support and advanced clarification aspects, the experimental class still showed higher scores than the control class. This difference indicates that students in the experimental class were better

trained in using information as a basis for reasoning and in providing further explanations of a concept. However, achievement in these aspects did not reach the very high category, indicating limitations in students' conceptual understanding and argumentation. This is supported by research (Istiqomah, 2012), which states that one way to become a critical thinker is to be able to provide reasons based on evidence that are convincing and reliable.

The inference aspect also showed a difference in scores between the experimental and control classes, although not as significant. This indicates that students' ability to draw conclusions based on data or information still needs further development, both through practice and through more varied presentation of problem contexts. This is supported by research (Jaya et al., 2020), which states that students who are able to draw conclusions are also able to understand the problem-solving process itself.

Nevertheless, individual achievement variations were still found, indicating that Pear Deck's effectiveness is influenced by factors such as learning readiness, prior abilities, self-confidence, and adaptation to technology. The findings of this study align with several previous studies showing that the use of interactive learning media based on Pear Deck has a positive impact on learning outcomes and the learning process. Research by Hanni (2022) shows that Pear Deck can significantly contribute to increasing student engagement and literacy skills. With an interactive approach supported by features such as open-ended questions, direct reflection, and collaborative activities, Pear Deck can create an active learning environment and encourage students to think critically.

Other studies have also found positive effects from the use of Pear Deck. For example, research conducted by Islamiya & Romadhon (2022) showed a significant increase in students' critical thinking skills and active learning engagement when implementing the problem-based flipped classroom model with Pear Deck compared to using only conventional learning models without the aid of media. This finding was based on interviews with class XI IPA students at MAN 5 Bogor regarding improvements in critical thinking and problem-solving skills during the learning process.

Thus, this study indicates that the use of Pear Deck interactive learning media resulted in higher critical thinking skill achievement compared to conventional learning, although these results cannot be interpreted as an increase in individual abilities from baseline because the research design used did not involve pre-test measurements.

5.2 Implications

The results of this study provide pedagogical implications that the use of Pear Deck interactive learning media can be a relevant alternative learning strategy to support the development of students' critical thinking skills in physics. Interactive activities involving real-time responses and reflection encourage students to be more active in the analysis and reasoning process, so that learning is not only oriented towards the final result but also towards students' thinking processes.

Furthermore, this research has implications for the broader development of educational technology. Pear Deck has the potential to support sustainable learning and aligns with global trends in physics education, such as student-centered learning, digital formative assessment, and strengthening 21st-century skills. This media also has the potential to be developed to measure other skills, such as technological literacy, communication, and collaboration, in various learning contexts.

5.3 Limitation

This study has several limitations that need to be considered when interpreting the results. First, the sample size and characteristics involved only two classes in one educational unit, so generalizing the results to a broader context requires caution.

Other limitations relate to the duration of the learning process and the post-test-only research design. This design does not allow for longitudinal measurement of students' critical thinking skills. Furthermore, external factors such as classroom conditions, student readiness, and variations in responses to technology use cannot be fully controlled. Therefore, future research is recommended to involve a larger sample size, a longer learning duration, and use a pre-test and post-test design for more comprehensive results.

However, because this study used a post-test-only control group design, the results cannot be interpreted as an improvement in individual students' abilities from their initial conditions. Therefore, the findings of this study are limited to differences in critical thinking skills achievement between groups after the treatment was administered. Nevertheless, the results of this study provide an empirical contribution in supporting the use of interactive learning media as an alternative physics learning strategy that has the potential to encourage student engagement and develop critical thinking skills.

6. Conclusion

Based on the results of descriptive and inferential analysis, this study indicates that the application of Pear Deck-based interactive learning media to the topic of work and energy has an impact on the critical thinking skills of eighth-grade junior high school students. Students who participated in learning using Pear Deck achieved higher levels of critical thinking skills than students who participated in conventional learning.

The Mann–Whitney U test results showed that the difference was statistically significant, thus concluding that the use of Pear Deck has an impact on students' critical thinking skills after the learning process. Therefore, Pear Deck-based interactive learning media can be an alternative physics learning strategy that supports the development of critical thinking skills.

Author's Contribution

Sisilia Junisa Putri: Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Nur Islami:** Conceptualization, Methodology, Writing – review & editing, Supervision. **Azizahwati:** Methodology, Writing – review & editing, Supervision.

Ethical statement

This study was conducted in regular classroom learning settings and was classified as minimal-risk educational research. Permission to conduct the research and collect data was obtained through an official research permit from the university and formal approval from SMP Islam As-Shofa Pekanbaru prior to the implementation of the study.

Participation in this study was entirely voluntary. All participants were clearly informed about the purpose of the research, the learning activities involved, the data collection procedures, and their right to withdraw from the study at any time without any academic consequences. As all participants were under 18 years of age, informed consent was obtained from the school as the authorized educational institution responsible for the students.

The research was conducted in accordance with ethical principles in educational research, emphasizing respect, fairness, and the protection of participants. No sensitive or personal identifying data were collected during the study. All student responses and test results were anonymized, kept confidential, and used solely for academic and research purposes.

Declaration of AI use

The authors used ChatGPT (OpenAI) to assist with language editing, including improving sentence clarity, readability, and overall organization of the manuscript. All AI-assisted outputs were carefully reviewed, revised, and approved by the authors. The authors remain fully responsible for the accuracy, originality, and integrity of the content presented in this manuscript.

Conflict of Interest

The authors declare that there are no financial or non-financial conflicts of interest related to this research. This study was conducted solely for academic purposes and was not supported by any commercial funding. All authors have reviewed and approved this statement.

Supplementary Materials and Data Availability

The research instruments used in this study, including the concept comprehension test instruments and the results of instrument validation, are presented in full in Appendix A and Appendix B.


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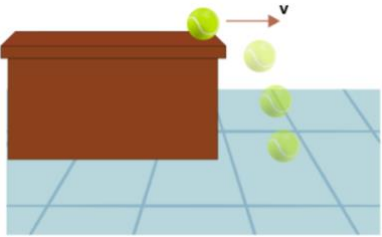
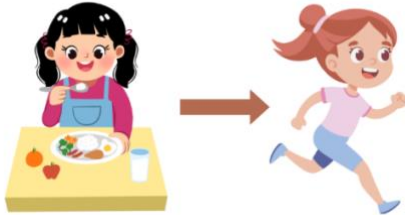
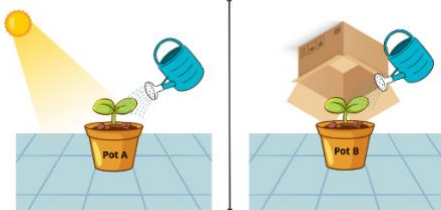
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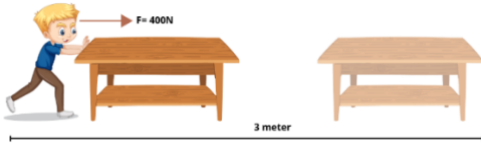
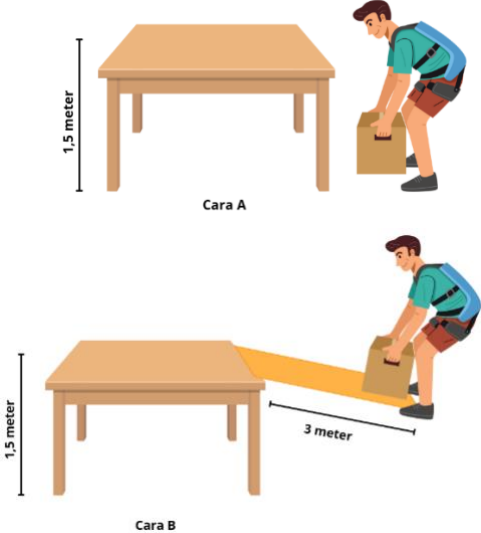
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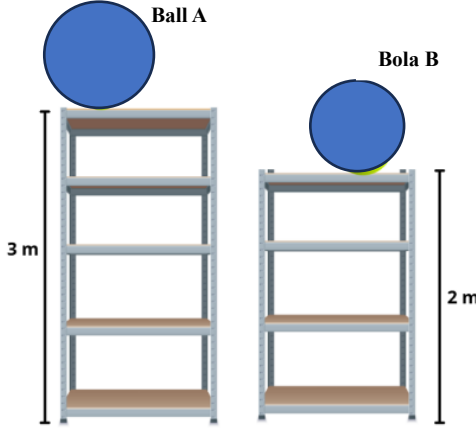
Appendix A. Research Instruments

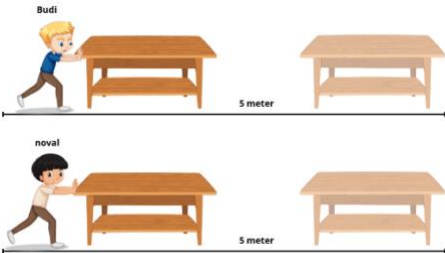
Table 5. Instruments for Critical Thinking Skills Indicators

No.	Indicators	Question Indicators	Questions	Answer
1	Elementary Clarification	Focusing questions	<p>1. Look at the picture below!</p>  <p>A child pushes a cupboard with a force of 100 N for 10 seconds, but the cupboard does not move. In this case, why does the child not do any work in physics, even though he feels tired?</p> <p>A. Because the force applied is too small B. Because there is no movement of the cupboard C. Because the mass of the cupboard is too short D. Because the time is too short</p>	B

No.	Indicators	Question Indicators	Questions	Answer
			<p>2. Look at the picture below!</p>  <p>A student lifts a ball onto a table, and it falls back to the floor. Why does the ball's potential energy convert to kinetic energy as it falls?</p> <p>A. Because the ball's height remains constant B. Because the ball's mass decreases as it falls C. Because of the influence of Earth's gravitational force D. Because potential energy is simply lost</p>	C
		Analyzing arguments	<p>3. Look at the picture below!</p>  <p>When we consume food, a moment later we run. In this case, chemical energy is converted into kinetic energy. Based on this statement, what is the correct explanation?</p> <p>A. True, chemical energy is converted into kinetic energy B. False, chemical energy is converted into muscle energy C. False, chemical energy is converted into heat energy D. All of the answers are incorrect.</p>	A.
		Ask and answer challenging questions	<p>4. Pay attention to the two experiments below!</p>  <ul style="list-style-type: none"> • Pot A contains plants placed in a bright place and given water • Pot B contains plants tightly closed in a dark box, but given water 	A.

No.	Indicators	Question Indicators	Questions	Answer															
			<p>B. Heat energy from the sun is stored as chemical energy, then converted into light and heat energy.</p> <p>C. Sunlight energy is converted into electrical energy by the solar panel, stored as chemical energy in the battery, and then reused as electrical and light energy in the light.</p> <p>D. Sunlight energy is converted into electrical energy, but not stored as chemical energy; it is directly converted into heat energy in the light.</p>																
		Observing and considering the results of observations	<p>7. Look at the picture below!</p>  <p>Andre pushes the table with a force of 400 N as shown in the picture. In order for the work done to be doubled, the correct data in the following table is...</p> <table border="1" data-bbox="644 938 1203 1128"> <thead> <tr> <th></th> <th>Force (N)</th> <th>Distance (m)</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>Enlarged 3 times</td> <td>Reduced by 2 times</td> </tr> <tr> <td>B</td> <td>Reduced by 2 times</td> <td>Enlarged 3 times</td> </tr> <tr> <td>C</td> <td>Reduced by 2 times</td> <td>Enlarged 4 times</td> </tr> <tr> <td>D</td> <td>Enlarged 2 times</td> <td>Reduced by 2 times</td> </tr> </tbody> </table>		Force (N)	Distance (m)	A	Enlarged 3 times	Reduced by 2 times	B	Reduced by 2 times	Enlarged 3 times	C	Reduced by 2 times	Enlarged 4 times	D	Enlarged 2 times	Reduced by 2 times	C
	Force (N)	Distance (m)																	
A	Enlarged 3 times	Reduced by 2 times																	
B	Reduced by 2 times	Enlarged 3 times																	
C	Reduced by 2 times	Enlarged 4 times																	
D	Enlarged 2 times	Reduced by 2 times																	
3.	Interference	Making deductions and considering the results of deductions	<p>8. Look at the picture below !</p>  <p>A student conducted an experiment lifting a 200 N weight onto a 1.5 m high table. He did this in two ways:</p> <ul style="list-style-type: none"> • Method A: Lifting directly vertically upwards • Method B: Using a 3 m long inclined plane to raise the weight onto the same table <p>From the experimental data, which deduction is correct regarding the work and force required?</p>	C															

No.	Indicators	Question Indicators	Questions	Answer
			<p>A. The work in method A is greater because the force is greater</p> <p>B. The work in method B is smaller because the distance is longer</p> <p>C. The work in methods A and B is equal, but the force in method B is smaller</p> <p>D. The work in method B is greater because there is an additional length of path.</p>	
		Making considering the results	<p>9. Pay attention to the following statement:</p> <ol style="list-style-type: none"> 1) Using low-wattage lights 2) Opening windows at home when there is sunlight 3) Turning off lights during the day unless necessary 4) Buying a television with a high wattage <p>The statement that exemplifies wasteful energy use is indicated by number...</p> <p>A. 1)</p> <p>B. 2)</p> <p>C. 3)</p> <p>D. 4)</p>	D
		Create and determine the results of considerations	<p>10. Look at the picture below!</p>  <p>Two balls of different masses are placed on shelves at different heights. Ball A, with a mass of 3 kg, is placed on a shelf approximately 3 m high, and ball B, with a mass of 1.5 kg, is placed on a shelf 2 m high. Based on these events, why does ball A have greater potential energy than ball B?</p> <p>A. Because mass is more influential than height</p> <p>B. Because potential energy is affected by both mass and height</p> <p>C. Because gravitational acceleration changes</p> <p>D. Because potential energy depends only on height</p>	C.
4.	Advanced Clarification	Identify terms, consider a definition	<p>11. A work of 1 joule is equal to...</p> <p>A. A force of 1 newton can move an object 1 cm.</p> <p>B. A force of 1 newton can move an object 1 m.</p> <p>C. A force of 1 dyne can move an object 1 cm.</p> <p>D. A force of 1 dyne can move an object 1 m.</p>	B

No.	Indicators	Question Indicators	Questions	Answer
		Identifying assumptions	<p>12. Pay attention to the following statement! "A person's power will remain the same even if the time is different, as long as the work is the same." From the statement above, what is the correct response? A. True, because power does not depend on time. B. False, because power will be different if the time is different even if the work is the same. C. True, because time has no effect on work. D. False, because power is equal to force x displacement.</p> <p>13. Pay attention to the information sources below!</p> <ul style="list-style-type: none"> Source 1: When the ball is at a height, it has potential energy due to its position. As the ball moves down, this energy is converted to kinetic energy, and the sum of the two is mechanical energy. Source 2: The ball at a height has potential energy, but as it begins to move down, its mechanical energy decreases because it is converted to kinetic energy. <p>Which of these two sources is correct and valid? A. The ball at a height has potential energy, and it converts to kinetic energy as it moves. B. The ball at rest at a height has kinetic energy because it is at rest. C. Mechanical energy consists only of kinetic energy. D. The ball has equal potential and kinetic energy when it is at rest at a height.</p>	<p>A.</p> <p>A.</p>
5.	Strategies and tactics	Deciding on an action	<p>14. Look at the picture below!</p>  <p>Budi and Noval were asked to move a table of the same weight. Noval was able to move the table 5 m in 10 seconds, while Budi was able to move the table 5 m in 20 seconds. If the work done was the same, who exerted the greater force, and what was the best strategy to avoid fatigue?</p> <p>A. Noval, and the best strategy was to slow down the work time. B. Noval, and the best strategy was to speed up the work time. C. Budi, and the best strategy was to slow down the work time.</p>	A.

No.	Indicators	Question Indicators	Questions	Answer
			D. Budi, and the best strategy was to speed up the work time.	
		Interact with others	<p>15. Dimas and Angga pull a crate together with a force of 400 N each. The crate moves a distance of 5 m. If their goal is to move the crate as efficiently as possible, which cooperative strategy is most appropriate for Dimas and Angga?</p> <p>A. Pulling the crate in opposite directions with equal forces to balance the work.</p> <p>B. Pulling the crate in the same direction to increase the total work and make the crate move more easily.</p> <p>C. Pulling in turns to prevent fatigue, even if the movement is slower.</p> <p>D. Letting one pull while the other rests to conserve energy.</p>	B.

Appendix B. Instrument Validation

Instrument validation was conducted on the critical thinking skills instrument developed to measure students' critical thinking skills on the subject of work and energy. The validation process was conducted by experts with reference to the critical thinking skills indicators used in the study. Validity assessment was conducted based on four main aspects as follows: A) Suitability of the test items with the critical thinking skills indicators, B) Accuracy of the substance and truth of the physics concept, C) Question construction in measuring higher-order thinking skills, D) Clarity of language and systematics of writing. The assessment was conducted by giving a score in the available assessment aspect column using a five-point Likert scale, namely score 1 is not good, score 2 is not very good, score 3 is quite good, score 4 is good, score 5 is very good. The following are the results of the validation of the critical thinking skills instrument on the subject of work and energy:

Table 6. *Validation results of critical thinking skills instruments*

Question No.	Validator 1				Validator 2			
	Aspect				Aspect			
	A	B	C	D	A	B	C	D
1	5	4	4	4	5	4	4	4
2	4	5	4	4	4	5	4	4
3	5	5	4	4	5	5	4	4
4	4	4	4	5	4	4	4	5
5	5	4	5	4	5	4	5	4
6	4	4	4	4	4	4	4	4
7	5	5	4	4	5	5	4	4
8	4	4	4	5	4	4	4	5
9	5	4	5	4	5	4	5	4
10	4	5	4	4	4	5	4	4
11	5	5	5	4	5	5	5	4
12	4	4	4	4	4	4	4	4
13	5	5	4	5	5	5	4	5
14	4	4	4	4	4	4	4	4
15	5	5	5	4	5	5	5	4

The scores obtained from the two validators for each aspect were then analyzed using Aiken's V to determine the content validity of each item in the critical thinking skills instrument. The results of the Aiken's V test can be seen in Table 7.

Table 7. *Content Validity Test Results for Items Using Aiken's V*

Question No.	Aiken's V	Category
1	0,88	Very Valid
2	0,88	Very Valid
3	1,00	Very Valid
4	0,88	Very Valid
5	1,00	Very Valid
6	0,75	Valid
7	1,00	Very Valid
8	0,88	Very Valid
9	1,00	Very Valid
10	0,88	Very Valid
11	1,00	Very Valid
12	0,75	Valid
13	1,00	Very Valid
14	0,75	Valid
15	1,00	Very Valid
Average Aiken's V	0,91	Very Valid

Based on the assessment results of two validators, the critical thinking skills instrument on the topic of work and energy obtained an average score of 4.45, categorized as very valid. Analysis using Aiken's V-coefficient showed an average score of 0.91, categorized as very valid. All test items were declared suitable for use in research with minor revisions as suggested by the validators.