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The influence of e-module based on guided inquiry learning model on students' critical thinking skills in the topic of work and energy

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ABSTRACT

This research stems from using learning materials that still consist mainly of textbooks and occasionally printed modules, resulting in low levels of students' critical thinking skills. This study aims to investigate the influence of an e-module based on the guided inquiry learning model on students' critical thinking skills on the topic of work and energy. The research method is a quasi-experimental design with a pretest-posttest control group design. The population in this study comprises all tenth-grade science students at SMA Negeri 3 Kota Tasikmalaya, and the sample was selected using cluster random sampling technique, with Class X MIPA 7 as the experimental group and Class X MIPA 8 as the control group. The data analysis technique includes prerequisite testing, hypothesis testing, and N-Gain analysis. Based on the hypothesis test results using the t-test, it was found that $t_{count} > t_{table}$, specifically, 3.75 > 1.67, leading to the rejection of H_0. Therefore, it can be concluded that using an e-module based on the guided inquiry learning model influences students' critical thinking skills on work and energy. The improvement in students' critical thinking skills was assessed using the N-Gain test, which yielded an average N-Gain score of 0.41, indicating moderate improvement.

Keywords: critical thinking skills, e-module, guided inquiry, work, and energy

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INTRODUCTION

The thinking skills required at the Senior High School (SMA) level are high-order thinking skills (HOTS) (Prastiwi et al., 2016). According to Cahyono (2017) (cited in Widya et al., 2021), their critical thinking skills can determine individual competitiveness in competition. Critical thinking skills involve thinking in a way that leads to making informed decisions or actions by posing logical questions about information. Furthermore, critical thinking in the learning process is considered one of the 21st-century skills known as the 4C skills. According to Junaedi et al. (2020), the 4C skills consist of creativity, critical thinking, communication, and collaboration.

Physics learning is essential in providing direct learning experiences so students can actively engage in the learning process and enhance their critical thinking skills. According to Hartawati et al. (2020), physics education is one of the subjects that helps students improve their critical thinking skills. Critical thinking is designed to solve problems, explore possibilities, draw conclusions, and make decisions. In practice, many students still find it challenging to understand physics concepts. Based on the survey responses from students at SMA Negeri 3 Kota Tasikmalaya, most mentioned and perceived physics lessons as challenging to comprehend. Several studies also indicate that physics involves concepts that require reasoning and understanding, leading to critical thinking, including work and energy. The work and energy subject necessitates critical thinking skills in students because it predominantly represents the relationships between variables and applies the concept of work and energy in everyday life (Nikat et al., cited in Sari, 2022). This is further supported by statements from SMA Negeri 3 Kota Tasikmalaya physics teachers, who state that the work and energy topic requires critical thinking skills among students. This is because discussions about work and energy are frequently applied in daily life, both in utilizing energy sources and applying work concepts that facilitate human tasks. Students must possess critical thinking skills to thoroughly understand the work and energy material. Furthermore, teachers emphasize that the work and energy topic is one of the subjects with relatively low learning achievement, with an average score of 53 in the 2020/2021 academic year.

Based on the observations conducted by the researcher on January 19, 2022, at SMA Negeri 3 Kota Tasikmalaya, it is evident that teachers have not fully optimized the teaching models in the learning activities. During the learning process, teachers still predominantly explain the material, and students tend to focus on the teacher's explanations. The learning resources used by students are limited to using textbooks, occasionally using modules, and accessing the internet as instructed by the teacher. As a result, the students' learning process remains passive, and they hesitate to express, answer, or question the teacher's explanations. Shofan et al. (in Huwana, 2020) state that students' learning abilities vary, so not all students can meet their individual needs. One of the strategies that can be applied in learning to accommodate students' needs independently is individualized learning using modules. Parmin and Peniati (2012) emphasize that modules are a crucial component of learning because they assist students in obtaining essential information about the subject matter. According to Winkel, learning modules are the most minor units of a learning program that students study independently.

One alternative to support students' varied learning styles and harness current technology is using electronic-based modules. The development of e-book technology facilitates the integration of printing technology with computer technology in delivering learning materials. Printed module presentations can be converted into electronic formats, giving rise to "e-module." The guidelines for creating e-learning modules provided by the Ministry of Education and Culture (2017) mention that e-modules are a form of self-directed learning material systematically organized within specific learning units, presented electronically. Within these e-modules, each learning activity is linked to navigation links, making it more interactive for participants. They are enriched with video tutorials, animations, and audio to enhance the learning experience. To ensure students' critical thinking skills develop optimally, e-modules based on the guided inquiry learning model are presented.

Critical thinking skills can be cultivated through the guided inquiry learning model. An article by Marisa & Fradisa (2018) mentions that students' critical thinking abilities significantly improved after engaging in learning using guided inquiry learning modules. The guided inquiry learning model is an instructional approach that serves as a solution for the student's learning process. This model optimizes student engagement in seeking and discovering various information and ideas, leading to investigations to construct new knowledge and meaning. It is considered more appropriate for teaching and learning as it stimulates students to participate in learning activities actively. The teacher's role in facilitating the learning process is significant at this level. The teacher determines the research topics to be explored, develops questions related to the chosen issues, specifies the procedures or steps to be taken by students, and guides them in analyzing data. Recognizing the importance of critical thinking skills, engaging learning materials, and supporting students' independent learning, the researcher conducted a study titled "The Influence of E-Modules based on the Guided Inquiry Learning Model on Students' Critical Thinking Skills in the Topic of Work and Energy." The researcher hopes that using the developed e-modules will make students more interested and active in their learning activities, facilitate independent learning, and help them acquire new knowledge.

RESEARCH METHODS

This research was conducted at SMA Negeri 3 Kota Tasikmalaya in the second semester of the academic year 2021/2022 for Grade X Science students. The population in this study consisted of all Grade X Science students at SMA Negeri 3 Kota Tasikmalaya for the academic year 2021/2022, comprising eight classes with a total of 279 students. The sample selection in this research used a cluster random sampling technique. Based on the drawing results, Class X MIPA 7 was chosen as the experimental group, which conducted learning using e-modules based on the guided inquiry learning model. At the same time, Class X MIPA 8 was selected as the control group, which conducted learning using the guided inquiry learning model only. This research is a quasi-experimental study with a pretest-posttest control group design. The research design can be seen in Table 1.

Table 1. Pretest-Posttest Control Group Research Design

Experiments	R	O_1	X_1	O_2
Control	R	O_3	X_2	O_4

Source: Sugiyono (2019)

This study has two variables: the dependent variable and the independent variable. The dependent variable in this research is students' critical thinking skills. The independent variable in this study is e-modules based on the guided inquiry learning model. Data in this research were obtained using a set of 10 valid open-ended questions as an instrument. A validator has validated the questionnaire and was also pilot-tested on Grade XI Science students at SMA Negeri 3 Kota Tasikmalaya who had studied the topic of work and energy.

The data analysis techniques used to determine the influence of e-modules based on the guided inquiry learning model on students' critical thinking skills in this study are prerequisite tests (normality test, homogeneity test) and hypothesis testing (t-test). Additionally, an N-Gain test was conducted to assess the improvement in students' critical thinking skills.

RESULTS AND DISCUSSION

Before administering the second treatment, both classes were given an initial assessment test (pretest). Based on the research data, the average pretest scores for students in the experimental class were 11.97 with a standard deviation of 3.56, while the average pretest scores for students in the control class were 11.60 with a standard deviation of 3.21. The maximum score if students answered all questions correctly is 40. For a detailed breakdown of the pretest data analysis results for both classes, please refer to Table 2.

Table 2. Pretest Statistical Data on Critical Thinking Skills

Statistical Data	Experimental Class	Control Class
Lowest Score	7	6
Highest Score	18	17
Maximum Score	40	40
Average Score	11,97	11,60
Standard Deviation	3,56	3,21

After the pretest, different treatments were administered to the two groups. The experimental class received e-modules based on the guided inquiry learning model, while the control class received the guided inquiry learning model alone. Subsequently, both classes concluded with a posttest. Based on the post-test results, the average scores for students in the experimental class were 23.11, with a standard deviation of 6.47, while the average scores for students in the control class were 18.17, with a standard deviation of 4.34. The maximum score if students answered all questions correctly is 40. For a detailed breakdown of the post-test data analysis results for both classes, please refer to Table 3.

Table 3. Posttest Statistical Data on Critical Thinking Skills

Statistical Data	Experimental Class	Control Class
Lowest Score	12	10
Highest Score	35	27
Maximum Score	40	40
Average Score	23,11	18,17
Standard Deviation	6,47	4,34

After obtaining the pretest and posttest data from the experimental and control classes, the next step was conducting prerequisite tests for normality and homogeneity. To assess the normality of the research data, a normality test was performed using the chi-square test (χ^2). The results of the normality test are presented in Table 4.

Table 4. Summary of Research Data Normality Test Results

Data	α	${\chi^2}_{count}$	${\chi^2}_{table}$	Information
Pretest KBK (Experimental Class)	0,05	9,46	11,07	Normal
Pretest KBK (Control Class)	0,05	7,45	11,07	Normal
Posttest KBK(Experimental Class)	0,05	6,09	11,07	Normal
Posttest KBK (Control Class)	0,05	5,10	11,07	Normal

Using an F-test, homogeneity testing was conducted on the pretest and posttest scores of the experimental and control classes. The results of the homogeneity test calculations are shown in Table 5.

Table 5. Summary of Research Data Homogeneity Test Results

Data	α	F_{count}	F_{table}	Information
Pretest KBK (Experimental Class – Control Class)	0,01	1,22	2,29	Homogenous
Posttest KBK (Experimental Class – Control Class)	0,01	2,22	2,29	Homogenous

After passing the prerequisite tests (normality test and homogeneity test), it was determined that the data from both samples were normally distributed and had homogeneous variances. Therefore, hypothesis testing can proceed using the t-test. The results of the hypothesis testing in the research are presented in Table 6.

Table 6. Summary of Data from T-Test Hypothesis Testing Results

Data	Experimental Class	Control Class	t_{count}	t_{table}
Number of Students	35	35	3,75	1,67
Average	23,11	18,17		
Standard Deviation	6,47	4,34		
Variance	41,87	18,85		

The results of hypothesis testing using the t-test with a significance level ($\alpha = 0{,}05$) yielded a calculated. t_{count} greater than the critical t_{table}, precisely 3.75>1.67. Therefore, H_a (the alternative hypothesis) is accepted, and H_0 (the null hypothesis) is rejected. This means that at a 95% confidence level, it can be concluded that there is an influence of using e-modules based on

the guided inquiry learning model on students' critical thinking skills in the topic of work and energy in Grade X Science at SMA Negeri 3 Kota Tasikmalaya for the academic year 2021/2022.

The influence of e-modules based on the guided inquiry learning model on students' critical thinking skills is attributed to the enjoyable impression created by the e-modules. These e-modules are equipped with audiovisual elements, providing students with more opportunities for independent learning and building their knowledge. According to Sukiman (2018), audio-visual-based learning media use hearing and sight senses to convey messages. As per Edgar Dale's Cone of Experience theory, Audiovisual learning media are more effective than purely visual or audio media (Peranginangin et al., 2021). This aligns with the findings of a study conducted by Minarni et al. (2019), which stated that using visual media combining text and images can make learning more engaging, enjoyable, and meaningful and enhance students' curiosity about what they are learning.

According to Piaget's constructivist theory, it is stated that an individual's potential can develop and succeed because they shape or construct it (Saputro & Pakpahan, 2021). The e-modules based on the guided inquiry learning model used in this context allow students to construct their own knowledge before formal learning activities take place. Furthermore, the guided inquiry learning model is considered a more student-centered and inquiry-based instructional approach. This means that the teacher is no longer solely in control of the learning process; instead, students are encouraged to discover knowledge independently. Using e-modules based on the guided inquiry learning model is also highly effective, enjoyable, and supportive in the learning process as it leverages technology, allowing students to access e-modules using smartphones. This aligns with the statement made by Ambarwati & Suyatna (2018) in their research, which revealed that the implementation of electronic modules with images and diverse exercise questions can nurture and enhance students' critical thinking skills.

Based on the N-Gain calculations, the average value in the control class was 0.41, and the average value in the experimental class was 0.24. The results of the N-Gain test are presented in Table 7.

Table 7. Summary of N–Gain Test Results Data

Results	Experimental Class	Control Class
Pretest Mean Score	11,97	11,60
Posttest Mean Score	23,11	18,17
Average N-Gain	0,41	0,24
Improvement Category	Currently	Low

The data above indicates that the improvement in the experimental class falls into the "moderate" category, while in the control class, it falls into the "low" category. This means that the enhancement of critical thinking skills in the experimental class, during the learning process using e-modules based on the guided inquiry learning model, outperforms the improvement in critical thinking skills in the control class, where the learning process uses the guided inquiry learning model alone.

The improvement in the experimental class is more substantial because in the learning activities, students are actively engaged, frequently inquire about the content and issues presented in the e-modules they use, and engage in scientific activities to discover the concepts they are studying. Furthermore, the learning process emphasizes critical thinking. This is reinforced by the findings of Khairiyah & Faizah (2020), who state that the advantage of learning that emphasizes critical thinking is that students can solve problems both during classroom teaching and in facing real-life issues in their daily lives. Therefore, the learning applied in the experimental class using e-modules based on the guided inquiry learning model significantly enhances students' critical thinking skills regarding work and energy. This is consistent with the research conducted by Rahmawati (2020), which indicates that learning using e-modules is highly effective in improving students' critical thinking skills. Additionally, the research undertaken by Sahania (2020) also states that the guided inquiry learning model can enhance students' critical thinking skills.

Improvements in each indicator of critical thinking skills in the experimental class can be observed in Picture 1.

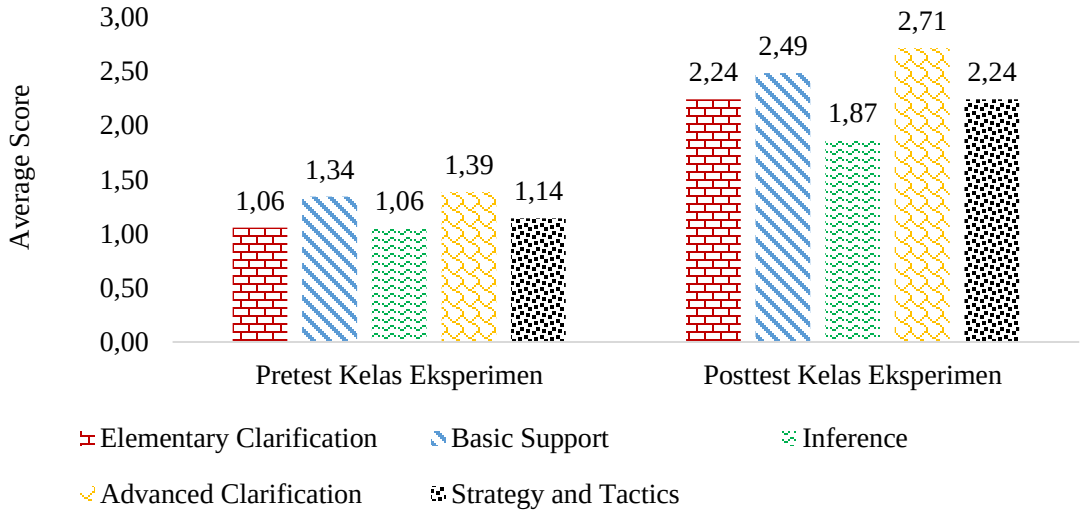

Figure 1. Diagram of an average score of critical thinking skills for each indicator in the experimental class

Meanwhile, improvements in each indicator of critical thinking skills in the control class can be seen in Picture 2.

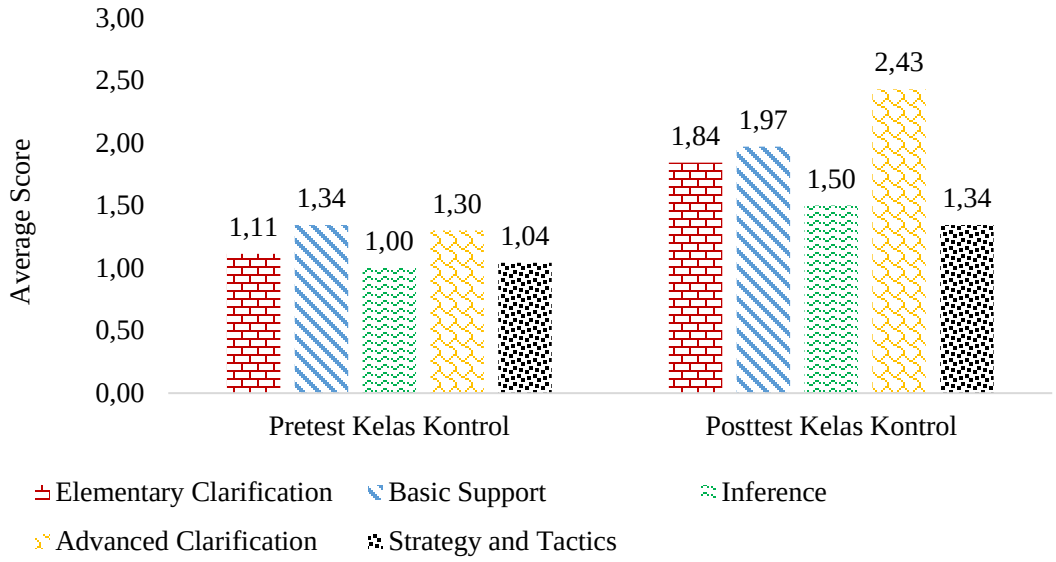

Figure 2. Diagram of Average Score of Critical Thinking Skills for Each Indicator in The Control Class

Based on Picture 1, it is evident that the use of e-modules based on the guided inquiry learning model in the experimental class enhances critical thinking skills in each indicator. The average scores for the pretest and posttest on the elementary clarification indicator increased from 1.06 to 2.24. On the primary support indicator, it increased from 1.34 to 2.49. On the inference indicator, it increased from 1.06 to 1.87. On the advanced clarification indicator, it increased from 1.39 to 2.71. Finally, the strategy and tactics indicator rose from 1.14 to 2.24. Picture 2 shows improvements in each indicator in the control class using the guided inquiry learning model alone.

The improvement in critical thinking skills is the most significant indicator in the experimental and control classes in the advanced clarification indicator. This occurs because the learning model used in both classes, whether experimental or control, is the guided inquiry learning model. The guided inquiry learning model is essentially one where students are guided to discover knowledge independently (Saputro & Pakpahan, 2021). Furthermore, in the advanced clarification indicator, students are trained by providing more in-depth explanations about the material they learn in each session. The improvement in critical thinking skills in the advanced clarification indicator in the experimental class surpasses that in the control class because in the e-modules based on the guided inquiry learning model, students are directed to audiovisual content linked to the subject matter. This makes students more interested in understanding the material. Audiovisual content incorporates both sound and visual elements, and the combination of these elements enhances the effectiveness of audiovisual media (Peranginangin et al., 2021). One of the most widely used theoretical frameworks for understanding the use of media in the learning process is Dale's Cone of Experience. This model explains that a person's learning outcomes begin with direct experiences, the realities in one's environment, and then move through replicas and verbal symbols. E-modules based on the guided inquiry learning model provide direct experiences to students as they are part of the audiovisual category that engages both visual and auditory senses,

making it less abstract. This aligns with Arsyad's (2008) assertion that direct experience provides the most comprehensive and meaningful impression of information and ideas in an experience because it involves the senses of sight, hearing, touch, smell, and taste, also known as "learning by doing."

The lowest improvement in critical thinking skills in the experimental class is in the inference indicator. This indicator received the lowest improvement score because students are guided to make comprehensive conclusions in this indicator. As a result, some students still find it challenging to draw complete conclusions about the material they are learning. Additionally, training for this indicator is only provided once in each session as an overall material conclusion, unlike other indicators that appear more frequently in the e-modules. On the other hand, the lowest improvement in critical thinking skills in the control class is in the strategy and tactics indicator. This indicator received the lowest improvement score because many students still struggle to solve the problems they encounter. Even in solving the questions, many students do not complete them thoroughly, resulting in imperfect scores in this indicator.

CONCLUSION

Based on the research findings and data analysis conducted, it can be concluded that there is a significant influence of the use of e-modules based on the guided inquiry learning model on students' critical thinking skills, as demonstrated by the hypothesis test results (t-test) with a significance level ($\alpha = 0{,}05$). The obtained t_{count} is 3,75, while the $t_{table} = t_{(0{,}95)(68)} = 1{,}67$. These results indicate that the calculated. $t_{count} > t_{table}$, precisely $3.75 > 1.67$, at a 95% confidence level. Therefore, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_a) is accepted, meaning that using e-modules based on the guided inquiry learning model influences students' critical thinking skills in the topic of work and energy in the 10th-grade science class at SMA Negeri 3 Kota Tasikmalaya. The influence of using e-modules based on the guided inquiry learning model is attributed to the fact that it falls under the inquiry-based learning category, providing students with the opportunity to discover knowledge on their own. Additionally, e-modules are considered audiovisual media that offer a direct learning experience to students by engaging both their visual and auditory senses in understanding the material, which can impact students' critical thinking skills.

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