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Profile of Critical Thinking Skills Test Assisted by E-Instrument as an Innovation of Conventional Student Tests to Improving Quality Education

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ABSTRACT
Objective: The study aims to determine the profile of students' critical thinking skills using E-Instruments. In this study, the profile of students' critical thinking skills, as assessed with conventional tests and E-instruments, is also compared. **Method:** The analysis of critical thinking skills profiles was conducted using quantitative methods. The study was conducted at a high school in East Java, Indonesia, that had used the independent curriculum. The population of this study was sampled purposively, comprising 65 students. **Results:** The profile of students' critical thinking skills in physics material is still relatively low. Based on the Wilcoxon test, the findings indicate that there is no significant difference between the test results obtained from conventional tests and those from E-instruments. **Novelty:** The novelty of this research lies in the application of E-instruments as a substitute for conventional instruments in measuring students' critical thinking skills. Its manifestation is in the implementation of point 4 of the SDGs, which aims to improve the quality of education in the field of digital technology. On the other hand, the level of students' critical thinking skills is determined by the difficulty of the material and the skill indicators that are drilled. In the future, comprehensive learning devices and models can be developed as alternatives to enhance students' skills, particularly in the use of digital technology, including media, devices, and assessment instruments, thereby increasing students' enthusiasm for learning.

INTRODUCTION

Quality education is a right for citizens, as outlined in one of the Sustainable Development Goals (SDGs), specifically SDG 4: Quality Education. To achieve quality education, consistency is necessary in adopting educational methods and systems with integrity (Hamad & Charles, 2024; Safitri et al., 2022). With quality education, human resources can further develop (Putri, 2025)—encompassing the growth of cognitive domains, abilities, knowledge, and skills. Competitive skills demands that are aligned with technology can be achieved by improving the quality of education in the country (Groumpos, 2021). The realization of quality education is significant for implementation through the improvement of 21st-century skills. 21st-century skills are currently necessary to enhance a person's capacity to coexist with the technological revolution (Lintangesukmanjaya et al., 2025; Jayadi et al., 2020).

21st-century skills encompass critical thinking, innovation, creativity, scientific knowledge, communication, and collaboration (Dignam, 2025; Astuti et al., 2024;

Kennedy & Sundberg, 2020). One of these skills is critical thinking, a reflective and rational thinking process that involves considering the results of information with full awareness (Lee et al., 2025; Blair et al., 2021). In addition, by thinking critically, a person can reflect on their thoughts rationally, based on reasoning, to determine the main idea or solution to a problem (Lintangesukmanjaya et al., 2024). Critical thinking itself is a problem-solving skill that involves logical analysis and considering facts and arguments reflectively (Lintangesukmanjaya et al., 2024; Maharani & Prahani, 2024). A person can solve problems, simple or complex, by thinking critically (Pereira et al., 2023). Therefore, this skill is essential for improving the development of education today (Ramona et al., 2023).

In fact, according to the PISA (Program for International Student Assessment) score, Indonesia ranked 68th out of 72 OECD countries in terms of literacy and numeracy skills in 2022 (Ismawati et al., 2023). Statistical data support this, indicating that only 60% of schools provide educational services in line with the educational achievements of students who have relatively low cognitive ability scores of C4-C5 (Yusuf, 2022). The low level of critical thinking skills among students is also a problem (Lintangesukmanjaya et al., 2024). Based on data from several previous studies, the level of critical thinking among high school students in physics and science learning experiences is problematic despite the importance of these skills (Neswary & Prahani, 2022).

It is essential to understand the constraints faced by students regarding learning facilities and infrastructure in order to provide more effective quality education (Astuti et al., 2024). The research question is: What is the profile of critical thinking skills among students, especially in physics? This is done based on the students' high or low skills. In addition, to improve the quality of education, as outlined in point 4 of the SDGs, the government has developed various approaches, including the curriculum and media used in various educational institutions. The standard of point 4 of the SDGs globally aims to achieve decent education, access to good media and facilities, active student engagement, and the development of 21st-century skills (Saini et al., 2023). Therefore, it is essential to analyze critical thinking skills in physics learning as a means to enhance the quality of education.

Previously, many devices were used to analyze critical thinking skills conventionally (Sunarti et al., 2023). The use of digital devices as an alternative to time constraints, visual effects, and place is infrequent. The novelty of this research lies in the application of E-instruments as a substitute for conventional instruments in measuring students' critical thinking skills. Its manifestation is in the implementation of point 4 of the SDGs, which aims to improve the quality of education in the field of digital technology. The analysis was carried out using an Electronic Instrument (E-Instrument) to help determine the profile of students' skills in critical thinking. The E-Instrument used to determine the level of critical thinking skills is an online tool that provides efficiency in terms of artistry and visuals. At the same time, this study also compared the profiles of students' critical thinking skills, as measured by conventional tests, with those measured by E-instruments. With this analysis, an innovation in developing and implementing better critical thinking skills instruments can be achieved.

RESEARCH METHOD

Types of research

The analysis of the critical thinking skills profile was conducted using quantitative methods based on the data obtained. Quantitative research was conducted by studying the results of empirical and theoretical data to measure critical thinking skills (Soleman & Victoria, 2021; Susanto et al., 2020). Empirical research was conducted using test data to determine the average score of students through a one-sample t-test (Rusnayati et al., 2023). The results were analyzed statistically, with theoretical supporting data used to strengthen the assumptions underlying the research findings.

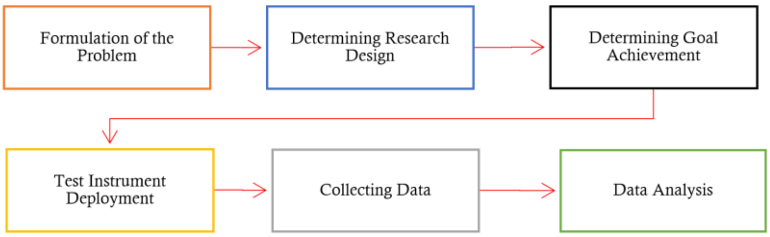

Figure 1. Research flow.

In determining the problem related to the topic and purpose of the research, the research design is also determined. The design framework is completed with the creation of instruments that can later be implemented in data collection. The resulting data are analyzed by following the skill indicators to find research novelty.

Research Instrument

The assessment instruments used in the study consisted of critical thinking skills tests, student response questionnaires, and teacher interview sheets. The research instruments created have met the objectives of knowing the improvement and analysis of students' critical thinking skills in physics learning assisted by E-Instruments (Almulla, 2020). The following is a list of research instruments and the objectives used,

Table 1. Research instrument.

Research Instrument	Objective	Analysis Indicators
Conventional Test Questions and E-Instruments	Analysis of Students' Critical Thinking Profiles	Quantitative Descriptive Analysis and Parametric Tests
Response Questionnaire	Practicality Response to Using E-Instruments	Likert Scale (1: Disagree, 2: Less Agree, 3: Agree, 4: Strongly Agree)
Interview Sheet	Response and Analysis	Qualitative Descriptive

Data Collection and Analysis Techniques

The study was conducted in high schools in East Java, Indonesia, that have used the independent curriculum. The population of this study was sampled using purposive sampling, where all members of the population had an equal opportunity to be included (Haw et al., 2022). This sample selection can be used to reduce subjective bias or individual bias by ensuring an equal opportunity for all individuals to be selected (Pryzant et al., 2020). A sample of 65 high school students was selected to participate in a limited test activity using E-Instruments aimed at improving students' critical thinking skills, in line with point 4 of the SDGs. Data were collected and analyzed related to the results of the student's critical thinking skills profile. To determine the practicality of using E-instruments, student response analysis was also conducted. An analysis of critical thinking indicators was conducted using five critical thinking indicators, as outlined by Ennis (2015), as shown in Table 2.

Table 2. Critical thinking indicators (Ennis, 2015).

Indicator	Information
Clarification	Able to formulate main ideas based on a problem.
Interpretation	Interpret and determine solutions that are appropriate to the problem indicators, considering multiple options.
Analysis	Select and analyze logical and relevant arguments for existing problems.
Evaluation	Digging up the facts needed to find solutions to problems.
Inference	Concluding means determining the consequences of a statement taken as a decision.

RESULTS AND DISCUSSION

Results

Based on data obtained from 65 students at one high school in East Java, Indonesia, the results can be interpreted about the research objectives. The critical thinking skills test was administered with the aid of an E-instrument developed as an alternative to conventional tests.

Figure 2. E-Instrument display.

The use of digital-based instruments that can be accessed directly by students has advantages in terms of efficiency and attractive virtual design (Rapiia et al., 2025). The results of students answering the questions in the E-instrument vary; the results of the five critical thinking indicators are presented in Table 3.

Table 3. Comparison of values from conventional tests with e-instruments.

Indicator	Conventional Tests		E-Instrument	
	Total Value	Average	Total Value	Average
Clarification	244	3.75	231	3.56
Interpretation	90	1.38	153	2.35
Analysis	120	1.84	107	1.64
Evaluation	150	2.31	128	1.97
Inference	161	2.47	163	2.50

The results in Table 2 show the difference in the average value of students' answers to critical thinking indicator questions. This difference in value is influenced by the characteristics of the students and the influence of the test platform provided (Ulfa, 2025). As a further analysis, a non-parametric test was conducted to determine whether this difference was statistically significant.

Table 4. Comparison of values from conventional tests with e-instruments

		N	Mean Rank	Sum of Ranks
E Instrument - Conventional	**Negative Ranks**	3[a]	3.00	9.00
	Positive Ranks	2[b]	3.00	6.00
	Ties	0[c]		
	Total	5		
E-Instrument - Conventional				
Z				-4.06[b]
Asymp. Sig. (2-tailed)				0.628

From the results in Table 4 of the non-parametric test (Wilcoxon test), it was found that the significance level was obtained. A value of 0.05 or greater indicates that, although the results of the conventional test and the E-Instrument have different indicator values, there is no significant difference in the results of the student skills test (Hidayat & Aripin, 2023). This means that, with the same questions, students answer and receive relatively similar scores and averages when using conventional tests and E-instruments. According to the test results from the E-instrument and conventional tests, there are differences in the average results for each critical thinking indicator. Figure 2 is a visual representation of the differences in values for each critical thinking skill indicator.

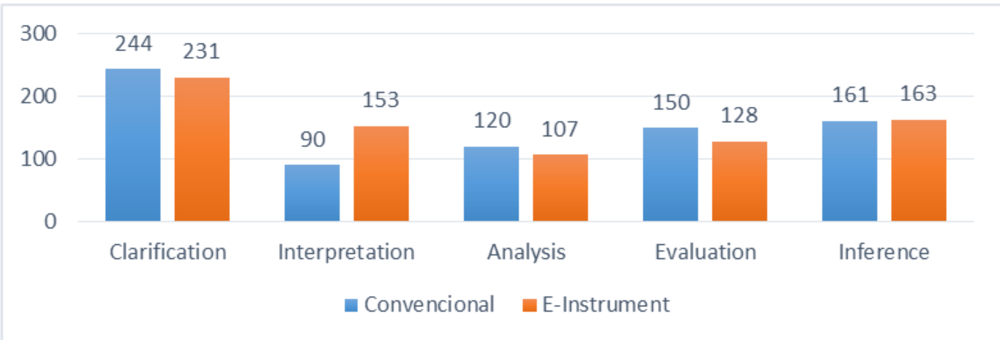

Figure 2. Comparison of students' critical thinking indicators

Discussion

Based on Table 3, the test scores given to students with conventional tests and E-instruments have different average scores. This indicates that there are differences in answers and approaches to solving physics problems in students' critical thinking indicators. Generally, when comparing the results of students' critical thinking skills measured by conventional instruments to those measured by E-instruments, there is no significant difference. This is supported by the Wilcoxon test, as shown in Table 4, which revealed no significant difference between the test results obtained from conventional tests and those from E-instruments. This suggests that the profile of students' skills in critical thinking is relatively low, as indicated by both conventional test instruments and E-instruments. The high or low skills of these students are only influenced by the question material and skill indicators used. Meanwhile, the use of electronic instruments without specific learning treatment is not a factor that can affect the improvement of students' cognitive abilities and critical thinking skills (Corcoran et al., 2023). This supports the finding that, with the same categories and questions, the type of instrument given to students —whether digital or conventional —does not yield a significant difference. The difference is only apparent from the slight difference in the average results on each instrument.

The analysis study of critical thinking skill indicators in Figure 2 describes that students' critical thinking skills are still relatively low. The indicator with the lowest value in the conventional test is the interpretation indicator. Interpretation poses a high level of difficulty, particularly when comparing data with conceptual facts in a single problem (Asrowi et al., 2025). In the E-instrument, the indicator that has the lowest level is the analysis indicator. Analysis requires high-level thinking skills, particularly when examining problems related to physics and mathematical concepts (Ikhsan et al., 2025; Lintangesukmanjaya et al., 2024). Without strong theories and arguments, students will not be able to solve problems. This is an important point in research where the low critical thinking skills of students can be a necessity that needs improvement. Critical thinking is a highly needed skill, especially in analyzing abstract concepts in science materials, such as physics (Dignam, 2025; Astuti et al., 2024). In addition, knowing the number of scores on each critical thinking indicator that has been measured can serve as an evaluation focus for teachers in disciplining students to improve indicators that are still relatively low. This requires effort and energy, especially in creating relevant media and learning models.

In addition, when viewed from the average results of two different instruments, the critical thinking indicator with the lowest value is analysis, with an average of 113.5. The low critical thinking skills of students are influenced by the quality of learning implemented by teachers. According to point 4 of the SDGs, quality education involves the practical application of technology to the instruments provided to students (Saphira et al., 2023). One of the indicators in point 4 of the SDGs is the integration of digital technology in learning to support lifelong learning (Meylani, 2025). The application of E-instruments is one of the implementations outlined in point 4 of the SDGs. However, based on the research conducted, there are still shortcomings, especially in the use of limited research samples. In addition, the test instruments used to measure critical thinking skills are only given in limited material in physics. In the future, comprehensive learning devices and models can be developed as an alternative to enhance student skills, particularly in the use of digital technology, including media, devices, and assessment instruments, which can increase student enthusiasm for learning.

CONCLUSION

Fundamental Finding: The profile of students' critical thinking skills in physics material is still relatively low. Based on the Wilcoxon test that has been carried out, it is found that Sig. (2-tailed) A value of 0.628 indicates that there is no significant difference between the test results obtained from conventional tests and those from E-instruments. **Implication:** The high or low skills of these students are only influenced by the material of the questions and the skill indicators used. The application of E-instrument is one of the implementations in point 4 of the SDGs. In line with the transition from conventional to digital technology. **Limitation:** The use of limited research samples, as well as the test instruments used to measure critical thinking skills, are only given in limited material in physical science. **Future Research:** In the future, comprehensive learning devices and models can be developed as an alternative to enhance student skills, particularly in the use of digital technology, including media, devices, and assessment instruments, to increase student learning enthusiasm.

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