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Needs Analysis of Authentic Electronic Assessment Based on Critical Thinking Abilities Integrated with Education for Sustainable Development in Measurement Topic

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ABSTRACT

We cannot avoid technological developments in the 21st-century. The development of technology is evenly distributed and increasingly prevalent in every field of life, including in the field of Education. In 21st-century education, technology has become the main complement to the learning process. 21st-century learning focuses on student center learning which aims to improve four learning competencies, namely critical thinking, cooperation, communication, and creative thinking (4C Skills). One of the abilities expected in the 21st-century is critical thinking. This study aims to analyze the need for the creation of authentic e-assessments based on ESD-integrated critical thinking skills in measurement materials. This study uses a qualitative descriptive approach with the Research and Development (R&D) method of the 4-D model at the definition stage. The research subjects consisted of 26 students of SMAN 1 Nan Sabaris who were selected using purposive sampling techniques. The object of the research is in the form of an authentic e-assessment based on critical thinking skills and integrated ESD Measurement Material. Data collection techniques include questionnaires of student needs, teacher interviews, and critical thinking ability tests. The test results show that students' critical thinking skills are still relatively low with an average percentage of 27.88%. In schools, teachers still tend to carry out conventional assessments that are not authentic, have not been integrated with Education for Sustainable Development (ESD), have not assessed critical thinking skills, and have not made optimal use of digital media.

INTRODUCTION

Twenty first century education is an educational approach that emphasizes the development of students' competencies to be able to face global challenges, scientific and technological developments, and rapid social change (Asrizal et al., 2022) Along with the development of science and technology, education is required to equip students with 21st - century skills or 4Cs (critical thinking, creativity, communication, and collaboration) which

are the key to success in facing global competition (Aryana Putu, 2020). The development of educational facilities encourages a shift in learning towards student-centered learning that emphasizes investigation, analysis, and evaluation activities (Anggraini et al., 2020), thereby having an impact on improving students' critical thinking skills.

Critical thinking can be understood as a comprehensive thinking process intellectually and mentally that involves the ability to seek information, observe, identify, filter information, and strengthen arguments so that a person is able to solve problems precisely and clearly (Khairunnisa et al., 2025). Critical thinking skills are reflective and rational thinking skills that focus on making decisions about what to believe or do (Wulandahri et al., 2025). Critical thinking skills are understood as students' cognitive abilities to process and evaluate information rationally, then make decisions and solve problems appropriately, especially in the context of physics learning (Oktaviawati & Mufit, 2025). Critical thinking skills in physics learning are the ability of students to analyze physical phenomena, relate concepts to facts or data, evaluate information, and make logical and scientific decisions or solutions in solving physics problems (Ramadhani Dar et al., 2025).

The development of students' critical thinking skills cannot be separated from the assessment strategies used in learning. Assessments in learning include assessment as learning, assessment for learning, and assessment of learning(Schellekens et al., 2021). Learning outcome assessment should prioritize *Assessment as Learning* and *Assessment for Learning*, as both encourage active engagement and application of knowledge in a real-world context (Emiliannur et al., 2018). In line with research (Riadhi et al., 2025), the Electronic Student Worksheet is not only used as a teaching material, but also as a means of assessment that assesses students' thinking processes through problem analysis, data processing, and conclusion drawing activities. The active involvement of students in each stage of electronic student worksheet activities encourages the emergence of a process of self-reflection and evaluation, which is the main feature of assessment as learning and assessment for learning.

The learning process in the classroom needs to be updated, including assessments, to make it more meaningful for students and teachers. One of the efforts to update assessments is to implement authentic assessments. Among the different types of assessments, authentic assessments are considered the most relevant for assessing 21st century skills because they involve tasks that reflect real-life situations (Wulan, 2020). Through authentic assessment, students are encouraged to analyze, evaluate, and solve problems contextually, so that critical thinking skills can be facilitated more optimally. This is especially important in the learning of Physics, where critical thinking is essential for connecting abstract concepts with real-world applications.

Physics is a part of the science that studies natural phenomena through a series of scientific processes. The results of this scientific process are expected to improve students' ability to find facts, develop concepts, build theories, and foster scientific attitudes (Darwis, 2021). Physics teaching has strategic importance for several reasons. First, Physics education goes beyond just the presentation of scientific facts—it serves as a medium to develop important thinking skills that enable students to analyze and solve problems encountered in everyday life. Second, Physics equips students with the competencies necessary for academic progress, particularly in meeting the requirements of knowledge, understanding, and admission for higher education, as well as preparing them to contribute to the advancement of science and technology (Tsabita et al., 2024). Therefore, the physics learning process requires an assessment that not only assesses the mastery of concepts, but is also able to develop students' critical thinking skills (Ramadi et al., 2025). In this context, authentic assessments play an important role because they are designed holistically and contextually so as to encourage learners to think reflectively and analytically. This assessment approach is in line

with *the principles of Education for Sustainable Development* (ESD), which emphasizes lifelong learning and active involvement of students in facing real problems.

In line with these goals, the expected learning outcomes of Physics education go beyond mastery of concepts to include the ability to respond to global challenges and actively participate in collaborative problem-solving. The concept of Education for Sustainable Development (ESD), which is a learning process that aims to develop activeness, creativity, problem-solving skills, scientific and social literacy, and responsibility for environmental, social, cultural, and economic sustainability(Agusti et al., 2019). One of the main competencies in ESD is the ability to think critically which requires students to analyze contextual problems and consider the impact of each decision taken (Yolanita, 2024). In the context of Physics, this includes not only the understanding of scientific phenomena but also the application of scientific reasoning to address pressing global issues such as climate change, energy sustainability, and technological innovation for a better future (Ramadhani Dar et al., 2025). Through ESD-based learning (Education for Sustainable Development), it is hoped that students can think critically in overcoming existing problems, especially in physics lessons. ESD equips students with the knowledge, skills, values, and attitudes needed to contribute to sustainable development. Education that instills awareness of environmental, social, and economic issues helps achieve the 17 SDGs (Sustainable Development Goals).

One of the topics studied in physics is measurement. In this study, the topic of Measurement is used to help students better understand the concept through a variety of informational texts that focus on sustainability. The main goal is to connect physics concepts with critical thinking skills and develop students' awareness of sustainable development. Thus, students not only learn the theoretical aspects of Confirmation but also integrate information from written texts, analyze measurement data, apply critical thinking skills in a broader context, and develop sustainable solutions to measurement problems. The results of the research at MAN 2 Jambi City show that students' understanding of quantities, units, and measurements still requires serious attention, which reflects the low mastery of basic physics topics at the high school level (Fitriani et al., 2021).

Based on interviews with physics teachers, it was found that schools predominantly use multiple-choice assessments in the learning assessments process. However, in practice, these assessments have not fully assessed students' critical thinking abilities particularly in connecting physics concepts with learning outcomes and predetermined objectives. In addition, students often experience difficulties when asked to relate environmental issues to the knowledge they have acquired. They also struggle to understand the relationship between local actions and their global impacts. This condition indicates that current assessment practices are still limited in supporting critical thinking abilities. Therefore, improvements in assessment strategies are needed to better facilitate the development of students' critical thinking abilities.

Based on the description above, this study aims to determine the need for developing an authentic assessment integrated with ESD-based critical thinking abilities to achieve Phase E learning outcomes aligned with the Sustainable Development Goals (SDGs). Furthermore, this research seeks to identify appropriate problem-solving methods through interviews with physics teachers who possess relevant knowledge and experience. In addition, this study emphasizes the importance of aligning assessment practices with real-world contexts and sustainability issues. The data obtained from these interviews are expected to provide a strong foundation for developing effective assessment instruments. These instruments will be designed to support the integration of critical thinking abilities within physics learning. Ultimately, the study is expected to contribute to improving the quality of assessment practices in physics education.

METHODS

This study employs a qualitative descriptive method with a Research and Development (R&D) approach to develop an authentic assessment instrument integrated with ESD-based critical thinking skills (Winaryati, 2021). The R&D approach is used because it allows for the systematic development and validation of educational products. The development model applied in this study is the 4-D model introduced by Thiagarajan which consists of four stages: define, design, develop, and disseminate. This model is widely used in educational research to produce valid and practical learning tools. Through this approach, the study aims to generate an assessment instrument that is both theoretically sound and applicable in physics learning. Therefore, this method is considered appropriate to achieve the research objectives.

The object of this research is the development of an authentic assessment instrument integrated with ESD-based critical thinking skills in physics learning. This instrument is designed to measure students' ability to think critically in the context of environmental and sustainability issues. The subjects involved in this study are students of SMAN 1 Nan Sabaris. A total of 26 students participated as the research population. These students were selected using a purposive sampling technique based on specific criteria relevant to the study. The object also includes the analysis of students' needs and their current level of critical thinking skills.

The scope of this research focuses on the development of an authentic assessment instrument integrated with ESD-based critical thinking skills in physics education. The study is limited to Phase E learning outcomes that are aligned with the Sustainable Development Goals (SDGs). It covers the identification of students' needs, the design of assessment instruments, and the evaluation of critical thinking indicators. The research also examines how environmental issues can be integrated into physics learning through assessment. However, this study does not extend to large-scale implementation or long-term impact evaluation. Therefore, the findings are limited to the development and initial analysis stages of the instrument.

The research procedure follows the 4-D development model, which consists of four main stages: define, design, develop, and disseminate. In the define stage, the researcher analyzes students' needs, curriculum requirements, and existing assessment practices. The design stage involves planning the structure and components of the assessment instrument based on ESD and critical thinking indicators. In the develop stage, the instrument is created and validated through expert review and limited trials. The final stage, disseminate, involves preparing the instrument for broader use in learning contexts. These steps ensure that the developed product is valid, practical, and relevant to educational needs.

The next stage is a critical thinking ability test sheet. The critical thinking ability test was developed based on the five core indicators of critical thinking proposed by (Ennis, 2011), which serve as an established framework for assessing critical thinking abilities. These indicators include: (1) providing a simple explanation, which assesses the ability to clarify concepts, define terms, and interpret statements accurately; (2) build basic skills, which measure the ability to identify assumptions, evaluate the credibility of sources, and observe relevant data; (3) draw conclusions, which evaluate logical reasoning in making conclusions and determine the validity of arguments; (4) provide further explanations, which test the ability to connect concepts to broader contexts, offer justification, and integrate supporting evidence; and (5) set up strategies and tactics, which assess planning, problem-solving

approaches, and the selection of effective methods for handling complex tasks. Together, these instruments provide a comprehensive overview of students' learning needs and their current level of critical thinking in Physics. The results of the needs analysis were analyzed using an assessment formula obtained by dividing the score by the maximum score and then multiplied by 100. Quantitatively, test instruments are used to determine the percentage of critical thinking students.

The percentage can be calculated using the following formula:

$$P = \frac{a}{b} \times 100\%$$

P = Percentage of critical thinking ability

a = Number of correct answers to critical thinking skills questions

b = Total number of critical thinking questions

A scale of criteria for the level of critical thinking of students. The criteria for the level of critical thinking ability of students are found in the following table 1:

Table 1. Student Ability Category

Total score range (%)	Category
81-100	Very high
61-80	Height
41-60	Medium
21-40	Low
0-20	Very low

Source : (Riduwan, 2015)

RESULTS AND DISCUSSION

Results

The results of this stud can be seen from the test of students' critical thinking ability, which was carried out at SMAN 1 Nan Sabaris. The test was held on November 24, 2024, and was attended by 26, 11th grade students. The test used was in the form of essay questions consisting of 5 stimuli and 39, 11th grade students completed the questionnaire. The data can be seen in more detail in Appendix 1. In this test, the instrument used was developed by Stuart E.The results of the analysis of the critical thinking ability test per indicator can be seen in the following figure.

The results of the problem analysis indicate that assessment practices in physics learning at SMAN 1 Nan Sabaris are still dominated by multiple-choice tests. This assessment has not been able to comprehensively assess students' critical thinking ability, especially in connecting physics concepts to real-life contexts and the environment. Based on interviews with teachers, the assessment process tends to focus more on cognitive outcomes at the level of remembering and understanding. In addition, students experience difficulties in connecting physics concepts to environmental issues and in understanding the relationship between local actions and global impacts. This condition indicates a mismatch between the expected learning outcomes and the assessment methods used. Therefore, it is necessary to develop authentic assessments that can better support and measure students' critical thinking skills integrated with ESD (Education for Sustainable Development).

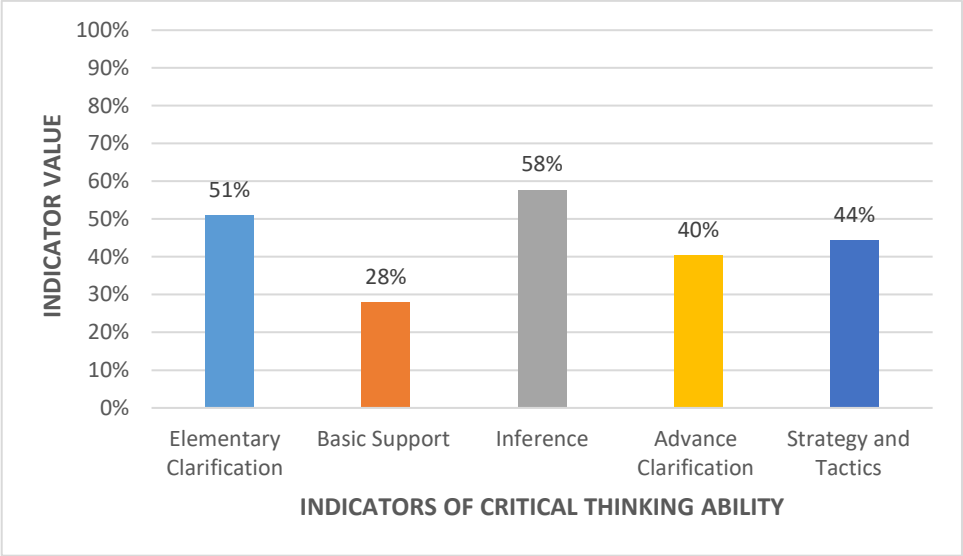

Figure 1. Critical Thinking Ability Test Results

Figure 1. Results of the Critical Thinking Ability Test Based on Figure 1, the highest average score was found in indicator 2, which is to make conclusions with a medium category. Meanwhile, the lowest average score was found in indicator 2, namely basic support (building basic skills) with a low category. In the question, students were given a graphic form to analyze two variables related to the relationship between spoon thickness and discharge to the power of the waterwheel. This condition indicates that students' critical thinking skills in general are still in the low category, which is suspected to be influenced by the assessments used that have not consistently trained critical thinking skills, such as analyzing data, interpreting graphs, and providing evidence-based reasons.

Based on the picture above, it is known that schools use multiple-choice assessments in midterm assessments. In the mid-semester assessment, there is no discourse or reading stimulus that supports an authentic assessment based on critical thinking skills that is integrated with ESD. This is because some teachers still need assistance or training to optimize the use of technology. Nonetheless, physics teachers have tried to leverage technology in the learning process, for example using PowerPoint or Canva for presentations.

In authentic assessment, students are faced with contextual and complex problems, so they are required to use critical thinking skills in finding the right solutions. This process also trains them to think sustainably by considering social, economic, and environmental impacts, in line with the principles of Education for Sustainable Development (ESD) which encourages learning to form individuals who are responsible and concerned about the sustainability of the world. Assessments are still carried out on paper, because schools have not fully utilized technology in the assessment process. The final component in the student needs questionnaire is the Technology Skills component. The results of the analysis for this component can be seen in Figure 2.

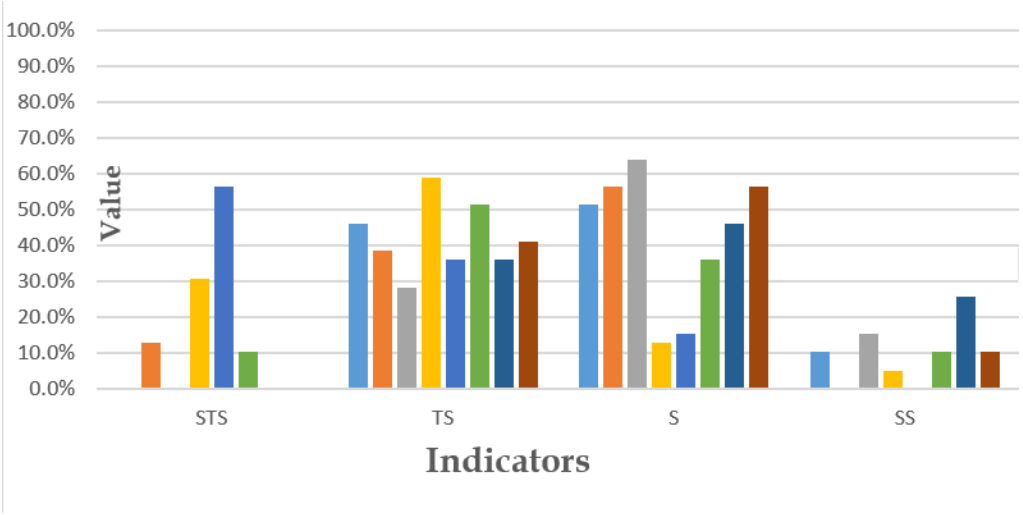

Figure 2. Questionnaire Analysis

The results presented in Figure 2 show students' responses to the use of digital assessment tools and technology in physics learning. The data are grouped into four categories: Strongly Disagree (STS), Disagree (TS), Agree (S), and Strongly Agree (SS). Overall, most responses are concentrated in the "Agree" category, indicating that students generally have positive perceptions toward digital-based assessments. Students acknowledge that tools such as Google Forms, Kahoot, and Quizizz are used in the assessment process, and they also report receiving feedback after completing tasks. However, there are still some responses in the "Disagree" and "Strongly Disagree" categories, suggesting that not all students have equal experiences or access to digital assessment tools. This variation indicates that the implementation of digital assessment has not been fully consistent across all students.

Furthermore, the data show that students perceive digital assessments as helpful in increasing engagement, interaction, and understanding of assessment criteria, especially through the use of digital rubrics and formative assessments. Most students agree that technology supports the learning process and facilitates real-time feedback, although the percentage of "Strongly Agree" responses remains relatively moderate. This suggests that while digital tools are beneficial, their use has not yet been optimized. Some students may still face challenges in fully utilizing these tools or understanding the feedback provided. Therefore, improvements are needed in the implementation of digital assessment, particularly in ensuring equal access, enhancing feedback quality, and maximizing student engagement in physics learning.

The concept analysis identifies key physics concepts that can be integrated with environmental and sustainability issues within the ESD framework. These concepts include topics that are closely related to students' daily lives, such as energy, motion, and environmental phenomena. However, current learning practices tend to emphasize theoretical understanding rather than the application of concepts in real-world contexts. As a result, students have limited opportunities to connect physics concepts with environmental problems and sustainability challenges. In addition, the integration of ESD values into physics concepts is still not optimally implemented. Therefore, it is necessary to develop assessment instruments that link conceptual understanding with real-life applications and sustainability issues.

The analysis of learning objectives shows that Phase E learning outcomes emphasize the development of critical thinking, problem-solving skills, and the ability to relate knowledge to

real-life situations. These objectives are aligned with the Sustainable Development Goals (SDGs), which encourage students to be more aware of environmental and global issues. However, the current assessment methods have not fully supported the achievement of these objectives. There is still a mismatch between the expected competencies and the evaluation tools used in physics learning. As a result, students' critical thinking skills are not optimally developed or measured. Therefore, it is necessary to design authentic assessment instruments that align with learning objectives and support the development of critical thinking abilities.

Discussion

Based on the results of the analysis of the critical thinking ability test given to students. The indicator of critical thinking with the lowest percentage was Basic Support (building basic skills) 27.88%, which indicates that learners have difficulty in providing basic support for their arguments. In the context of critical thinking, this indicator includes the ability to present relevant reasons or evidence to support a claim. Low scores in this aspect can be due to a lack of understanding in collecting and organizing evidence, as well as limitations in accessing sources that support arguments. This condition may occur because students are not used to finding and relating evidence appropriately. As stated in the study Fadila et al. (2025), the development of critical thinking skills, especially in basic support indicators, requires contextual, authentic, and integrated assessments and learning with sustainability issues. Therefore, learning and assessment strategies are needed that explicitly train learners to find, select, and use relevant evidence in constructing arguments. The training can be carried out through an analysis task based on sustainability issues, where students are asked to formulate arguments supported by clear data or facts, so that basic support skills and critical thinking as a whole can develop optimally. These findings are strengthened by D Sobari & Ramalis (2022) the results of the study finding that integrating ESD (environmental pollution materials) in the learning process results in a high critical thinking score in the basic skills aspect (78.1%), which reflects the ability of basic support students to analyze, explain, and support their thinking in the context of sustainability issues.

In the interview results, the teacher knows about authentic assessment and ESD, but has not applied it to the learning process due to limited understanding of the stages. In the learning process, teachers have applied assessment for learning as a formative assessment through the provision of practice questions and daily assignments to determine the level of understanding of students during learning. It is known that teachers have not used rubrics in the assessment process. This condition shows that the implementation of the assessment does not have clear and structured assessment criteria, so it has the potential to cause subjectivity and inconsistency in scoring. Rubrics are metacognitive tools that help learning become visible and real (Vincent-Lancrin, 2023). Based on the results of the document analysis Masamah et al. (2025), it is known that assessments in schools are not authentic, this is in line with assessment research in mathematics learning in vocational schools, which are still dominated by written tests that do not fully reflect students' real abilities in the context of life. This study concludes that authentic assessments play an important role in creating meaningful learning. The assessment research used byUsman Rery & Anwar (2020) high school teachers has not been designed to assess critical thinking skills because it is still dominated by questions that measure memorization and comprehension, even though critical thinking skills are important

to understand concepts in depth and solve problems. School assessments have not been integrated with ESD. The research Abiyya et al. (2025) shows that the integration of ESD in high school learning still faces challenges in consistent implementation, including limited teacher understanding and lack of assessment instruments that support the comprehensive implementation of ESD

Based on the results of the questionnaire, where 61.9% of students agreed with the assessment using visual media such as pictures or videos. Then 66.7% of students choose to use digital media because they get real-time feedback. The creation of e-assessments is designed with interactive, visual, and problem-based characteristics in order to be able to overcome students' difficulties in measurement and connect them with real phenomena. So it can be concluded that students want an interesting, interactive, and fun assessment by utilizing technology, such as the creation of authentic e-assessments based on integrated critical thinking skills ESD offers assessments that allow students to be actively involved in solving problems, encouraging cognitive activeness, and stimulating critical thinking skills. Development of an interactive and contextual Electronic Student Worksheet. The Electronic Student Worksheet is designed with visual features, problem-based questions, step-by-step guides, and multimedia integration to respond to the needs of students who prefer visual, independent, and digital-based learning. (Permata Sari, 2025)

The use of E-SWS (Electronic Student Worksheet) has been proven to help improve students' critical thinking skills, the integration of technology in E-SWS makes learning more interactive and contextual thus increasing student involvement in the higher-level thinking process (Putri et al., 2025). This is in line with research The development of an authentic technology-based assessment system (ICT) shows its effectiveness in measuring students' critical thinking skills, strengthening the theoretical basis for the use of authentic e-assessments in the context of modern learning (Setiyadi et al., 2021). Its implementation is also expected to produce a more dynamic, efficient, and attractive learning environment (Utami & Emiliannur, 2025).

Based on the explanation that has been explained above, the researcher wants to make an assessment in the form of an authentic e-assessment based on ESD-integrated critical thinking skills. E-Assessment can be a more effective assessment and in accordance with the needs of students. The E-Assessment is prepared by including interesting images, videos, the latest information about the material, rubrics and questions (Setiyadi et al., 2021). The difference between this study and the previous one lies in the approach used, namely ESD and the material used is measurement. The creation of this e-Assessment is carried out by utilizing the wizer.me application. Wizer.me serves to create student worksheets with the teacher's creativity and allows for quick creation. The app Wizer.Me considered to be a useful tool for understanding and assimilating concepts. This Wizer.me application can be applied by teachers in the teaching and learning process at school (Kaliappen et al., 2021).

Creation of authentic e-assessments based on ESD-integrated critical thinking skills that are interactive and contextual. The characteristics of the proposed authentic e-Assessment are able to answer students' difficulties in understanding the concept of measurement. With integrated ESD, students are trained to craft evidence-based arguments, evaluate solutions, and think reflectively. To overcome this, the researcher proposes the creation of an authentic

e-assessment based on ESD-integrated critical thinking skills to assess students' critical thinking skills on measurement materials.

CONCLUSION

This study shows that 21st-century learning requires the development of 4C skills, especially critical thinking skills in physics learning. Critical thinking ability are important because they help students analyze, evaluate, and solve problems logically and scientifically. The development of these skills is strongly influenced by the assessment strategies used in the learning process. Based on the results of the research analysis conducted, this study found that the assessments made by teachers were not authentic, did not fully assess students' critical thinking ability, especially in connecting physics concepts with learning outcomes and learning objectives that had been determined, while students had difficulty connecting the physics concepts they had learned with real phenomena and were unable to develop logical arguments based on the data obtained. Given this gap, there is a need for electronic assessments specifically designed to improve critical thinking skills in the context of Education for Sustainable Development (ESD), particularly on measurement topics. Therefore, the development of an electronic authentic assessment integrated with ESD is considered essential to address these issues. Ultimately, this approach is expected to create a more meaningful learning experience and effectively enhance students' critical thinking skills in line with the demands of 21st-century education.

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