Journal of Innovative Physics Teaching
Volume 4, Issue 1 June 2026, 111 - 122
ISSN: 3021-8551 (Online)
Doi: https://doi.org/10.24036/jipt/vol4-iss1/133
https://jipt.ppj.unp.ac.id/index.php/jipt

Need Analysis to Develop Dynamic Fluid E-Assessment Integrated Critical Thinking for Sustainable Education Assisted Google Sites and Formative

Rindi[1], Emiliannur[2*], Hamdi[3], Dea Stivani Suherman[4]
[1,2,3,4] Department of Physics, Padang State University, Padang, Indonesia.

Article Info

Article history:

Received April 29, 2026
Revised June 10, 2026
Accepted June 15, 2026

Keywords:

Assessment
Critical Thinking Skills
ESD
Physics
Google Sites
Formative

ABSTRACT

The development of students' critical thinking skills in physics learning has not been optimally supported by the assessment practices currently used. In the context of 21st-century education, critical thinking is recognized as a fundamental competency for achieving Sustainable Development Goals (SDGs), particularly Goal 4 on quality education. This study seeks to examine the need for developing assessment tools that integrate critical thinking skills with Education for Sustainable Development (ESD) in physics learning". This study uses a descriptive approach in Research & Development (R&D) involving 25 grade XI Phase F students. Data collection techniques include critical thinking tests based on Facione indicators, student response questionnaires, and teacher interviews."The findings reveal that students' critical thinking skills are generally categorized at a moderate to low level, with the weakest performance observed in the inference indicator. This suggests that students still encounter difficulties in connecting physics concepts with real-world phenomena. However, students demonstrate a relatively good level of sustainability awareness. Therefore, it is necessary to develop electronic assessments integrated with ESD to enhance students' critical thinking skills and improve the overall quality of physics learning .

***Correspondence:**
Emiliannur, Department of Physics, Padang State University, Padang, Indonesia.
· email : emiliannur@fmipa.unp.ac.id

INTRODUCTION

Along with the development of science and technology in the 21st century demands that the education system produce students who not only have theoretical knowledge, but also practical skills and strong character (Agusti et al., 2019). A number of global educational institutions such as the Partnership for 21st Century Learning (P21) and the Indonesian ministry of education, culture, research, and technology have formulated four main

competencies that students must master in this era, namely critical thinking, creativity, communication, and collaboration, or known as the 4Cs (Pusmenjar, 2020). Among the four competencies, critical thinking skills have the most fundamental role because they are the foundation for students in critically examining information, evaluate existing arguments, solve problems, and make decisions based on logical evidence (Zubaidah, 2016). Thus, for the success of education in preparing a generation that is intelligent, adaptive, and highly competitive in the global era, mastery of critical thinking skills is required.

Critical thinking is a high-level cognitive skill that is essential for dealing with the complexities of 21st-century problems. Critical thinking is widely regarded as a key skill for achieving success in both academic and professional contexts (Hirahmah & Yani, 2024). Critical thinking is an essential skill for every individual, especially as it relates to problem-solving (Fadilah et al., 2020). Ennis (2011) critical thinking is defined as a reflective thought process focused on making decisions about what to believe or do. Critical thinking skills are the ability to think logically, reflectively, and productively so as to assess situations and make informed decisions (Facione, 2020).

This process requires the ability to assess evidence, evaluate arguments, and consider multiple perspectives before reaching a decision. One use of critical thinking skills is to solve a problem (Hartati, 2022; Adilla & Jatmiko, 2021). Each individual has different critical thinking tendencies depending on their experience, cognitive abilities, and learning environment (Asniar et al., 2022). So critical thinking skills can be interpreted as logical thinking skills by collecting, analyzing and evaluating information systematically so that a deep understanding, correct decisions and ideas for solving problems effectively are obtained (Ramadhani & Wasis, 2024).

Critical thinking skills play a crucial role in physics education, as they allow students to analyze, evaluate, and solve problems through a comprehensive understanding of fundamental concepts (Velempini, 2025). Students' critical thinking skills can be trained and developed effectively through the implementation of well-designed assessments throughout the learning process. Assessments serve not only to measure learning outcomes but also as a means to stimulate students' higher-order thinking processes (Anggraena, 2025). Assessment in learning is a systematic and continuous process to collect information about students' learning development, so that educators can make appropriate decisions based on certain criteria and considerations (Rosnaeni, 2021; Yolanita, 2024). Good assessment implementation allows teachers to identify the extent to which students understand concepts, reason information, and apply knowledge to solve problems (Arta, 2024; Munaroh, 2024). Therefore, assessments need to be designed not only to assess final results but also to measure students' thinking processes.

One of the goals of learning Physics is to develop the ability to think objectively, systematically, and creatively in understanding and applying scientific concepts to face challenges while fostering innovation in learning and its application in real life (Amalissholeh et al., 2023; Lestari et al., 2025). Physics not only serves to transfer knowledge, but also plays a role as a means of developing critical thinking, analytical and problem-solving skills that are applicable in everyday lifee (Ardianti et al., 2025**).** Critical thinking is widely regarded as a key competence in achieving sustainability, especially in physics education (Rieckmann, 2018). According to Orhan (2022), critical thinking helps students develop a deeper understanding of environmental conditions. Furthermore, this skill enables students to critically analyze and address environmental issues, as well as understand the role of political, social, and economic systems in supporting sustainable development (Tilbury & Wortman, 2004). Therefore, physics learning needs to be connected to real-life contexts that are oriented toward sustainability, as emphasized in the education for sustainable development (ESD) concept.

Education for sustainable development (ESD) is a lifelong educational approach that aims to empower students to think critically, creatively, and scientifically, as well as to develop problem-solving skills in social and environmental contexts. ESD emphasizes the importance of personal and collective responsibility for community well-being and environmental sustainability (UNESCO, 2017; Kioupi, 2019). UNESCO (2017), emphasizes that ESD aims to integrate sustainability values into the learning process so that students not only understand scientific concepts but also have a critical awareness of the social, economic, and environmental impacts of the application of science. In addition, ESD has an inherent interdisciplinary nature.

Although it is often linked to natural sciences and environmental topics, in practice it is implemented across various subjects within school curricula in different countries (Hallingfors & Elmersjo, 2025). Therefore, critical pedagogy encompasses a social dimension within the framework of critical thinking, emphasizing the importance of applying reflective and critical reasoning to promote social transformation in the context of ESD (Reffhaug & Lysgaard, 2024). A learning approach that engages students in interdisciplinary real-world issues not only emphasizes the development of critical thinking skills, but also encourages action, reflective thinking, and ethical decision-making (Felix et al., 2025). Therefore, ESD-based learning fosters conceptual understanding, reflective awareness, and responsibility for the impacts of science.

On the other hand, the development of digital technology has impacted information transparency and ease of access, intensified competition in all sectors of life, and threatened human resources lacking competencies and skills (Sukaesih et al., 2023). Technological developments have positive and negative impacts and present challenges, especially in the field of education (Sinaga, 2023). One example is the use of digital platforms such as Google Sites and Formative, which offers opportunities for developing more interactive and adaptive assessments (Fatmawati, 2021). The use of digital technology in assessments allows for more efficient evaluation processes and supports the presentation of more varied and engaging stimuli (Ashari et al., 2023). Digital-based platforms are also capable of presenting more representative visualizations, thus helping students understand abstract physics concepts.

Fluid dynamics is a relatively complex physics topic, involving concepts such as the continuity equation and Bernoulli's principle, which are not always readily understood. The abstract nature of the concepts means that students cannot simply rely on memorizing formulas. They are required to interpret how fluid flow works, especially when related to real-life situations frequently encountered in everyday life. In such circumstances, the learning process needs to be supported by assessments that not only test final results but also encourage thought processes.

Contextual presentation of problems, accompanied by relevant visualizations, is crucial for students to develop deeper understanding and practice their critical thinking skills. Previous studies have developed various technology-based learning media and instruments to improve critical thinking skills, such as ESD and digital electronic assessments (Kurniati & Ratnaningrum, 2025; Nur et al.,2025). However, most research still focuses on developing learning media rather than designing assessments that specifically measure critical thinking skills systematically. Furthermore, the integration of electronic assessments using Google Sites and Formative with ESD principles in the context of physics learning is still limited.

To address this issue, a new approach is needed through the development of an electronic assessment of critical thinking skills integrated with ESD using Google Sites and Formative on fluid dynamics material. The novelty of this research lies in the integration of critical thinking skill indicators, sustainability contexts, and the utilization of Google Sites and Formative as interactive digital media that support students' critical thinking processes

through collaborative activities and contextual stimuli. Thus, the developed assessment functions not only as an evaluation tool but also as a medium to stimulate students' critical thinking skills more effectively and interactively. Based on this description, the purpose of this study is to develop an electronic assessment that aligns with the characteristics of critical thinking skill indicators and fulfills the criteria of validity and practicality. This research is expected to contribute to the development of innovative, interactive, and sustainability-oriented physics learning assessments.

METHODS

This study used a descriptive approach within a Research and Development (R&D). The research design used in this development is the 4D model (Define, Design, Develop, Disseminate) proposed by (Thiagarajan et al., 1974). The study was conducted on December 11, 2025, and the study population consisted of 25 grade XI Phase F students in the 2025/2026 academic year. This study was conducted at Semen Padang High School, with a population consisting of physics teachers and 25 students as research subjects. A needs analysis was conducted to determine the needs for physics learning at Semen Padang High School. Furthermore, the scope of this study was to analyze the critical thinking skills of grade XI Phase F students and develop an electronic assessment on static electricity.

This study included test questions to determine students' understanding of electronic assessments and ESD a test that included critical thinking indicators to determine students' levels of critical thinking skills, and interviews with physics teachers to determine the assessments used in the learning process. Furthermore, this study aimed to examine whether current physics learning practices align with students' needs and expectations. By using data from a student needs questionnaire and a critical thinking skills test, this study is expected to provide insight into the steps needed to improve the quality of physics learning, particularly in facilitating students to develop better critical thinking skills.

The data collection instruments employed in this study included two main components: a student learning style questionnaire and a critical thinking skills test. The student learning style questionnaire was designed to gather information regarding student needs related to physics learning, thus providing input for developing the most appropriate learning strategies according to their needs. The three learning styles are visual, auditory, and kinesthetic. Meanwhile, the critical thinking test was constructed based on Facione's, (2020) framework, which encompasses six indicators: interpretation, analysis, evaluation, inference, explanation, and self-regulation. The data in this study were processed using descriptive statistical techniques, which aim to process, summarize, and present data in a structured manner for easier understanding. The analysis of students' critical thinking skills was conducted by calculating the scores obtained according to Riduwan, (2019). The results were interpreted based on the critical thinking skill level classification shown in Table 1.

Table 1. Categories of Students' Critical Thinking Skills

Index (%)	Category
81-100	Very high
61-80	Tall
41-60	Enough
21-40	Low
0-20	Very low

Source: (Riduwan, 2019)

Based on the Likert scale in Table 1, an index of 81-100 is considered very high, 61-80 is considered tall, 41-60 is considered sufficient, 21-40 is considered low, and an index of 0-20

is considered very low. The percentage of the obtained data can then be calculated using equation 1.

$$p = \frac{a}{b} \times 100\% \quad (1)$$

Description:
p = percentage of students' critical thinking skills
a = Number of correct answers on critical thinking skills test questions
b = Number of correct answers on critical thinking skills test questions

RESULTS AND DISCUSSION

Results

The first findings of this study were obtained from a critical thinking skills test administered at Semen Padang High School on December 11, 2025, with 25 11th-grade students participating. The test consisted of six essay questions, each containing six indicators of creative thinking. The analysis of the results is shown in Figure 1.

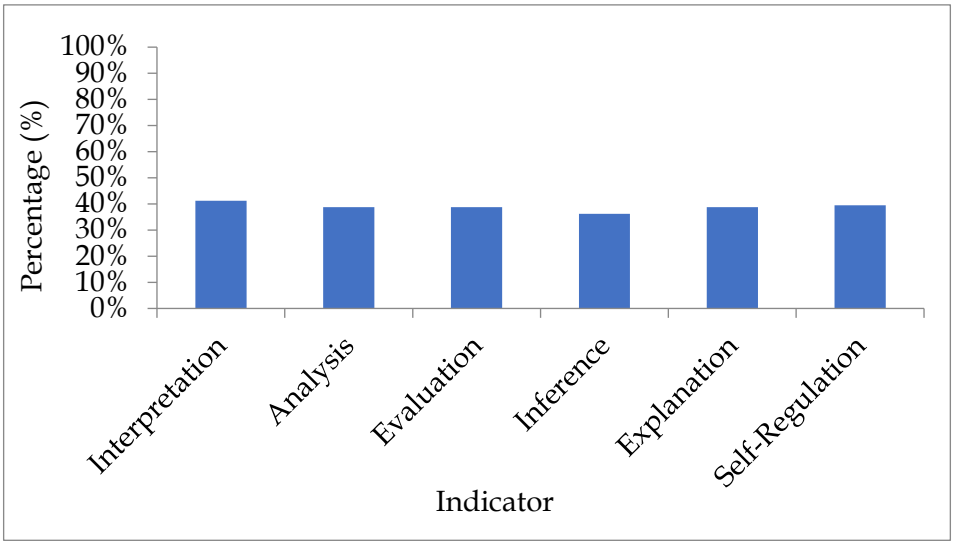

Figure 1. Results of the Initial Test of Students' Critical Thinking Skills

Based on the data in Figure 1, it shows that students' critical thinking skills are still in the low category with an average of 39%, with the inference indicator receiving the lowest score. This conclusion is drawn from the analysis of students' responses to the critical thinking test items. The findings suggest that students still face difficulties in formulating logical conclusions. Similar results have been reported in previous studies (Dar et al., 2025; Fadila et al., 2025) which reveal that most students demonstrate moderate to low levels of critical thinking. This indicates that most students still focus on solving problems procedurally without understanding the conceptual meaning behind them. The low level of students' critical thinking skills is closely related to the nature of the assessment practices implemented in schools. In a similar vein, assessment practices in higher education, particularly in physics laboratory courses, continue to face a range of complex challenges (Emiliannur et al., 2026)

The second research outcome presents an analysis of electronic assessment covering three main aspects, namely assessment, ESD, and technology. This analysis compares the ideal characteristics of electronic assessment with its actual implementation in schools. The purpose of this comparison is to identify gaps between the expected and current conditions of electronic assessment practices. The results of the analysis are presented in Figure 2.

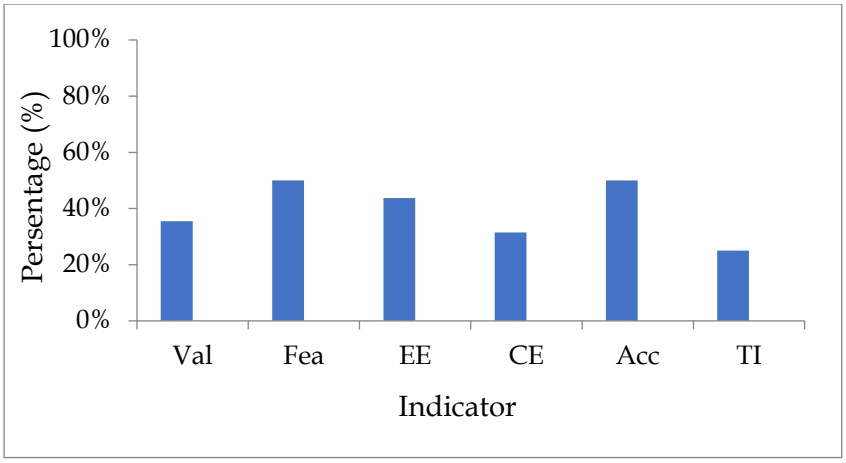

Figure 2. Analysis of Problems in Electronic Assessment

Based on Figure 2, the analysis shows that the characteristics of electronic assessment in schools are categorized as low, with an average percentage of 39,33%. Among the indicators Val (Validity), Fea (Feasibility), EE (Educational Effectiveness), CE (Catalytic Effect), Acc (Acceptability), and TI (Technology Integration). Overall, these results indicate that the problems encountered in electronic assessment are still at a low level and do not constitute a major obstacle to its implementation. Assessment is not only used to measure academic achievement but also to provide meaningful feedback that helps students develop their potential to the fullest (Munaroh, 2024). These results indicate that the characteristics of electronic assessment implemented in schools have not yet fully met the expected standards. Therefore, the development of electronic assessment systems that can better accommodate these various characteristics is necessary.

Based on these findings, it is important to examine how broader contexts may influence the quality of assessment implemented in schools. One aspect that needs attention is the integration of ESD into the assessment process, which not only emphasizes academic achievement but also fosters students' awareness, attitudes, and sustainability-related skills. Assessment that integrates ESD and involves sustainability-related contextual issues not only focuses on measuring critical thinking, but also encourages reflection, action, and ethical decision-making (Felix et al., 2025). This is supported by research conducted by Aprilia et al., (2026), which reveals that the integration of ESD is not yet evenly distributed across all chapters and learning components. Therefore, an analysis table of ESD integration in assessment is presented in Figure 3.

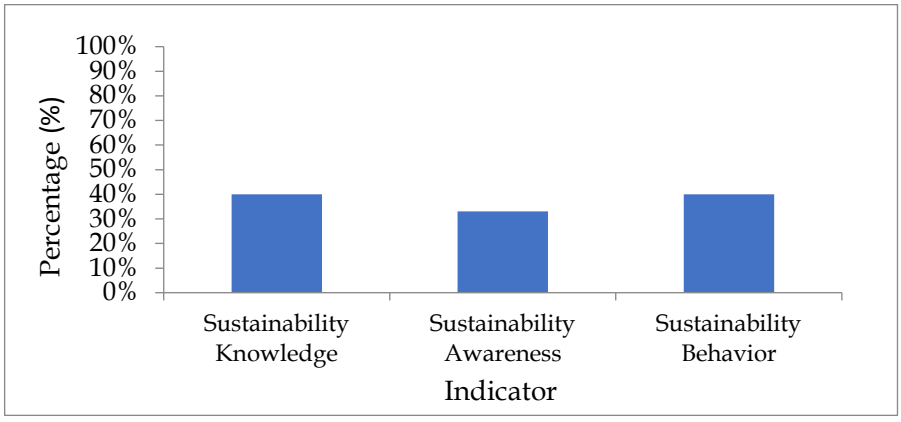

Figure 3. Results of ESD Integration in Assessment

Based on Figure 3, the analysis results indicate that the integration of ESD in assessment is categorized as low, with an average percentage of 37.67%. The low level of ESD integration suggests that students have not been provided with sufficient opportunities to develop their understanding, awareness, and actions related to sustainability issues through assessment activities. In fact, ESD-integrated assessment can help students connect the concepts they learn with sustainability-related issues and challenges (UNESCO, 2020; Tilbury, 2011). Furthermore, sustainable education aims to develop students' critical thinking, problem-solving, and decision-making skills while considering environmental, social, economic, and cultural impacts (UNESCO, 2017). Therefore, the development of assessments integrated with ESD is needed to support sustainable learning.

To support the development of electronic assessments integrated with ESD students' technological readiness must be taken into consideration. Technological capability is an important factor in supporting the effective use of technology in assessment practices. Therefore, an analysis was conducted to determine students' readiness to utilize technology in supporting both learning and assessment processes. The development of electronic assessment through various applications or web-based platform represents an educational innovation that serves as a solution for preparing learners to adapt to the demands of a rapidly changing era (Meccawy et al., 2021). Therefore, this condition supports the development of an electronic assessment assisted by Google Sites and Formative in physics learning. This, finding is further reinforced by the results of the students' learning style questionnaire analysis presented in Figure 4.

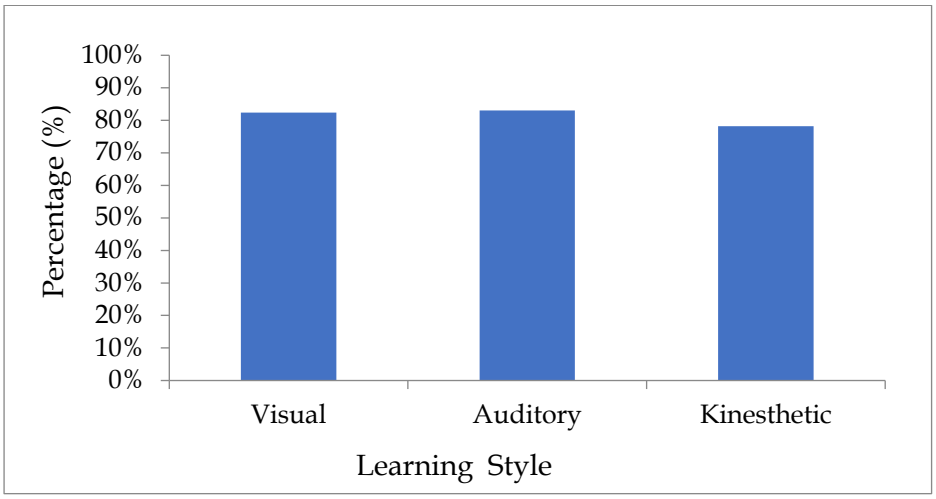

Figure 4. Graph of Student Learning Style Tendencies

Based on Figure 4, it was found that students' learning styles tended toward auditory and visual. This indicates that students more easily understood learning material through listening to explanations, discussions, viewing images, graphs, illustrations, or educational videos. These findings indicate that students show a positive attitude toward the integration of technology in the learning process. In line with this, teachers also reported that the use of technology greatly facilitates the assessment process. Previously, assessments were mostly conducted using conventional methods, particularly through paper-based tests. Currently, due to sophisticated technology, assessments can be conducted with the help of devices and implemented online, such as using applications and special software for assessment tests. This assessment is considered more relevant because it greatly assists teachers and institutions in implementing assessments effectively (Ashari et al., 2023). Therefore, these findings indicate that the development of electronic assessment assisted by Google Sites and Formative is highly relevant to support physics learning and assessment practices.

Discussion

Based on the research findings obtained, this study focuses on four main findings, namely low students' critical thinking skills, assessment practices that have not fully aligned with the ideal characteristics of electronic assessment, the lack of integration of ESD in assessment, and the results of the analysis of students' learning styles. These findings are also supported by students' characteristics, which indicate potential to support the development of digital-based assessment through their dominant learning style tendencies.The first finding shows that students' critical thinking skills are still in the low category, with an average score of 39, as reflected in the indicators of critical thinking skills proposed by Facione (2020), which include interpretation, analysis, evaluation, inference, explanation, and self-regulation. This condition is consistent with previous studies by Dar et al., (2025); Fadila et al., 2025), which show that students' critical thinking abilities remain low due to learning processes that still emphasize procedural understanding rather than conceptual understanding. This finding is further supported by Emiliannur et al., (2026), who state that assessment practices in education have not yet fully been able to measure higher-order thinking skills. Therefore, innovation in assessment design is needed so that students' critical thinking skills can be measured and developed optimally in line with the demands of 21st-century learning.

The second finding indicates that the characteristics of electronic assessment in schools have not yet fully aligned with the ideal characteristics of electronic assessment. The function of assessment, which should promote interactivity, meaningful feedback, and the development of higher-order thinking skills, has not been optimally implemented. Ideally, assessment is viewed as an integral part of the learning process that contributes to improving students' understanding (Munaroh, 2024). Theoretically, assessment is not only used to measure learning outcomes but also serves as part of the learning process that provides meaningful feedback and enhances student engagement (Black & Wiliam, 1998; Hattie & Timperley, 2007). To achieve ideal learning quality, assessment processes need to be properly designed and implemented in accordance with learning objectives so that each topic can be optimally measured through appropriate assessment approaches (Nasucha, 2022). Therefore, development and innovation in electronic assessment are needed to align it with ideal characteristics and to support the learning process more effectively.

The third finding indicates that the integration of Education for ESD in assessment is still in the low category. This suggests that assessment activities have not yet fully connected learning content with real-life sustainability issues. Ideally, ESD emphasizes the development of critical, creative, and scientific thinking skills as well as problem-solving abilities in social and environmental contexts (Kioupi, 2019). In addition, ESD promotes interdisciplinary learning that integrates sustainability values and raises awareness of the impacts of science in various aspects of life (UNESCO, 2017). Therefore, strengthening the integration of ESD in assessment is necessary to support the development of reflective thinking, ethical decision-making, and sustainable learning.

The fourth finding indicates that students' technological capability is in the very high category. This suggests that students are well-prepared to utilize technology to support learning processes, including assessment activities. The development of electronic assessment represents an educational innovation that is relevant to the demands of the digital era (Meccawy et al., 2021; Ashari et al., 2021). In addition, the use of technology can support the presentation of more varied information and stimuli, thereby enhancing students' understanding of concepts more effectively (Ashari et al., 2023). Thus, technological development provides opportunities to create a more effective and efficient

assessment process in learning.

Student characteristics play an important role in supporting the development of digital-based assessment. Learning preferences such as auditory, visual, and kinesthetic styles indicate how students respond to different forms of learning and assessment. High tendencies in auditory and visual styles suggest that students are more responsive to verbal instructions, discussions, and visual representations such as graphs, images, and videos. Considering these characteristics can help improve the effectiveness of learning and assessment through the appropriate use of media (Nurmaya et al., 2023; Aziz et al., 2019). Therefore, understanding student characteristics provides a strong basis for developing more interactive and suitable digital-based assessment.

This situation presents a significant opportunity to develop digital-based e-assessment, such as electronic assessment integrated with Google Sites and Formative. Google Sites is used to present assessment instructions, assessment indicators, and activity links that are connected to Formative as a student response medium. Formative functions as an interactive space for students to express answers, provide reasoning, and complete problem-solving-based assessment tasks both individually and collaboratively (Aulia & Riefani 2021). According to Al-Fitrie et al., (2023), Formative can be used as a learning medium that facilitates direct and interactive collaboration among students during the learning process. The integration of these two platforms enables the assessment process to become more interactive, flexible, and capable of capturing students' critical thinking skills more authentically without relying on the presentation of learning materials (Pratiwi, 2024; Fatmawati et al., 2024). Therefore, the results of this study indicate a gap between classroom assessment practices and the demands of 21st-century learning, highlighting the need to develop interactive e-assessment based on Google Sites and Formative to optimize students' critical thinking skills.

CONCLUSION

Based on the analysis conducted, students' critical thinking skills are still at a low level, particularly in the aspects of analysis, evaluation, inference, and explanation. The assessment practices currently implemented in schools have not fully reflected the characteristics of effective assessment that support higher-order thinking skills. In addition, ESD principles have not yet been integrated into the assessment process. As a result, students have limited opportunities to relate physics concepts to real-world sustainability issues. The findings also indicate that electronic assessment has not been optimally implemented in schools. This condition is not in line with the demands of 21st-century learning, which emphasizes the integration of technology in educational practices. Furthermore, students tend to have visual and auditory learning preferences that require interactive and technology-based assessment tools. Therefore, the development of an ESD-oriented electronic assessment integrated with critical thinking skill indicators on fluid dynamics material is needed to support students' competencies in the 21st century.

REFERENCES

Adilla, I. N., & Jatmiko, B. (2021). Keefektifan Pembelajaran Daring Fisika SMA Berbasis Probing Promting untuk Meningkatkan Keterampilan Berpikir Kritis Peserta Didik. *PENDIPA Journal of Science Education, 5*(3), 426–435.

Agusti, K. A., Wijaya, A. F. C., Tarigan, D. E. (2019). Problem Based Learning dengan Konteks ESD untuk Meningkatkan Keterampilan Berpikir Kritis dan Sustainability Awareness Siswa SMA pada Materi Pemanasan Global. *Prosiding Seminar Nasional Fisika (E-Journal) VIII*,175–182.

Al-Fitrie, A. L., Solihatin, E., Kustandi, C. (2023). Pengembangan Bahan Ajar Digital dengan Pendekatan Collaborative Learning Menggunakan Formative untuk Meningkatkan Writing Skills Siswa. *Jurnal Paedagogy, 10*(4), 1045.

Amalissholeh, Nindy, Sutrio, Rokhmat, J. (2023). Analisis Kesulitan Belajar Peserta Didik pada Pembelajaran Fisika di SMAN 1 Kediri. *Empiricism Journal 4*(2), 356–64.

Anggraena, D. (2025). *Pembelajaran dan Asesmen Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah Edisi Revisi Tahun 2025*. Jakarta: BSKAP Kemendikbudristek.

Arta, G. Y. (2024). Asesmen dalam Pendidikan: Konsep, Pendekatan, Prinsip, Jenis, dan Fungsi. *JPBB: Jurnal Pendidikan, Bahasa dan Budaya, 3*(3), 170-190.

Ashari, M. K., Athoillah, S., Faizin, M. (2023). Model E-Asesmen Berbasis Aplikasi pada Sekolah Menengah Atas di Era Digital *: Systematic Literature Review*. *6*(2), 132–150.

Asniar, Nurhayati, Khaeruddin. (2022). Analisis Keterampilan Berpikir Kritis dalam Pembelajaran Fisika Peserta Didik di SMAN 11 Makassar. *Jurnal Sains dan Pendidikan Fisika, 18*(2), 140–151.

Aulia, D., Riefani, M. (2021). Google Sites as a Learning Media in the 21st Century on the Protista Concept. *BIO-INOVED: Jurnal Biologi-Inovasi Pendidikan,* 3(3), 173-178.

Aziz, A. O., Nadira, N., Irawan, S. S. D. (2019). Media Audio-Visual: Upaya Mengatasi Perbedaan Gaya Belajar Siswa dalam Pembelajaran Biologi. *Prosiding Seminar Nasional Biologi VI,* 218-221.

Brookhart, S. M. (2010). *How to Assess Higher-Order Thinking Skills in Your Classroom*. Alexandria, VA: ASCD.

Brookhart, Susan, M. (2015). *How to Make Decisions with Different Kinds of Student Assessment Data*. Alexandria, VA: ASCD.

Dar, S. R., Emiliannur, E., Festiyed, F., Riyasni, S., & Winarno, N. (2025). The Importance of Integrating Education for Sustainable Development in Global Warming Assessments to Improve Students' Critical Thinking Skills. *Jurnal Penelitian Pembelajaran Fisika*, *11*(2), 223–234.

Ekamilasari, Permanasari, A., Pursitasari, I. D. (2021). Students' Critical Thinking Skill and Sustainability Awareness in Science Learning for Implementation Education for Sustainable Development. *Indonesian Journal of Multidiciplinary Research, 1*(1), 121-124.

Emiliannur, Novitra, F., Doni, R., Liana, M., Winarno, N., Hakim, L. (2026). Development and Content Validation of a HOTS-Oriented Performance Assessment for Physics Practicum in Higher Education to Support SDG 4. *Jurnal Penelitian Pendidikan (JPPIPA)*, *12*(3), 681–692.

Ennis, R. H. (2011). *The Nature of Critical Thinking : An Outline of Critical Thinking Dispositions*. 1–8.

Facione, P. A. (2020). *Advancing Thinking Worldwide Critical Thinking What It Is And Why It Counts*. *California Academic Press.*

Fadila, A., Emiliannur, Festiyed, Riyasni, S. (2025). The Importance of Integrating Education for Sustainable Development in Alternative Energy Assessment to Develop Students Critical Thinking Skill. *Pillar of Physics Education, 18*(3), 193-200.

Fadilah, E., Wulan, A. R., Diana, S. (2020). Kontribusi Seesaw Sebagai Assesment for

Learning dalam Mengukur Keterampilan Berpikir (Seesaw's Contribution as an Assessment For Learning in Measuring 21st Century Thinking Skills). *Indonesian Journal of Biology Education*, *3*(2), 51–54.

Fatmawati, A., Dewi, R., Windayani, D. (2024). Penerapan Asessmen Formatif Melalui Padlet untuk Mengintegrasikan Video Musikalisasi Puisi di SMK N 5 Yogyakarta. *Jurnal Pendidikan, Bahasa dan Sastra. 5(01). 1-9.*

Felix, S. M., Lønnum, M., Lykknes, A. (2025). Teachers' Understanding of and Practices in Critical Thinking in the Context of Education for Sustainable Development : A Systematic Review. *Education Sciences*, 15, 1-27.

Hallingfors, H., Astrom Elmersjo, H. (2025). Guarding the Boundaries: A Swedish Policy Debate About Geography and Education for Sustainable Development. *Nordic Journal of Studies in Educational Policy, 11*(3), 1–13.

Hamidah, S. N., Emiliannur, Festiyed, Yumna, H., Hakim, L., Winarno, N. (2023). Needs Analysis of Authentic Electronic Assessment Based on Critical Thinking Abilities Integrated with Education for Sustainable Development in Measurement Topic. *Jurnal Penelitian Pembelajaran Fisika, 9*(1), 71-82.

Hartati. (2022). *Berpikir Kritis dan Kreatif Sekolah Dasar*.Tasikmalaya:Perkumpulan Rumah Cemerlang Indonesia (PRCI).

Hirahmah, A., Yani, I. P. (2024). Critical Thinking Skills in Assessment Essays to Improve Motivation and Learning Outcomes : Bibliometric Analysis. *Jurnal Pijar MIPA, 19*(5) 916–921.

Kelley, T. R., Knowles, J. G., Han, J., Sung, E. (2019). Creating a 21st Century Skill Survey Instrument for High School Students. *American Journal of Educational Research, 7*(8), 583-590).

Kioupi, V. (2019). Education for Sustainable Development: A Systemic Framework for Connecting the SDGs to Educational Outcomes. *Sustainability (Switzerland)* 1-18.

Kurniati, F. I., Ratnaningrum. (2025). Pengembangan E-Asesmen Berbasis Liveworksheet untuk Meningkatkan Hasil Belajar IPAS Siswa Kelas V Sekolah Dasar. *Jurnal Pendidikan MIPA*, *15*(1), 20-30.

Lestari, T., Rosidin, U., Distrik, I. W., Ertikanto, C., Herlina, K. (2025). Analysis of Assessment Instrument Needs to Measure Students Critical Thinking Skills and Self-Efficacy in Physics Learning. *Jurnal Penelitian Pendidikan IPA, 10*(12), 11257–11262.

Munaroh, N. L. (2024). Asesmen dalam Pendidikan : Memahami Konsep , Fungsi dan Penerapannya. *Jurnal Pendidikan Sosial Humaniora, 3*(3), 281–297.

Nasucha, J. A. (2022). Prosedur Pengembangan dan Karakteristik Assesment dalam Pembelajaran. *Jurnal Pendidikan dan Keislaman, 2*(1), 34-40.

Nur, A. R., Haka, N. B., Solviana, M. D., Masya, H. (2025). E-Modul Berbasis Education for Sustainable Development: Membangun Literasi Lingkungan Peserta Didik pada Mata Pelajaran Biologi. *Jurnal Bioterdidik. 5*(1) 44-55.

Nurmaya, E., Rusilowati, A., Sulhadi, S. (2023). Analisis Asesmen Diagnostik Peserta Didik MAN 1 Kab.Semarang untuk Pembelajaran Fisika Berdiferensiasi Materi Teori Kinetik Gas. *Prosiding Seminar Nasional Pascasarjana, 2023, 232-238*

Oktaviawati, D. A., Mufit, F. (2025). Design and Validity of Electronic Assessments to Assess

Students' Critical Thinking Skills on Momentum and Impulse Materials. *Jurnal Penelitian Pembelajaran Fisika, 11*(2), 198–210.

Orhan, A. (2022). Critical Thinking Dispositions as a Predictor for High School Students ' Environmental Attitudes. *Journal of education in Environment and Health, 8*(1), 75-85.

Pratiwi, R. (2024). The Effect of Science Learning on Students' Critical Thinking Ability: A Review. *International Journal of Science Education and Science (IJSES),* 1(1), 1-5.

Pusmenjar. (2020). *Desain Pengembangan Soal Asesmen Kompetensi Minimum.* Kementerian Pendidikan Dan Kebudayaan.

Reffhaug, M. B. A., Lysgaard, J. A. (2024). Conceptualisations of Critical Thinking in Environmental and Sustainability Education. *Environmental Education Research, 30*(9), 1519–1534.

Riduwan. (2019). *Belajar Mudah Penelitian untuk Guru, Karyawan dan Peneliti Pemula*. Bandung: Alfabeta.

Rosnaeni. (2021). Karakteristik dan Asesmen Pembelajaran Abad 21. *Jurnal Basicedu, 5*(5), 4334–4339.

Rieckmann, M. (2018). *Learning to Transform the World: Key Competencies in Education for Sustainable Development.* UNESCO: Paris, France.

Simanjuntak, S., Mulya, H. C., Engry, A., Alfian, I. N. (2025). Dataset of Digital Literacy of University Students in Indonesia. *Data in Brief Journal Homepage.* 58, 111227.

Sinaga, A. V. (2023). Peranan Teknologi dalam Pembelajaran untuk Membentuk Karakter dan Skill Peserta Didik Abad 21. *Journal on Education*, *06*(01), 2836–2846.

Suji, A., Fitriyanto, S., Yahya, F., Arianti, W. R. (2025). Studi Pendahuluan: Identifikasi Problematika dalam Pembelajaran Fisika di MAN 2 Sumbawa Besar. *BIOCHEPHY: Journal of Science Education*, *5*(1), 706–720.

Sukaesih, S. (2023). Mewujudkan Generasi Cerdas, Kompetitif dan Berkarakter pada Abad 21 Melalui Pendidikan Biologi dan Inovasi Riset Berkelanjutan. *Prosiding Seminar Nasional Biologi* , 11, 16-22.

Susanti, W., Sudiansyah. (2024). Meningkatkan Pemahaman Konseptual dan Keterampilan Prosedural Matematika melalui Pendekatan Diferensiasi Berbantuan LKPD Terstruktur. *Jurnal Pendidikan Matematika.* 4(2), 61-63.

Tilbury, D., Wortman, D. (2004). *Engaging People in Sustainability.* IUCN The Word Conservation Union.

Tulvika, N., Ramadhani, W. (2024). Asesmen Keterampilan Berpikir Kritis Peserta Didik SMA pada Materi Fluida Statis Melalui Assessment for Learning. *Jurnal Review Pendidikan dan Pengajaran*, *7*(3), 11455–11466.

UNESCO. (2006). *International Implementation Scheme.* United Nations Decade of Education for Sustainable Development (2005-2014): International Implementation Scheme.

UNESCO. (2017). *Education for Sustainable Development Goals: Learning Objectives*.

Velempini, K. (2025). Assessing the Role of Environmental Education Practices Towards the Attainment of the 2030 Sustainable Development Goals. *17(5):1–20.*

Zubaidah, S. (2016). Keterampilan Abad Ke-21 : Keterampilan yang Diajarkan Melalui Pembelajaran. *2*, 1–17.