

Practicality of Electronic Assessment to Assess Student Critical Thinking Ability on Circular Motion Material

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ABSTRACT

This study is motivated by the importance of critical thinking skills as essential 21st-century competencies that need to be effectively trained and assessed in physics learning, particularly in circular motion material. However, existing assessments are still limited, less interactive, lack contextual representation of real phenomena, and do not provide optimal feedback to measure students' critical thinking abilities. Therefore, this study aims to determine the practicality of an electronic assessment developed to assess students' critical thinking skills on circular motion material. The assessment instrument was developed using Wizer.me and Google Sites platforms by integrating critical thinking indicators proposed by Ennis. This research employed the Development Research method using the Plomp development model combined with Tessmer's formative evaluation, which includes self-evaluation, one-to-one evaluation, and small group evaluation stages. Data were collected through a practicality questionnaire and analyzed using quantitative descriptive methods. The results showed that in the one-to-one evaluation stage, the average practicality score was 81% based on students' responses and 92% based on teachers' responses, both categorized as very practical. In the small group evaluation stage, the average score was 88%, also categorized as very practical. These findings indicate that the developed electronic assessment is easy to use, engaging, efficient, and beneficial in helping teachers assess students' critical thinking abilities. Therefore, this electronic assessment is feasible to be used as an alternative assessment tool in physics learning.



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INTRODUCTION

Critical thinking ability has an important role in the world of education. Critical thinking abilities are important to train students in dealing with problems, providing explanations that underlie reasons, and assessing the information they receive (Savitri & Kholiq, 2023). Critical thinking abilities help students overcome problems both in learning activities and in everyday life (Gunada et al., 2023). This critical thinking involves the ability to analyze, evaluate, and synthesize information, and make decisions based on evidence and logic (Amelia & Chusni, 2024; Azizah & Hidayat, 2024). So, it can be concluded that the ability to think critically is a 21st century ability that is very important in the world of education.

The development of critical thinking abilities is fundamentally intertwined with the process of learning physics. As stated by the Ministry of Education and Culture, the objective of physics instruction is to deepen students' understanding of the fundamental laws governing

the universe, thereby facilitating the cultivation of critical thinking competencies. Within the framework of physics education, learners are systematically trained to engage in scientific reasoning, analytical thinking, and effective problem solving (Kemendikbud, 2022). The necessity for such competencies arises from the demands placed upon students to respond adaptively and resolve various conceptual and practical challenges encountered during physics instruction (Putri et al., 2023). Accordingly, the study of physics holds a pivotal role in fostering critical thinking abilities that are transferable to everyday problem-solving contexts. Physics education extends beyond the transmission of theoretical knowledge, incorporating hands-on experimentation as a means to sharpen analytical skills within real-life scenarios (Atika & Mufit, 2024). In view of this, it is evident that critical thinking constitutes an essential dimension in the pedagogy of physics learning.

Critical thinking abilities can be assessed through learning assessments. Critical thinking assessment is needed to determine the extent of critical thinking abilities of school students. Assessment has an important role in assessing critical thinking abilities, because it can provide information about the extent to which students master these abilities. Assessment is an integral component of learning in schools that has. It plays a crucial role in measuring student achievement and improving the overall educational process (Arta, 2024). Assessment is carried out to find evidence or a basis for consideration of the achievement of learning objectives (Anggreana et al., 2022). Assessments that pay attention to principles that include validity, reliability, and practicality need to be developed so that the assessment results can provide an accurate picture of student abilities (Arta, 2024). Therefore, a good assessment can be used to assess students critical thinking abilities.

Along with technological advances, e-assessment offers a new approach that is more flexible and contextualized in measuring critical thinking abilities. Electronic assessment is an attempt to integrate technology in the assessment process, which is in accordance with the characteristics of 21st century learning (Suryati & Mufit, 2024). Assessments that use electronic media make assessment more interesting, more accessible, and easier to understand (Dirman & Mufit, 2022). Electronic assessments enable the development of questions based on real-life phenomena, present dynamic visualizations, and provide instant feedback (Ashari et al., 2023). This previous research supports that electronic assessment has many benefits and needs to be developed.

The results of the preliminary study indicate that the questions used in schools have not yet fully measured students' critical thinking skills. The instruments used to assess these skills were found to be in the form of questionnaires given to students, rather than direct critical thinking test items. In physics learning, several critical thinking assessments have been developed in previous studies. Assessments for static fluid material were developed by Rosdiana et al (2019) and Nurazizah et al (2024), electrical material by Murdani (2021), straight motion material by Yuliantaningrum (2020). It can be seen that there have been several assessments developed by previous researchers for physics material. Especially in circular motion material, researchers found that the assessment had already been developed. The assessment was developed by Lesmana (2022) with essay-shaped questions that are carried out online but the application used is not explained. Then Nyeneng (2022) developed essay-shaped assessment questions using *Google Form*. *Google Form* does not yet have a feature to use video and cannot provide *feedback* to students. So, there is still a need to develop assessments that provide *feedback* to students after doing the questions.

This study aims to examine the practicality of a developed electronic assessment instrument intended to evaluate students' critical thinking abilities in the context of circular motion. The assessment's practicality is appraised based on its ease of use, time efficiency, level of engagement, and perceived benefits. Drawing upon Ennis' critical thinking indicators (Ennis, 2011) the assessment tasks are designed to elicit students' deep comprehension of

physical phenomena, foster analytical reasoning across interrelated concepts, and encourage evidence-based problem-solving. The novelty of this study resides in its use of authentic, real-world phenomena (e.g., carousels, bicycles, and electric fans) integrated with critical thinking indicators into an interactive electronic assessment format, implemented within senior high school physics instruction. Compared to traditional paper-based assessments, the electronic version offers enhanced conceptual visualization through integrated video media. The contextually grounded illustrations embedded in the tasks provide a more engaging and meaningful learning experience for students (Ashari et al., 2023). The incorporation of diverse digital platforms and web-based tools into the assessment design represents an educational innovation, addressing the need for adaptable learning tools aligned with the competencies required in the 21st century (Meccawy et al., 2021). It also responds to the limitations of conventional assessments, which often struggle to depict physical phenomena authentically and lack flexibility in administration and management.

In light of this background, the research question posed is: How practical is the electronic assessment in evaluating students' critical thinking abilities in circular motion? This study seeks to identify and describe the assessment's practicality from the perspective of its users and the instructional context in which it is applied. The research is expected to lay the groundwork for developing innovative and contextually relevant assessment instruments, and to offer actionable insights for educators in implementing evaluations that are not only efficient but also pedagogically meaningful.

METHODS

This study is a type of development research aimed at developing and validating a product to ensure its feasibility for use. The research is designed based on the Plomp development model. The Plomp model consists of three stages: (1) the preliminary research stage, which includes needs analysis and literature review; (2) the prototyping stage, which involves product design, development, evaluation, and revision; and (3) the assessment stage, which involves field testing to obtain valid and feasible test items. Through these stages, the resulting product is expected to have high quality and be aligned with learning needs.

In the preliminary stage, the researcher analyzes needs and proposes solutions through a literature review. The needs analysis is conducted to identify the problems faced by teachers in assessing students' critical thinking skills in physics learning. This needs analysis is carried out through interviews with physics teachers to understand how the assessment of students' critical thinking skills is implemented. The results of this analysis then serve as the basis for designing the development of an assessment that is appropriate to field conditions.

In the prototyping phase, the researchers designed an electronic assessment tool targeting students' critical thinking capabilities. This phase encompassed iterative cycles of evaluation and refinement to ensure the production of a high-quality instrument. Various instruments were utilized, including self-assessment checklists, expert validation forms, and practicality questionnaires for both individual and small-group testing. Initially, the prototype underwent a detailed formative evaluation by the researcher, aligning its features with established theoretical frameworks and expert recommendations.

Following revisions, the electronic assessment instrument specifically tailored to the topic of circular motion was subjected to expert validation. The validation process involved three lecturers from Universitas Negeri Padang with recognized expertise in educational assessment. The validity of the product was quantitatively assessed using Aiken's V formula, which measures the content relevance of each item as rated by multiple experts. Four domains

were scrutinized during this validation: content accuracy, visual communication, instructional design, and technological appropriateness.

The resulting data were analyzed according to Aiken’s validity index to determine both content feasibility and construct adequacy. Items rated within the high validity range advanced directly to the practicality evaluation stage. During the practicality testing phase, both one-to-one and small-group evaluations were undertaken. This stage sought to determine how effectively the electronic assessment could be deployed in authentic educational settings by both students and teachers. The one-to-one trial involved three 11th-grade students (Phase F) from SMA Negeri 1 Lareh Sago Halaban, purposefully selected to reflect high, medium, and low ability levels. Each student completed the assessment independently while being observed to capture data related to usability, engagement, efficiency, and utility. These observations informed refinements to the interface, question clarity, and user interaction.

Subsequently, a small group evaluation was conducted with nine students of diverse academic profiles to simulate a more realistic classroom environment, albeit on a limited scale. Feedback from this stage focused on the same four dimensions usability, appeal, efficiency, and perceived benefit and was instrumental in gauging the practical utility of the assessment from an end-user standpoint. The overall practicality index of the developed electronic assessment was then analyzed using user feedback data. Dimensions considered included operational simplicity, time efficiency, engagement level, and instructional value. To quantitatively interpret this data, a percentage-based scoring formula was applied, as outlined in Equation 1.

$$Value = \frac{value\ obtained}{B_{Maximal\ skor}} \times 100 \tag{1}$$

The score obtained comes from the results of the practicality questionnaire filled out by students and teachers after using the electronic assessment. Each statement item in the questionnaire uses a Likert scale from 1 to 5. The total score is calculated based on the accumulation of respondents' answers, with the practicality category detailed in table 1.

Table 1 Practicality Categories

Value (%)	Category
81-100	Very Practical
61-80	Practical
41-60	Practical enough
21-40	Less Practical
0-20	Not Practical

Source: (Khairul Anshari et al., 2019)

The last stage is a field trial which aims to determine the feasibility of the product after being validated by experts. At this stage of the trial, an assessment of the content construct validity, reliability, distinguishing power, difficulty level of the questions, and analysis of the results of students' critical thinking abilities was carried out. So as to obtain an assessment that is valid, reliable, difficulty level and good differentiation and can be used to assess students' critical thinking abilities.

RESULTS AND DISCUSSION

Results

One to One Evaluation

The one-to-one evaluation stage aims to evaluate the practicality of the electronic assessment through direct interaction with three students who have different ability levels high, medium, and low. Each student was asked to work on the assessment independently. After students use the electronic assessment, they are asked to fill out a questionnaire consisting of four aspects of assessment. The four aspects are convenience, attractiveness, efficiency and benefits. Based on the results of the *one-to-one* practicality test, the findings are detailed in Table 2.

Table 2. Questionnaire Results of One-to-One Evaluation

Aspects assessed	Practicality results (%)	Category
Ease	80	Practical
Attractiveness	80	Practical
Efficiency	77	Practical
Benefits	87	Very Practical
Overall average	81	Very Practical

Table 3 presents a summary of the practicality questionnaire results based on four primary dimensions. The dimensions of *usability* and *engagement* each garnered a score of 80%, which falls under the practical classification. The *efficiency* dimension yielded a slightly lower score of 77%, yet remained within the same category. Notably, the *perceived utility* aspect received the highest score at 87%, thereby qualifying as highly practical. On average, the overall practicality score across all measured aspects was 81%, indicating that the electronic assessment tool is considered highly practical. These findings suggest that the developed assessment is well-suited for individual use by students and holds substantial promise for broader application in instructional settings.

While the student was using the assessment, the researcher observed the student. The researcher identified the difficulties faced by the student during the use of the assessment. The observed aspects include ease, attractiveness, efficiency and usefulness. The following is a summary of the results of the observations of the three students in the form of table 3.

Table 3. Observation Results of One-to-One Evaluation

Student A	Observation result	
	Student B	Student C
The student was able to use the assessment easily and immediately understood the workflow.	The student found it fairly easy to use, though was initially confused.	The student initially had difficulty, but was able to understand after receiving an explanation.
The student was interested in using the assessment.	The student was interested in using the assessment.	The student was interested in using the assessment.
The student quickly understood how to use the assessment.	The student needed time to understand how to use the assessment.	The student needed time to understand how to use the assessment.

Based on the data in Table 3, it can be seen that the developed electronic assessment demonstrates a fairly good level of ease of use, although there are differences in initial understanding among students. Student A was able to use the assessment very easily and immediately understood the workflow, while Students B and C required an adaptation period, especially at the beginning. In terms of attractiveness, all students showed high interest in using the assessment, indicating that its design and presentation can enhance learning motivation. Regarding efficiency, not all students were able to quickly understand how to use the assessment, suggesting that clearer instructions are needed to make the process more effective. In terms of usefulness, the assessment was able to encourage deeper thinking, help students relate physics concepts to real-life situations, and support a more concrete understanding of circular motion. Overall, these results indicate that the developed assessment is practical, engaging, and beneficial, although improvements are still needed, particularly in enhancing ease of use for students with different ability levels.

In addition to the one-to-one evaluation involving students, a practicality assessment was also conducted with the participation of teachers, who serve as facilitators and evaluators of the assessment process. Teachers were invited to complete a practicality evaluation questionnaire based on the same four criteria: ease of use, attractiveness, efficiency, and perceived benefit of the developed electronic assessment. The outcome of the teacher responses is summarized in Table 4.

Table 4. Results of Evaluation Questionnaire Analysis for Teachers

Aspects assessed	Practicality results (%)	Category
Ease	93	Very Practical
Attractiveness	91	Very Practical
Efficiency	91	Very Practical
Benefits	93	Very Practical
Overall average	92	Very Practical

Based on Table 4, all aspects scored above 90%, indicating a very high level of practicality. The ease and usefulness aspects each scored 93%, while the attractiveness and efficiency aspects each scored 91%. The overall average of the four aspects is 92%, which falls into the very practical category. These results show that from the teacher's perspective, the developed electronic assessment is very feasible to use in the learning process because it is easy to use operated, interesting, efficient, and provides significant benefits in assessing students critical thinking abilities.

In the practicality test to the teacher, several suggestions were obtained for the electronic assessment product. Based on the suggestions given by the teacher, revisions were made to the electronic assessment. The teacher suggested adding navigation buttons on each page. The following results of the improvements made can be seen in Figure 3 before and Figure 4 after repair.



Figure 3. Before Navigation Buttons Were Added to Each Page.



Figure 4. After Navigation Buttons Were Added to Each Page.

In Figure 4, revisions were made by adding a navigation menu to improve usability for students. This addition aims to make the electronic assessment easier to navigate. To support this, navigation buttons such as “Next,” “Previous,” and “Back to Home” were included. These buttons allow students to move between pages more efficiently during the assessment process. As a result, students can access different sections, including returning to the main page, without having to manually reload the page.

Small Group Evaluation

The practicality test continued at the small group evaluation stage involving nine students from various academic ability backgrounds. The evaluation was conducted by asking students to use the electronic assessment and respond to four aspects of practicality, namely ease, attractiveness, efficiency, and benefits. Presented below are the analytical results of the small group evaluation questionnaire as summarized in Table 5.

Table 5. Results of The Small Group Evaluation Questionnaire Analysis for Students

Aspects assessed	Practicality results (%)	Category
Ease	84	Very Practical
Attractiveness	86	Very Practical
Efficiency	89	Very Practical
Benefits	82	Very Practical
Overall average	88	Very Practical

Overall, the assessment obtained an average practicality score of 88%, which indicates that this electronic assessment is very practical to use in learning, both in terms of ease of access

and use, attractive appearance, time efficiency, and benefits in assessing students' critical thinking abilities. These results strengthen the previous findings in the *one to one* test, and show that this assessment is feasible to be used on a wider scale.

At the small group evaluation stage, there were also several revisions to improve the electronic assessment product. This input was obtained from comments and suggestions given by students. The following is a table of comments and suggestions given by students after using the electronic assessment in table 6.

Table 6. Comments And Suggestions for The Small Group Stage

Respondent	Comment	Suggestion
S 1	The assessment contains images and videos, making it more interesting.	Add more time to complete the assessment.
S 2	This electronic assessment is effective for assessing students' critical thinking skills. The questions stimulate student analysis.	Provide feedback.
S 3	This assessment is very beneficial.	Provide space for reasoning (add more time for completion).
S 4	The electronic assessment is easy to understand.	-
S 5	The electronic assessment is easy to use and understand.	Ensure the assessment does not lag or encounter errors during use.
S 6	The questions are easy to understand due to the presence of images and videos.	Use a web platform with features that block access to Google searches during the assessment.
S 7	Overall, the electronic assessment provides ease and flexibility.	Use more varied question types, such as multiple choice.
S 8	The electronic assessment is quite effective in assessing students' critical thinking skills.	Simplify the instructions to make them easier for students to understand.
S 9	The questions encourage deeper thinking.	The questions should not be too difficult.

Based on the responses from the nine students who became respondents, the electronic assessment developed generally received positive responses, especially in terms of visual appearance, ease of use, and its effectiveness in assessing students' critical thinking abilities. Some students stated that the assessment became more interesting because it presents images and videos that are relevant to the context of the question. This visualization also helps students understand the questions more easily. Other students stated that the assessment was effective in triggering critical thinking abilities, as the questions were designed to encourage analysis and deep thinking. In addition, electronic assessments are considered to provide convenience and flexibility in the process.

However, some suggestions for improvement were also made. Some students suggested increasing the processing time so that they have more space to think, especially when they have to provide in-depth reasoning. Other suggestions included providing feedback on students' answers, simplifying the question instructions to make them easier to understand. Feedback from the assessment can be received by students after the teacher has finished checking students' answers. The following is the feedback display for students in

Figure 5.

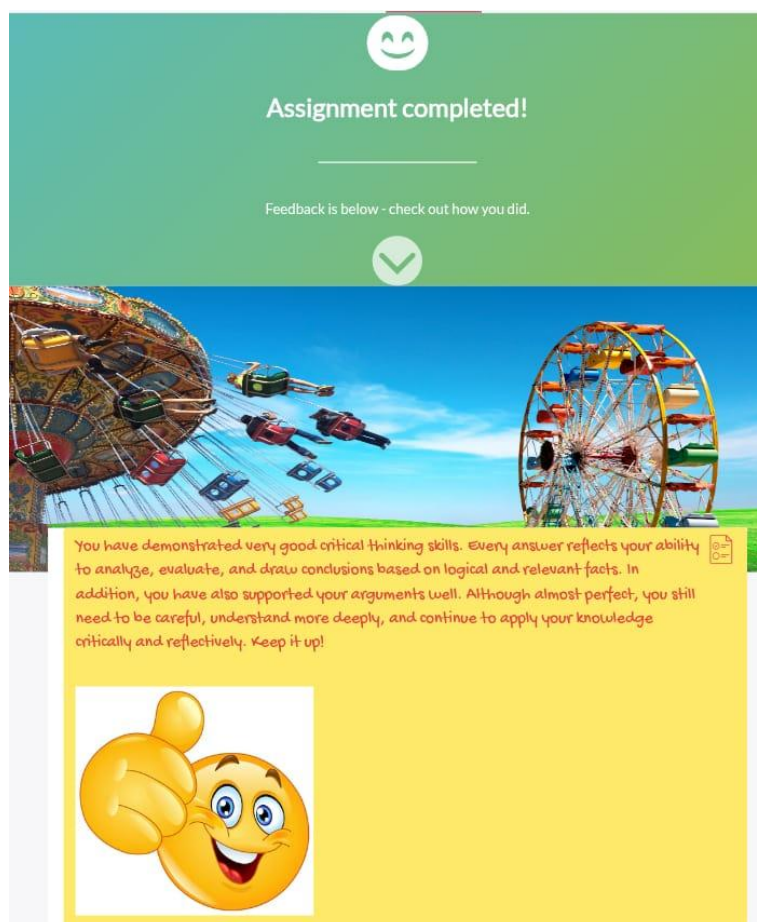


Figure 5. Feedback after Students Take the Assessment

Overall, the assessment results show that the instrument used has high practicality. Students can understand the instructions and context of the questions well, and are able to provide appropriate answers without experiencing significant confusion. The processing time was also within reasonable limits, and the question format, both description and contextual phenomenon-based, proved to encourage active student involvement. Thus, this instrument is can use in the learning and evaluation process to measure students' critical thinking abilities effectively and efficiently.

Discussion

The practicality evaluation of the developed electronic assessment shows positive results, reviewed from four aspects: ease of use, attractiveness, time efficiency, and the benefits of assessment. These four aspects reflect the extent to which the assessment can be used effectively and comfortably by students in the context of physics learning. The following is a discussion of each aspect:

Ease of Use

In terms of ease of use, this assessment is designed with a user-friendly interface that allows students to access and complete it independently. Students with varying levels of technological proficiency were able to complete the assessment, with most requiring no assistance and only a few needing minimal initial guidance. This aligns with previous research (Dirman & Mufit, 2022), which states that the use of electronic media makes assessment more engaging, more accessible, and easier to understand. This indicates that the assessment can be widely used by students from diverse technological backgrounds.

Attractiveness

From the attractiveness aspect, the use of engaging and contextual visual elements in this assessment successfully increases student interest and motivation. Visuals relevant to real-life contexts help students better understand the material. This finding is supported by prior research, which states that an attractive interface can enhance student engagement in digital learning environments (Kori Sundari et al., 2024). The use of visually appealing and contextual elements in electronic assessments can boost students' interest and motivation. This aligns with the study by Purwaningsih et al. (2023), which showed that appealing visual designs in learning modules can increase students' learning interest. This proves that assessments with attractive appearances can enhance students' willingness to complete them.

Efficiency

Regarding efficiency, the average time required by students to complete the diagnostic assessment ranges from 30 to 45 minutes. For the summative assessment, more time is needed, around 1 to 1.5 hours. This duration aligns with regular classroom learning time. This indicates that the assessment is efficient and can be easily integrated into classroom activities (Kori Sundari et al., 2024). This is also in line with the findings of previous research (Ariska et al., 2021), which demonstrated the practical use of assessments in terms of time and ease.

Usefulness

In terms of usefulness, students receive feedback from their completed work. This provides an interactive and enjoyable experience in working through the assessment. This is consistent with Mufit et al., (2023), who stated that well-designed software can provide meaningful feedback to users. The feedback in this online assessment can be delivered in real time, allowing students to immediately see their results (Strzelecki, 2023). These previous findings reinforce the results of this study on the practicality of the developed electronic assessment.

Overall, these findings corroborate the results of the one-to-one evaluation stage and show that the e- assessment developed is not only practical in terms of technical use, but also has educational value, increasing the attractiveness and relevance of learning. This innovation stands out from conventional assessments because it incorporates elements of user friendliness, contextualization of materials, and encouragement of higher order thinking. This research contributes to the development of digital-based assessments that are not only practical but also educative. Efficient and easy to use, but also effective in supporting the development of students' critical thinking abilities in challenging physical materials such as circular motion.

CONCLUSION

Based on the results of the practicality test, it can be concluded that the electronic assessment to assess students' critical thinking ability on circular motion material developed has a high level of practicality. In the one-to-one evaluation test, the practicality results showed 80% in the aspect of convenience, 80% for attractiveness, 77% for the efficiency aspect and 87% in the benefit aspect. Then for the practicality test to the teacher, 93% was obtained in the aspect of convenience, 91% for attractiveness, 91% for the efficiency aspect and 93% in the benefit aspect. Furthermore, the practicality results in the small group evaluation test showed 84% in the aspect of convenience, 86% for attractiveness, 89% for the efficiency aspect and 82% in the benefit aspect. The results of this practicality test show that students can easily understand the instructions, clarity of the context of the phenomena used, time efficiency and assessment utilization. In addition, questions based on real phenomena are proven to facilitate students to think critically actively. Thus, this electronic assessment can be used to support the evaluation of critical thinking skills in the topic of circular motion effectively and efficiently.

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