Journal of Innovative Physics Teaching
Volume 3, Issue 1 June 2025, 80 - 93
ISSN: 3021-8551 (Online)
Doi: https://doi.org/10.24036/jipt/vol3-iss1/89
https://jipt.ppj.unp.ac.id/index.php/jipt

Design and Validity of Electronic Assessments to Assess Students Critical Thinking Abilities on Circular Motion Materials

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Article Info

Article history:

Received May 23, 2025
Revised June 01, 2025
Accepted June 29, 2025

Keywords:

Validity
Electronic assessment
Critical thinking
Circular motion

ABSTRACT

Critical thinking abilities are one of the essential 21st-century abilities that students must possess. These abilities are important for training students to deal with problems, provide reasoned explanations, and evaluate the information they receive. Critical thinking abilities can be measured using appropriate assessments. However, the availability of assessments to evaluate these abilities is still limited. Therefore, the purpose of this study is to develop an electronic assessment to measure students critical thinking abilities in the topic of circular motion that meets good validity criteria. This research is a type of Research and Development (R&D) using the Plomp development model. In this study, 45 assessment items were developed, consisting of 15 diagnostic questions and 30 summative questions. The results showed that the electronic assessment developed had a validity score of V=82 for the diagnostic assessment. The validity score for the summative assessment was V=81, both categorized as very valid. Based on these results, it can be concluded that the electronic assessment for evaluating students critical thinking abilities in circular motion has met the criteria for good validity and can therefore be used to assess students critical thinking abilities effectively.

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INTRODUCTION

Along with the times, students are required to master 21st century abilities. The 21st century abilities are basic abilities that every individual must have in order to compete globally (Mufit et al., 2023). One of the key competencies essential in 21st-century education is the ability to think critically. Critical thinking abilities are important to train students to deal with problems, provide explanations based on reasoning, and assess 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). 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). The low level of critical thinking abilities is caused by several factors, one of which is that students tend to memorize material and formulas rather than understand the concepts (Arif et al., 2019). Therefore,

students low critical thinking abilities can be stimulated by providing higher order thinking questions.

Critical thinking abilities are closely intertwined with physics education. Critical thinking abilities are very important for students, especially in physics learning (Gunada et al., 2023).These abilities are essential because students are expected to respond thoughtfully and solve problems that arise during physics learning (Putri et al., 2023). Physics not only introduces theoretical concepts but also includes hands-on experiments that serve as a medium for developing critical thinking in real-life contexts (Atika & Mufit, 2024). Therefore, it can be concluded that critical thinking plays a significant role in physics education.

Critical thinking abilities can be evaluated through learning assessments. Assessing students critical thinking is necessary to determine their level of mastery. Assessment serves a vital role in this process by providing data on student cognitive abilities. As a fundamental component of the school learning system, assessment helps measure student achievement and enhances the overall educational process (Arta, 2024). The goal of assessment is to gather evidence that informs the extent to which learning objectives are achieved (Anggreaena et al., 2022). Effective assessments must meet key criteria such as validity, reliability, and practicality to ensure that the results accurately reflect student abilities (Arta, 2024). A well designed assessment tool should demonstrate strong validity (Sanjaya et al., 2024), making it suitable for evaluating students critical thinking.

However, the implementation of assessments targeting critical thinking remains suboptimal. Although teachers are making efforts to foster critical thinking in schools, assessment practices specifically aimed at measuring such abilities are still lacking (Nurazizah et al., 2024). Research suggests that many teachers have limited understanding of proper assessment principles, leading to ineffective evaluation practices (Arta, 2024). This highlights the need for appropriate assessments that can genuinely measure students critical thinking abilities in school settings.

Interviews with three physics teachers at SMA N 1 Lareh Sago Halaban revealed that current assessments used in physics classes do not effectively measure students critical thinking. Most existing tools consist of surveys or questionnaires that assess student perceptions of learning rather than test their critical thinking directly. One key reason for the lack of such assessments is the difficulty teachers face in designing questions that target critical thinking abilities. Another finding was that current school assessments are still predominantly paper-based and conducted manually, despite the shift toward digital tools and ICT integration in modern education.

The results of the analysis of the assessments used by teachers in schools show that not all critical thinking indicators can be measured through the current assessment questions. Although the questions provided involve material comprehension, they mostly focus on memorization and mathematical calculations. Calculation-based questions have limitations in measuring critical thinking abilities. These types of questions tend to focus on performing calculations and solving problems, with less emphasis on essential critical thinking aspects such as analyzing, evaluating, and drawing conclusions (Rochayanah & Kristina, 2024). When working on these types of questions, students are more inclined to memorize physics equations and solve problems according to existing formulas (Sundari & Sarkity, 2022). Such questions are more directed toward testing knowledge rather than assessing critical thinking ability.

In physics learning, there are several critical thinking assessments developed in previous studies. The assessment for static fluid material was 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) develop assessment questions in the form of essays using Google Form. Google Form does not yet have a feature to use video and cannot provide feedback to students. This highlights the importance of developing assessments that supply feedback to students after they work on the tasks.

To address the issues identified in the preliminary research, it is necessary to develop an assessment that effectively measures students critical thinking abilities in physics learning, particularly on the topic of circular motion. Circular motion is a key component of the kinematics chapter in physics and requires a deep conceptual understanding. It integrates several fundamental physics concepts, such as displacement, velocity, acceleration, and the forces acting on objects moving in circular paths (Amalia et al., 2021). This topic is particularly suited for assessing students critical thinking because of its conceptual complexity and demand for analytical reasoning. Engaging with this material allows students to strengthen and demonstrate their critical thinking abilities (Fajria et al., 2023). As such, circular motion provides an effective context for evaluating students critical thinking in physics.

The assessment developed takes the form of essay questions based on specific critical thinking indicators. Critical thinking encompasses abilities such as analysis, evaluation, drawing conclusions, deduction, and induction (Rahmi et al., 2024). For this study, the assessment is built around 13 indicators of critical thinking proposed by Ennis (2011), which are reflected in the essay format questions. Essay assessments are particularly valuable because they allow students to demonstrate how they collect, organize, synthesize, and critically examine knowledge. They encourage deeper cognitive engagement, enabling the evaluation of students reasoning processes and higher-order thinking abilities (Amanda et al., 2023). Moreover, essay-type questions prompt students to apply their understanding independently when constructing responses (Festiyed, 2017). Therefore, essays are an effective tool for measuring students critical thinking abilities.

The assessment is designed in an electronic format to take advantage of technological advancements in education. Prior research has shown that electronic media have not yet been fully utilized in assessment practices (Suryati & Mufit, 2024). However, educational institutions are increasingly expected to adopt innovative approaches in response to technological progress. According to Fu'ad et al. (2022), e-assessment can enhance both teachers' and students proficiency in critical thinking, innovation, and digital literacy. Electronic assessments are considered more relevant and practical, enabling more efficient and effective evaluation processes for educators and institutions (Ashari et al., 2023). Therefore, incorporating technology into the assessment is expected to improve its ability to measure critical thinking, particularly in the context of circular motion.

In light of the identified challenges, this study aims to design and validate an electronic assessment to evaluate students critical thinking abilities related to circular motion. The goal of this research is to produce an effective and valid assessment tool that accurately captures student levels of critical thinking. Additionally, it is hoped that the findings will support teachers in conducting more meaningful assessments and encourage students to become more engaged and reflective in learning about circular motion.

METHODS

The type of research conducted is Research and Development which is used to develop and validate the product so that it is suitable for use. This research was designed based on the Plomp development model. The Plomp model has three stages, namely: (1) preliminary research stage, at this stage a needs analysis and literature review are carried out, (2)

prototyping stage, at this stage design, product design, evaluation, and revision are carried out, (3) assessment stage, at this stage field trials are carried out to obtain questions that are valid and feasible to use.

At the preliminary research, the researchers identified existing needs and formulated potential solutions through a literature review. The needs analysis aimed to uncover challenges faced by teachers in evaluating students critical thinking abilities in physics education. This analysis was carried out by conducting interviews with physics teachers to understand how assessments of students critical thinking are currently implemented. During this preliminary research phase, an interview guide served as the research instrument. Interviews were conducted with three physics teachers at a senior high school in Lareh Sago Halaban. The collected interview data were then processed and analyzed using a qualitative approach.

In the prototype stage, researchers design electronic assessments to assess students critical thinking abilities. Then conduct evaluations and revisions to produce high-quality products. At this stage, self-evaluation sheets, validation sheets by experts, and practicality sheets for individual and small group trials were used. This prototype was first formatively evaluated by the researcher himself, in detail on the product that had been made, and adjusted to the theory of the previous experts.

After making revisions to the electronic assessment designed to evaluate critical thinking abilities on circular motion topics, the assessment was then validated by experts. Three physics lecturers from UNP, who specialize in assessment, conducted the validation. The validity data of the electronic assessment was analyzed using the V-Aiken formula. The evaluation of the product's validity covered four key areas: content quality, visual communication, instructional design, and software usage. The assessment used a Likert scale ranging from 1 to 5, as shown in Table 1.

Table 1. Likert scale

Likert scale	Category
1	Strongly disagree
2	Disagree
3	Undecided
4	Agree
5	Strongly agree

Source: (Sugiyono, 2017).

The data obtained were analyzed with the validity index proposed by Aiken. Validity was carried out on the aspects of content validity and construction validity. The V Aiken formula is used to determine the content validity coefficient based on the assessment results of n experts on an item. Aiken's formula used is equation 1.

$$V = \frac{\sum s}{n(c-1)}$$
$$s = r - l_0 \qquad (1)$$

Description:
V = Rater agreement index
l0 = Lowest validity rating (in this case = 1)
c = Highest validity rating (in this case = 5)
r = Number given by a rater
n = Number of raters

After obtaining the rater agreement index, the category of the index value is decided. The results of the category decision based on Aiken's V Index as in Table 5.

Table 2. Decision Based on Aiken's V Index

Interval	Category
≤ 0,4	Invalid
0,4 < V ≤ 0,8	Valid
V > 0,8	Highly valid

Source: (Retnawati, 2016)

Item validity based on Aiken's V index can be classified into three categories, namely less, medium, and high. If the Aiken's V value is at or below 0.4, then the item is in the less category, which means its validity is low and not suitable for use so that it requires a thorough revision. If the Aiken's V value is between 0.4 and 0.8, then the item is categorized as moderate. In this category, the item can still be used but should be revised to improve its clarity and quality. Meanwhile, if the Aiken's V value exceeds 0.8, then the item has high validity and is considered suitable for use in assessment without the need for major revisions. Question items with this high category can also proceed directly to the practicality test stage.

The last stage is the 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, differentiating power, level of difficulty of the questions, and analysis of the results of students critical thinking abilities were carried out. However, in this study, researchers limited it to the formative evaluation stage, namely only validation by experts.

RESULTS AND DISCUSSION

Results

Based on the research that has been conducted, the results of the research in the preliminary research and prototyping stages, which include needs analysis, electronic assessment design, self-evaluation, and expert review.

Needs Analysis

During the initial research phase, a preliminary study was carried out, which involved analyzing the use of assessments in educational institutions. The preliminary research on educators was carried out via interviews with three physics instructors at SMA N 1 Lareh Sago Halaban. In the preliminary research stage, an initial study was conducted in the form of an analysis of assessment practices in schools. This initial study involved interviews with three physics teachers at SMA N 1 Lareh Sago Halaban. The purpose of the interviews was to understand how assessments are implemented at the school. The results of the interviews with the three teachers were as follows: (1) the assessment questions used in the school are still focused on mathematical calculations and memorization, (2) teachers rarely assess students critical thinking abilities, (3) there is a lack of electronic assessments available to evaluate students critical thinking abilities in circular motion topics, (4) there is limited use of technology for electronic assessments, (5) students critical thinking abilities remain low, and (6) the questions used by teachers do not yet include indicators of critical thinking abilities. According to the findings from the teacher analysis, it is essential to create assessments that aid teachers in evaluating students critical thinking abilities, particularly concerning circular motion topics.

Then, a document analysis was conducted on the assessment questions used by teachers in the school. The assessments used in the school were in the form of multiple-choice

questions. These assessment questions only required students to perform calculations using mathematical formulas. This is supported by the research of Rochayanah (2024), which states that these questions tend to focus on calculating and solving problems, with less emphasis on important aspects of critical thinking such as analyzing, evaluating, and concluding. When working on the questions, students tend to memorize physics equations and solve problems according to the given formulas (Sundari & Sarkity, 2022). Clearly, such questions are not yet capable of measuring students critical thinking abilities.

Additionally, a literature review was carried out to assess the level of students critical thinking abilities. The findings indicated that students critical thinking abilities remain relatively low. Several studies have reported that these abilities generally fall within the moderate to low range. For example, research by Asniar et al. (2022) found that 67 students, or 53.6%, scored in the low category for critical thinking when solving physics problems. Similarly, Amelia and Chusni (2024) reported that most students demonstrated low critical thinking abilities, with 24.2% classified as low, 20% as medium, and 20.3% as high. Furthermore, Nurazizah et al. (2024) noted that students scored very low in providing simple explanations, low in building basic abilities, very low in drawing conclusions, and very low in offering further explanations.

These findings highlight the ongoing need for assessments specifically designed to evaluate and improve students critical thinking abilities. In response to these issues identified in the preliminary research, it is necessary to develop a solution. Creating an assessment tool can support teachers in evaluating students critical thinking abilities related to circular motion topics. The assessment was designed in essay format using the platforms Google Sites and Wizer.me.

Prototyping Stage

The results obtained at this prototype stage are in the form of assessment product design, self-evaluation, and expert review. The product design is an electronic assessment to assess students critical thinking abilities on circular motion material. There are two assessments developed, namely diagnostic assessments and summative assessments. Diagnostic assessments are given before students learn. Summative assessment is given when students have learned the material. The assessments are made in the form of essays that develop based on critical thinking indicators according to Ennis (2011). The assessment was developed using google sites and Wizer.Me website. This prototype design is also equipped with question grids, answer keys, and scoring guidelines. The electronic assessment was designed based on the question grids as well as the circular motion materials that students learn at school. The design was further developed to ensure that students are more interested in using this electronic assessment. The following is a look at the electronic assessment developed on Wizer.me in figures 1(a) and 1(b).

Figure 1(a). Diagnostic Assessment Interface

Figure 1(b). Summative Aassessment Interface

Next, the electronic assessment was integrated into a single website using Google Sites. This was intended to make it easier for students to access the assessment without having to switch between websites. The Google Sites page includes several menu options: a menu for students and a menu for teachers. The menu contains usage instructions, the assessment blueprint, assessment questions, and scoring guidelines. The student menu only includes usage instructions and the assessment itself. To prevent students from logging into the teacher menu, it was designed to require special access. The appearance of the teacher and student menus can be seen in Figures 2 and 3.

Figure 2. Teacher Menu Interface

Figure 3. Student Menu Interface

Formative Evaluation Results: Self-Evaluation Results

After the assessment prototype was developed, a formative evaluation was conducted in two stages: self-evaluation and expert review. The self-evaluation is an assessment carried out by the researcher to evaluate the completeness and suitability of the electronic assessment developed to measure students critical thinking abilities on the topic of circular motion. This self-evaluation stage was conducted before the product was reviewed by validators for validation. During this stage, the researcher read through the materials, checked for completeness, revised errors, and added any missing parts. The indicators assessed in the self-evaluation covered four aspects: the structure of the assessment, the content feasibility, the language, and the visual appearance.

Formative Evaluation Results: Content Validity Test Results by Experts

Expert Review is the stage of validity testing conducted by experts. The validation of the electronic assessment to measure students critical thinking abilities on the topic of circular motion was carried out by three physics lecturers from UNP. The results of this validation serve as a guideline for revising the product and determining the feasibility of the developed assessment. The product validation instrument consists of four aspects, material, instructional design, visual communication, and software utilization. After the validators assigned scores to the electronic assessment, data analysis was conducted to determine the assessment's validity. Based on the evaluation instrument used, the validation scores for all four aspects were analyzed. The validity test data based on the assessment aspects were analyzed using Aiken's V formula for each item. The assessment consisted of four aspects with a total of 15 evaluation indicators.

The validation of the electronic assessment to evaluate students critical thinking abilities on the topic of circular motion was carried out by three physics lecturers from UNP. The results of this validation were used as a guide for revising the product and determining the feasibility of the developed product. The product validation instrument consisted of four aspects, material, instructional design, visual communication, and software utilization. The validation results from the three experts, including feedback and suggestions to be considered for revision, are presented in Table 3.

Table 3. Results of Validation Diagnostic Assessment

Item No.	V Value				Average	Category
	Content Substance	Instructional Design	Visual Communication	Software Utilization		
A1	0.79	0.7	0.83	0.88	0.8	Moderate
A2	0.77	0.72	0.83	0.88	0.8	Moderate
A3	0.8	0.72	0.83	0.88	0.8	Moderate
A4	0.79	0.75	0.83	0.88	0.8	Moderate
A5	0.79	0.7	0.83	0.88	0.8	High
B1	0.81	0.72	0.83	0.88	0.81	High
B2	0.81	0.75	0.83	0.88	0.81	Moderate
B3	0.8	0.7	0.83	0.88	0.8	High
B4	0.81	0.72	0.83	0.88	0.81	High
B5	0.82	0.75	0.83	0.88	0.82	High
C1	0.85	0.8	0.83	0.88	0.85	High
C2	0.85	0.8	0.83	0.88	0.85	High
C3	0.85	0.8	0.83	0.88	0.85	High
C4	0.85	0.8	0.83	0.88	0.85	High
C5	0.85	0.8	0.83	0.88	0.85	**High**
Overall Average					**0.82**	**Tinggi**

Based on the question validity assessment table, it is known that of the 15 questions analyzed A1–C5, the overall average validity value V is 0.82 which is included in the high category. All questions have consistently high scores in the visual communication aspect of 0.83 and software utilization of 0.88. However, in the question group A1–A5, the values in the material and learning design aspects are slightly lower at around 0.70–0.79, so that all questions in this group are in the medium category even though the average value is right on the high threshold. Most of the question groups are categorized as high. Meanwhile, the question group C1–C5 has the highest and most consistent validity value with an average of 0.85, reflecting very good quality in all aspects of the assessment. The results of this analysis indicate that in general the questions developed have

Next, for the validation data on the summative assessment. This assessment is also tested for validity based on four aspects, namely material, learning design, visual communication, and software utilization. The results of the validation assessment for each assessment can be seen in Table 4.

Table 4. Results of Validation Summative Assessment

Item No.	V Value					
	Content Substance	Instructional Design	Visual Communication	Software Utilization	Average	Category
A1	0.81	0.75	0.86	0.83	0.81	High
A2	0.81	0.72	0.86	0.83	0.81	High
A3	0.81	0.75	0.86	0.83	0.81	High
A4	0.81	0.75	0.86	0.83	0.81	High
A5	0.81	0.72	0.86	0.83	0.81	High
B1	0.81	0.75	0.86	0.83	0.81	High
B2	0.8	0.77	0.86	0.83	0.82	High
B3	0.8	0.75	0.86	0.83	0.81	High
B4	0.8	0.75	0.86	0.83	0.81	High
B5	0.8	0.77	0.86	0.83	0.82	High
C1	0.8	0.75	0.86	0.83	0.81	High
C2	0.8	0.77	0.86	0.83	0.82	High
C3	0.8	0.75	0.86	0.83	0.81	High
C4	0.8	0.75	0.86	0.83	0.81	High
C5	0.8	0.75	0.86	0.83	0.81	High
D1	0.8	0.77	0.86	0.83	0.82	High
D2	0.8	0.77	0.86	0.83	0.82	High
D3	0.8	0.77	0.86	0.83	0.82	High
D4	0.8	0.77	0.86	0.83	0.82	High
D5	0.8	0.77	0.86	0.83	0.82	High
E1	0.8	0.77	0.86	0.83	0.82	High
E2	0.8	0.77	0.86	0.83	0.82	High
E3	0.8	0.77	0.86	0.83	0.82	High
E4	0.8	0.77	0.86	0.83	0.82	High
E5	0.8	0.77	0.86	0.83	0.82	High
F1	0.8	0.77	0.86	0.83	0.82	High
F2	0.8	0.77	0.86	0.83	0.82	High
F3	0.8	0.77	0.86	0.83	0.82	High
F4	0.8	0.77	0.86	0.83	0.82	High
F5	0.8	0.77	0.86	0.83	0.82	High
Overall Average					**0.81**	**High**

Based on the table of question validation results, the overall average value was obtained at 0.81 which is included in the high category, indicating that in general the questions developed have good validity quality. The assessment was carried out based on four aspects, namely material, learning design, visual communication, and software utilization. The visual communication aspect of 0.86 and software utilization of 0.83 obtained the highest scores consistently in all questions, reflecting the appearance and utilization of digital media which were very good. Meanwhile, the material aspect of the validation results ranged from 0.80 to 0.81, and the learning design showed a variation from 0.72 to 0.77, which affected the variation in the question validity category. Questions with a medium category generally had a lower learning design score of 0.72, as seen in most questions in groups A, B, and C. In contrast, questions from groups D, E, and F all had a high category with consistent values, especially because the learning design value increased to 0.77. Thus, further development should be focused on improving the learning design to improve the consistency of the quality of all questions.

Based on the results of the assessment validation, several suggestions were also provided by the validators. These suggestions and inputs are useful for improving the assessment to make it better. The feedback and recommendations will be taken into consideration in revising the developed assessment. Some of the suggestions and comments from the validators can be seen in Table 5.

Table 5. Validator Suggestions

Validator	Suggestions
Validator 1	1. Each phenomenon should cover all five aspects of critical thinking abilities. 2. The questions should preferably be in essay format.
Validator 2	1. The text in the first diagnostic question is quite complex for students to understand. It should be simplified, for example, through a dialogue between two people. 2. The assessment and rubric should be placed close together, not separately.
Validator 3	1. Some questions are still not aligned with the critical thinking indicators and learning objectives. 2. In the application, the display of the questions is very small, making it difficult for students to read or type their answers.

Based on the suggestions from the validators, several important points need to be considered to improve the quality of this diagnostic assessment. First, to comprehensively measure students critical thinking abilities, each question should ideally be based on a single phenomenon that includes all five aspects of critical thinking. In addition, essay-type questions are recommended, as they provide students with more space to express their thoughts. Next, regarding the discourse used in the questions particularly in the diagnostic assessment it is advised that the language and presentation be simplified to make them easier for students to understand. One recommended solution is to present the discourse in the form of a dialogue between two people discussing the relevant material, making it more contextual and less confusing. In terms of document organization, the assessment and scoring rubric should be placed close together or integrated into a single document to facilitate the assessment process and document management. Validators also emphasized that each question must align with the specified critical thinking indicators and learning objectives. This

ensures that the assessment is accurately targeted and can measure the intended competencies.

Discussion

Students critical thinking abilities can be assessed through the administration of assessments. Critical thinking skills can be measured using critical thinking assessments. Such assessments integrate critical thinking indicators into the questions. According to Ennis (2011), there are 13 critical thinking indicators categorized into 5 main aspects. Based on the principles of assessment stated by Anggreaena (2022), a good assessment is one that meets the criteria of validity.

The findings from the needs analysis and literature review conducted by the researcher indicate that current assessments for measuring critical thinking abilities are still insufficient. The preliminary study identified several issues: (1) teachers seldom evaluate students critical thinking abilities, (2) there is no available electronic assessment specifically for critical thinking in circular motion material, (3) limited use of technology in electronic assessments, (4) students critical thinking abilities remain low, and (5) the questions used by teachers lack indicators related to critical thinking. Therefore, there is a clear need for an assessment tool to measure students critical thinking abilities, particularly in the topic of circular motion. These findings align with previous research (Aliman, 2020; Mappalesye et al., 2021), which also emphasizes the necessity of assessments designed to evaluate critical thinking abilities.

Validation was conducted based on the material substance, instructional design, visual communication, and software utilization. The results of the validation indicated that the developed assessment was considered valid however, there were some suggestions regarding wording improvements and context alignment, which were then revised by the researcher. This validation process refers to formative evaluation according to Tessmer in Plomp (2013). Research by Azizah & Hidayat (2024) also showed similar findings, stating that electronic assessments are feasible for use based on validation results. Similarly, studies by Fadzillah et al. (2023) and Ariska et al. (2021) demonstrated that the assessments they developed were valid and appropriate for evaluating students' critical thinking skills. In this study, the developed electronic assessment was deemed valid for use based on the four evaluation aspects applied.

In response, this study developed an electronic assessment aimed at evaluating students critical thinking abilities on the topic of circular motion. The assessment was designed based on Ennis critical thinking indicators and incorporated real life phenomena to enhance the relevance and meaningfulness of the learning experience. The validity of the assessment was determined through expert review. Validation results from three experts showed that the diagnostic assessment achieved an Aiken's V score of 0.82, and the summative assessment scored 0.81, both categorized as highly valid. This outcome supports findings from Nurazizah et al. (2024) study, which developed a critical thinking assessment on static fluid material and concluded that valid assessments can effectively measure students critical thinking abilities.

Based on the results of the validity test by three validators, the validation results obtained for the electronic assessment to evaluate students critical thinking abilities on the topic of circular motion were declared valid with a very valid category. This indicates that the developed electronic assessment instrument has fulfilled all the essential aspects required in question development, including the substance of the material, instructional design, visual communication, software utilization, and its alignment with critical thinking indicators. This success suggests that electronic assessment can be effective in evaluating students higher-order thinking abilities in physics learning. However, this study is limited in scope as it only focuses on one physics topic circular motion and includes only two types of assessment: diagnostic and summative. Therefore, the development of electronic assessments needs to be expanded to cover other physics topics. It is crucial to ensure that all aspects of students critical

thinking abilities are measured comprehensively.

CONCLUSION

The electronic assessment to assess students critical thinking abilities on circular motion material consists of two assessments, namely, diagnostic and summative. This assessment is in the form of essays developed using google sites and wizer.me. The questions in this electronic assessment were developed based on critical thinking indicators according to Ennis 2011. This electronic assessment can be accessed using electronic devices connected to the network. This electronic assessment can assess students critical thinking abilities, especially on circular motion material. The results of content validation by experts review show that the electronic assessment to assess students critical thinking abilities on circular motion material is categorized as valid. The validation result for diagnostic assessment is 0.82 and summative assessment is 0.81. This shows that the developed electronic assessment is feasible to use to assess students critical thinking abilities. Therefore, it is hoped that further studies will be conducted on the practicality and effectiveness of this electronic assessment to assess critical thinking abilities. Electronic assessments to assess critical thinking abilities can be developed on other physics materials.

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