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Validity of Guided Inquiry-Based Learning Device on the Human Respiratory System Material to Support Students' Critical Thinking Skills and Conceptual Understanding

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ABSTRACT

This study was conducted to examine the validity of Guided Inquiry-based learning devices on the human respiratory system topic in supporting students' critical thinking skills and conceptual understanding. The study employed a Research and Development (R&D) approach using the ADDIE model and was limited to the development stage, focusing on product validation. The developed learning devices consisted of a learning module, student worksheets (LKPD), and an assessment instrument containing 18 multiple-choice questions. Product validation was conducted by two expert validators and two practitioner validators using structured validation sheets. Validation data were analyzed descriptively by calculating the average scores obtained from the validators. The results showed that the learning module achieved validation scores ranging from 94 –100, the student worksheets 94 –100, and the assessment instrument 96 –100, indicating that all developed learning devices were categorized as very valid. Therefore, the Guided Inquiry-based learning devices are considered suitable for biology learning on the human respiratory system. However, this study was limited to product validation and did not evaluate the practicality or effectiveness of the learning devices in improving students' critical thinking skills and conceptual understanding.

1. Introduction

The 21st century is an era of globalization characterized by rapid technological development and innovation, which has significantly influenced various sectors, including education. These developments require the education sector to transform learning processes to prepare students with relevant skills to face global challenges. Education plays an important role in helping individuals acquire the ability to utilize technology, communication, and information media effectively in the current era (Utami et al., 2021). Therefore, 21st-century learning is no longer focused only on

mastering factual knowledge but also emphasizes the development of higher-order thinking skills, creativity, problem-solving abilities, and the ability to apply knowledge in real-life contexts.

Critical thinking skills and conceptual understanding are essential competencies that need to be developed in 21st-century learning. Critical thinking enables students to analyze information, evaluate arguments, and solve problems logically, while conceptual understanding encourages students to comprehend fundamental principles deeply and apply knowledge in various situations (Saido et al., 2015). These abilities are particularly important in biology learning because biology not only requires students to memorize concepts but also to understand biological processes, analyze relationships between concepts, and apply scientific knowledge to solve problems (Reece et al., 2015). Comparable findings were reported by Maisaroh et al. (2025), who found that technology-assisted, multiple-representation modules can effectively strengthen students' conceptual understanding alongside their scientific attitude.

The development of digital technology provides opportunities to improve the quality of learning through innovative and interactive learning media. The integration of technology in education can create learning environments that are more engaging, meaningful, and student-centered (Bond et al., 2020). One of the technologies that can be utilized in developing learning materials is *Articulate Storyline*. *Articulate Storyline* is a software application designed to create interactive learning media by integrating various elements such as text, images, animations, videos, quizzes, and feedback to support active learning processes (Mayer, 2020). The development of Articulate Storyline-based teaching modules has great potential to improve learning quality because it allows students to learn independently, explore learning materials, and actively engage in learning activities through interactive features (Rifkiyani & Aeni, 2025).

The use of interactive modules can support constructivist learning principles, in which students are not only passive recipients of information but actively construct knowledge through exploration, observation, and problem-solving activities (Mayer, 2020). Furthermore, the integration of animations, simulations, contextual problems, and interactive evaluations in Articulate Storyline can encourage students to analyze information, evaluate concepts, and make decisions during the learning process. Recent studies published in the *Journal of Educational Sciences* have also demonstrated the effectiveness of interactive learning media developed using Articulate Storyline in improving students' learning outcomes and engagement. The integration of multimedia-based learning environments enables students to actively construct knowledge while supporting higher-order thinking skills (Faiz et al., 2025; Fitriyani et al., 2026). Furthermore, previous literature reviews have highlighted that Articulate Storyline has increasingly been integrated with inquiry-based learning approaches to improve conceptual understanding and critical thinking skills in science education.

The human respiratory system is one of the biology topics that contains complex concepts because it discusses structures, functions, mechanisms, gas exchange

processes, and their relationship with human health. Many concepts in this topic are abstract because the biological processes occur inside the body and cannot be directly observed by students. This condition often causes difficulties for students in understanding the relationship between structures and functions, as well as the mechanisms involved in the respiratory system (Reece et al., 2015). Similar difficulties have also been reported in other human body system topics, such as the human circulatory system (Dewi et al., 2024; Rosiana et al., 2023), which likewise require interactive and structured learning media to support students' critical thinking and cognitive learning outcomes. Therefore, appropriate learning media are needed to visualize abstract concepts and facilitate students' understanding. The use of *Articulate Storyline*-based teaching modules can be an alternative solution to overcome these learning problems. Through interactive animations and simulations, processes such as inspiration, expiration, gas exchange in alveoli, and respiratory regulation can be presented more clearly and dynamically. These features allow students to build deeper conceptual understanding and reduce misconceptions in biology learning. In addition, the presentation of contextual problems, analytical questions, and evaluation activities can stimulate students' critical thinking skills, including interpretation, analysis, evaluation, and conclusion-making (Facione, 2015).

Based on observations conducted with biology teachers on August 29, 2025, at Tilango Senior High School 1, it was found that the learning materials used by teachers were still limited and less varied. The teaching modules used were not sufficiently interactive, while the student worksheets mainly contained exercises without activities that encouraged students to analyze and develop a deeper understanding. This condition indicates the need for innovative learning materials that support student-centered learning and are in accordance with the demands of the Independent Curriculum, which emphasizes active participation, critical thinking, and meaningful learning experiences. The low level of students' understanding of the human respiratory system may also be influenced by the abstract characteristics of the material and the limited use of learning media that can provide visual and interactive experiences. Students often experience difficulties in understanding biological processes because these processes cannot be directly observed (Ritonga, 2016).

Therefore, the development of an interactive teaching module based on *Articulate Storyline* is considered relevant as a solution to support students in understanding concepts and developing critical thinking skills. A similar needs analysis conducted prior to media development has also been reported by Hartati et al. (2025), who found that identifying students' critical-thinking needs at the outset helps ensure that the resulting learning media directly addresses the intended learning problems. Based on these problems, this study aimed to analyze the validity of an *Articulate Storyline*-based teaching module to improve students' critical thinking skills and conceptual understanding of the human respiratory system. The development of this teaching module was expected to provide a valid, interactive, and innovative learning resource that supports biology learning in accordance with the demands of 21st-century education.

2. Methodology

This study used a Research and Development (R&D) method referring to the ADDIE development model. The product developed in this study was an Articulate Storyline-based teaching module designed to improve students' critical thinking skills and conceptual understanding of the human respiratory system. The developed learning tools consisted of a teaching module for three learning meetings, student worksheets (*LKPD*) for three learning meetings, and a test instrument consisting of 18 multiple-choice questions. The teaching module and student worksheets were developed based on the Independent Curriculum. The developed test instrument was designed to measure students' critical thinking skills and conceptual understanding. The learning tools were developed based on the learning standards for the senior high school level.

The development process followed three stages of the ADDIE model, namely Analysis, Design, and Development, because the present study focused only on product validation. During the Analysis stage, a needs analysis, curriculum analysis, and student characteristics analysis were conducted through classroom observations and interviews with biology teachers to identify learning problems related to the human respiratory system. The Design stage involved preparing the structure of the teaching module, student worksheets (*LKPD*), and assessment instrument based on the Guided Inquiry learning model and the Independent Curriculum. In the Development stage, the learning devices were developed using Articulate Storyline, validated by expert and practitioner validators, revised according to the validators' suggestions, and finalized as valid learning products. The overall research procedure is illustrated in Figure 1.

During the Analysis stage, the researchers identified learning problems through classroom observations and interviews with biology teachers. The analysis focused on identifying students' learning difficulties, curriculum requirements, characteristics of Grade XI students, and the availability of learning resources related to the human respiratory system. The results of this stage became the basis for determining the learning objectives and specifications of the developed learning devices. During the Design stage, the researchers prepared a detailed blueprint consisting of learning outcomes, learning objectives, Guided Inquiry learning syntax, module organization, *LKPD* structure, storyboard and navigation of the Articulate Storyline media, learning activities, assessment blueprint, and evaluation indicators for critical thinking skills and conceptual understanding. During the

Development stage, the initial prototype of the learning devices was produced using Articulate Storyline software. The prototype then underwent expert validation followed by revisions based on validators' comments. After revision, the improved prototype was assessed by practitioner validators. Suggestions from practitioner validators were incorporated into the final revision before the learning devices were declared valid.

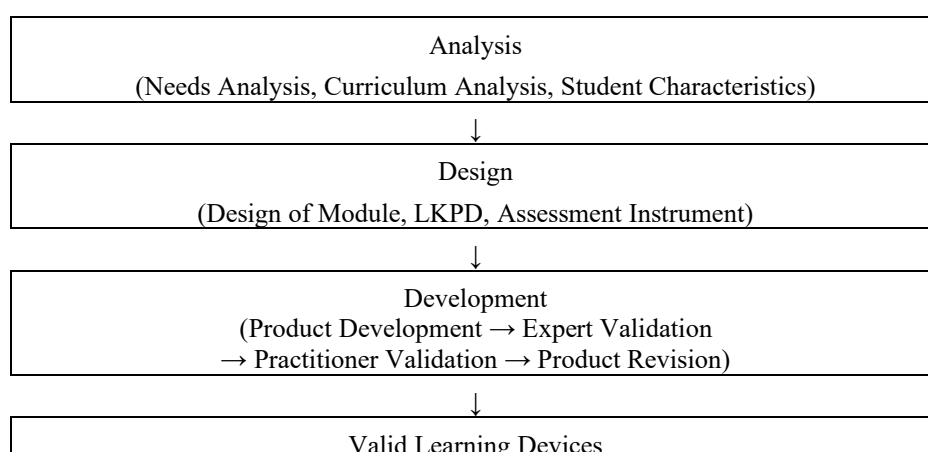


Figure 1. Research Procedure

The validation process involved two expert validators and two practitioners. The expert validators were biology education lecturers from Universitas Negeri Gorontalo, while the practitioner validators were biology teachers from Tilango Senior High School 1 and Gorontalo Senior High School 1. The validation was conducted by providing the developed learning tools to the validators. The validators assessed the quality and validity of the developed products using validation sheets that had been prepared. The expert validators evaluated the learning devices regarding content accuracy, instructional design, language appropriateness, and media feasibility. Practitioner validators assessed the applicability and practicality of the learning devices for classroom implementation. Suggestions from both groups of validators were incorporated into the revised version before the products were categorized as valid.

The data collection instruments used in this study were validation sheets for the teaching module, student worksheets, and test instruments. The validation sheets were used to obtain assessments from expert validators and practitioners regarding the validity of the developed learning tools. The data obtained from the validation process consisted of quantitative data in the form of validation scores and qualitative data in the form of suggestions and comments from validators for product improvement. The validation sheets were developed based on the indicators of content validity, construction, language, presentation, learning activities, media integration, and assessment feasibility. Each indicator was assessed using a five-point Likert scale ranging from 1 (very poor) to 5 (excellent). The assessment aspects used to validate each learning device are presented in Table 1.

Table 1. Aspects of Learning Tools Assessment

Code	Learning Module	Student Worksheet	Test
A1	Learning Module Information	Content Validity	Material
A2	Learning Outcomes Phase	Language Validity	Construction
A3	Learning Objectives	Display Feasibility	Language
A4	Characteristics of Articulate Storyline Media	Feasibility of Articulate Storyline-Integrated Media	

A5	Pancasila Student Profile	Implementation and Measurement
A6	Learning Activities	Feasibility
A7	Learning Materials	

The validation data were analyzed by calculating the scores obtained from each validator. The score from expert validators was determined based on the average score of all expert assessments, while the score from practitioner validators was calculated based on the average score of all practitioner assessments. The average validation score was converted into a percentage using the following equation:

$$\text{Validity} = \frac{\text{Maximum score}}{\text{Obtained score}} \times 100$$

The validity level was interpreted based on the criteria proposed by Fatayah et al. (2022), in which scores of 81-100 were categorized as Very Valid, 61-80 as Valid, 41-60 as Fairly Valid, 21-40 as Less Valid, and 0-20 as Invalid. The validity categories used to interpret the validation scores are presented in Table 2.

Table 2. Categories for assessing the validity of learning tools

Category	Score
Very valid	81-100
Valid	61-80
Fairly valid	41-60
Less valid	21-40
Invalid	0-20

3. Results and Discussion

The developed Guided Inquiry-based learning devices consisted of a teaching module, student worksheets (LKPD), and an assessment instrument designed to support students' critical thinking skills and conceptual understanding of the human respiratory system. Following the development stage, all learning devices were evaluated through expert and practitioner validation to determine their validity in terms of content, instructional design, language appropriateness, media integration, and assessment quality. The validation results were used as the basis for revising and improving the developed products before determining their overall validity. The results of the validation for each learning device are presented in the following sections.

Before presenting the validation results, it is necessary to describe how the developed Guided Inquiry-based learning devices were structured and applied during the study. The teaching module was designed for three learning meetings and organized following the Guided Inquiry syntax -orientation, formulating problems, formulating hypotheses, collecting data, testing hypotheses, and drawing conclusions - each accompanied by contextual illustrations and practice questions related to the human respiratory system. The student worksheet (LKPD) was developed for the same three meetings to guide students through structured

investigative activities that paralleled the Guided Inquiry stages in the module, including observation tasks, data recording, and analytical questions. The assessment instrument consisted of 18 multiple-choice items measuring both critical thinking skills and conceptual understanding, distributed across the indicators of interpretation, analysis, evaluation, and conclusion-making, as well as the corresponding levels of Bloom's taxonomy for concept mastery. All three products were developed using Articulate Storyline so that they could be accessed and used interactively by students, before being submitted for expert and practitioner validation as reported in the following sections.

Learning Module

The validation results of the developed learning module obtained from expert and practitioner validators are presented in Figure 2.

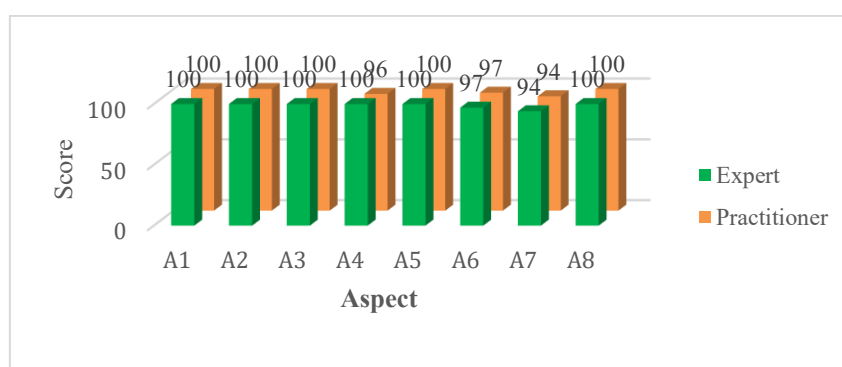


Figure 2. Learning Module Validation Result

Based on the data presented in Figure 2, it shows that all aspects assessed in the teaching module are categorized as very valid. Practitioners gave scores above 90 for all assessed aspects. Experts also provided assessments similar to those given by practitioners. All assessed aspects obtained a very valid category. The results of the study indicate that the developed teaching module meets the validity criteria. This shows that the teaching module can be used for the next stage. The detailed average validation scores for each aspect of the learning module are presented in Table 3.

Table 3. Average Validation Scores of the Learning Module

Assessment Aspect	Mean Score	Category
Learning Module Information	100	Very Valid
Learning Outcomes Phase	98	Very Valid
Learning Objectives	97	Very Valid
Characteristics of Articulate Storyline	100	Very Valid
Pancasila Student Profile	96	Very Valid
Learning Activities	98	Very Valid
Learning Materials	99	Very Valid

Based on the validity criteria proposed by Fatayah et al. (2022), validation scores ranging from 81–100 are categorized as *Very Valid*. As presented in Figure 2 and

Table 3, all aspects of the developed learning module obtained average scores ranging from 94 to 100. Therefore, the developed module fulfilled the predetermined validity criteria and was categorized as *Very Valid*. The high validation results indicate that the developed teaching module has fulfilled the feasibility aspects as a learning tool. According to Nesri & Kristanto (2020), the development of technology-assisted learning modules needs to undergo a validation stage to ensure that the developed product is in accordance with learning objectives, students' needs, and quality standards before being implemented in the learning process. The validation results from experts and practitioners serve as an indicator that the developed module is appropriate in terms of content, presentation, and instructional design aspects.

Furthermore, Ramadhan et al. (2020) explained that the validation process in the development of teaching materials is an important stage to determine the feasibility level of a product. Learning products that obtain a very valid category indicate that the components of the developed teaching materials are in accordance with the development criteria, making them suitable as learning resources to support the learning process. According to Cahyani & Said (2024) expert validation is conducted to assess the quality of teaching materials based on aspects of content, presentation, language, and the relationship between learning components. High validation results indicate that the developed product has good quality and can be used after improvements are made based on the validators' suggestions. Therefore, the very valid category obtained by the teaching module indicates that the learning tool meets the feasibility standards for learning implementation.

The findings of this study are consistent with those reported by Rifkiyani and Aeni (2025), who found that Articulate Storyline-based learning media achieved a very valid category after expert validation. Similarly, Zaputra et al. (2021) reported that technology-assisted learning modules generally obtain high validity because they successfully integrate content accuracy, instructional design, language, and visual presentation. However, unlike previous studies, the present study integrates the Guided Inquiry learning model into the Articulate Storyline platform, allowing students to investigate biological concepts systematically through interactive multimedia. This combination provides additional value by encouraging active learning while supporting critical thinking skills and conceptual understanding. This finding aligns with Nuraini et al. (2025), who reported that the Guided Inquiry learning model significantly strengthens students' critical thinking skills, further supporting its suitability for integration with interactive digital media such as Articulate Storyline. These findings are also supported by Hastri et al. (2025) who reported that interactive learning media developed using Articulate Storyline through the ADDIE model achieved high validity and effectively facilitated students' problem-solving skills. The consistency of these findings indicates that Articulate Storyline is an appropriate platform for developing valid and interactive learning resources across different educational contexts.

In addition, Zaputra et al. (2021) through a meta-analysis study stated that developed learning modules need to fulfill validity aspects before being used in the learning process. The validity aspects include content, presentation, language, and

visual appearance, indicating that the module has met the characteristics of an appropriate teaching material. A module with a high level of validity has the potential to support effective learning implementation. Based on the validation results from experts and practitioners, it can be concluded that the developed teaching module has fulfilled the validity criteria with a very valid category. This indicates that the Articulate Storyline-based teaching module developed in this study is feasible to be used for the next stage, namely implementation in the learning process. During the validation process, several suggestions were provided by the validators to improve the developed learning devices. The revisions included refining the wording of several learning objectives, improving the consistency of Guided Inquiry syntax, revising illustrations and layouts to enhance readability, correcting grammatical errors, and modifying several assessment items to better represent indicators of critical thinking skills and conceptual understanding. After these revisions, the learning devices were re-examined and categorized as very valid.

Student Worksheet

The validation results of the developed student worksheet (LKPD) assessed by expert and practitioner validators are presented in Figure 3.

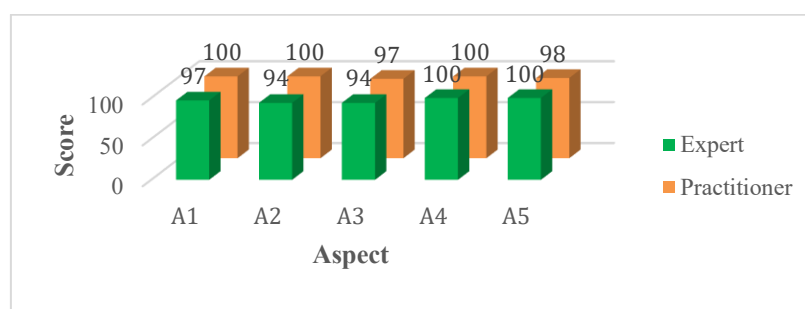


Figure 3. Student Worksheet Validation Result

Based on the data presented in Figure 3, it is indicated that all aspects assessed in the student worksheet are very valid. Practitioners gave a score of more than 90 for all aspects assessed. Experts have also provided the same value as practitioners. All aspects that have been assessed receive a very valid category. Research has found that the student worksheet developed meets the validity criteria. This indicates that the student worksheet can be used for the next stage. The average validation scores for each assessment aspect of the developed student worksheet are presented in Table 4.

Table 4. Average Validation Scores of Student Worksheet

Assessment Aspect	Mean Score	Category
Content Validity	100	Very Valid
Language Validity	100	Very Valid
Display Feasibility	98	Very Valid
Articulate Storyline Integration	100	Very Valid
Learning Activity	97	Very Valid

Based on the validity criteria proposed by Fatayah et al. (2022), scores ranging from 81–100 are categorized as Very Valid. As shown in Table 4, all aspects of the developed student worksheet obtained average scores between 97 and 100. Therefore, the developed student worksheet fulfilled the predetermined validity criteria and was categorized as Very Valid. The high validation results of the student worksheet (LKPD) indicate that the developed product has fulfilled the feasibility aspects as a teaching material. According to Ningsih & Rosdiana (2019), the validity of LKPD can be assessed based on the suitability of didactic, construction, and technical aspects. LKPD that obtains a valid category indicates that the content, presentation of learning activities, and LKPD appearance are in accordance with the principles of teaching material development, making it suitable to support the learning process. The results of this study are also consistent with the research conducted by Watika & Suliyanah (2019) which stated that LKPD developed through an expert validation stage can be categorized as feasible when it meets the aspects of content, construction, and presentation. Expert validation aims to ensure that the LKPD has alignment between learning objectives, materials, student activities, and the evaluation used. Therefore, the high validation scores indicate that the LKPD has met the feasibility standards as a learning tool.

According to Novriani et al. (2021), the development of LKPD needs to consider validity aspects because LKPD serves as a guide for students' learning activities. A valid LKPD indicates that the components of material, design, language, and presentation are appropriate to learning needs, thereby helping students understand the concepts being studied. The high validation results become an indicator that the LKPD has good quality and can be used in the learning process. Furthermore, Januarni et al. (2025) explained that LKPD validation is conducted to ensure the suitability of the product based on format, content, and language aspects. LKPD that obtains a very valid category indicates that the product has fulfilled the criteria of good teaching materials and can be used to support learning activities as well as improve students' engagement and conceptual understanding.

The present findings are consistent with the study conducted by Januarni et al. (2025), who reported that Guided Inquiry-based student worksheets achieved a very valid category after expert validation. Likewise, Ningsih & Rosdiana (2019) emphasized that valid student worksheets should fulfill didactic, construction, and technical requirements. However, the student worksheet developed in this study differs from previous studies because it is integrated with Articulate Storyline, enabling students to engage in interactive Guided Inquiry activities supported by multimedia features. This integration is expected to increase students' learning engagement and conceptual understanding. An example of the validated student worksheet cover developed using Articulate Storyline is presented in Figure 4.

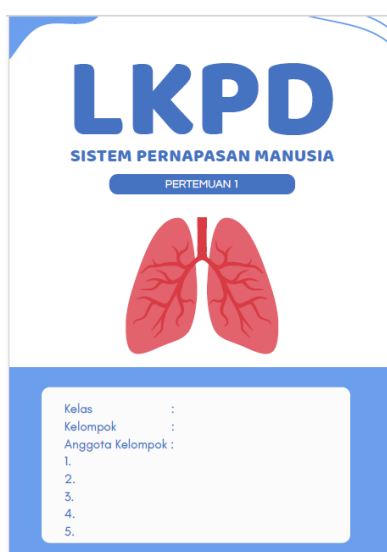


Figure 4. Example of a Validated Student Worksheet Cover

Based on the validation results from experts and practitioners, it can be concluded that the developed LKPD has fulfilled the validity criteria with a very valid category. This indicates that the Articulate Storyline-based LKPD developed in this study is feasible to be used for the next stage, namely implementation in biology learning on the human respiratory system material.

Test

The validation results of the developed assessment instrument evaluated by expert and practitioner validators are presented in Figure 5.

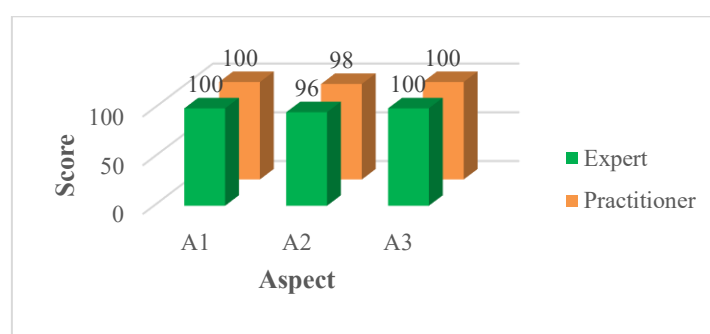


Figure 5. Assessment Instrument Validation Result

Figure 5 indicates that all aspects assessed to determine the level of validity have been met. Both practitioners and experts assessed more than 90, and the test was declared very valid. Research has found that the test developed meets the validity criteria. The detailed average validation scores of the assessment instrument are presented in Table 5.

Table 5. Average Validation Scores of Assessment Instrument

Assessment Aspect	Mean Score	Category
Material	99	Very Valid
Construction	97	Very Valid
Language	95	Very Valid
Critical Thinking Indicator	100	Very Valid
Concept Understanding Indicator	99	Very Valid

Based on the validity criteria proposed by Fatayah et al. (2022), all aspects obtained average scores ranging from 95 to 100. These scores fall within the Very Valid category, indicating that the developed assessment instrument is appropriate for measuring students' critical thinking skills and conceptual understanding. This indicates that the test can be used for the next stage. The high validation results of the test instrument indicate that the developed test items have fulfilled the feasibility aspects as a learning evaluation tool. According to Panji Yudha (2019), the development of assessment instruments needs to undergo a validation process by experts and practitioners to ensure that the resulting instrument is able to measure the expected competencies. Content validation through expert assessment is used to determine the suitability between indicators, materials, test construction, and measurement objectives. Validation results categorized as very good indicate that the instrument has adequate quality for measuring students' abilities.

Furthermore, Ismawati & Trisnowati (2019) explained that developed test instruments must meet validity criteria before being used in the learning process. Expert validation is an important stage to ensure that each test item is appropriate with the competencies being measured. Instruments that obtain a valid category indicate that the test items are appropriate in terms of content, construction, and measurement characteristics. According to Agustika (2019) the development of test instruments needs to consider several stages, including the preparation of test specifications, development of test items, expert review, revision, and instrument trials. These validation stages aim to produce instruments that are capable of accurately measuring students' abilities. Therefore, validation results showing a very valid category indicate that the developed test instrument is in accordance with the principles of learning evaluation instrument development.

In addition, Putri (2020) stated that a good test instrument is not only determined by the number of test items but also by the quality of the instrument, including validity and reliability aspects. An instrument that has been validated and meets feasibility criteria can produce accurate data regarding students' abilities. This indicates that the test instrument developed in this study has good quality and can be used as a tool for measuring learning outcomes. Consistent with the research of Pandra & Bellinda (2024) the development of test instruments through the Research and Development (R&D) method needs to consider the validation process to ensure that the resulting product meets quality standards. Their study showed that test instruments developed through validation stages generally obtain valid and reliable categories, making them suitable for use as data collection instruments.

These findings are consistent with those reported by Pandra and Bellinda (2024), who found that assessment instruments developed through the Research and Development approach generally achieved high validity following expert review. Similar findings were reported by Yanti (2025), who demonstrated that Guided Inquiry learning significantly improved students' critical thinking skills. Consequently, assessment instruments designed to measure critical thinking should undergo rigorous validation to ensure that they accurately evaluate students' higher-order thinking abilities. Likewise, Panji Yudha (2019) emphasized that expert validation is essential to ensure that assessment instruments accurately measure the intended competencies. However, unlike previous studies, the assessment instrument developed in the present study was specifically designed to measure both critical thinking skills and conceptual understanding within Guided Inquiry-based biology learning. Therefore, the instrument provides a more comprehensive evaluation of students' higher-order thinking skills. Examples of the critical thinking test items developed in this study are presented in Table 6.

Table 6. Examples of Critical Thinking Questions

Learning Objective	Critical Thinking Aspect	Question	Answer	Item Type	Weight
Classifying respiratory organs based on their role in the process of air entering the body	Interpretation	1. Consider the following organs: (1) Nose (2) Pharynx (3) Larynx (4) Alveolus	A	MC	1
		The organs that function as the airway before gas exchange occurs are ... a. (1), (2), (3) b. (1), (3), (4) c. (2), (3), (4) d. (1), (2), (4) e. (1), (2), (3), (4)			
Classifying respiratory organs based on their role in the process of air entering the body	Interpretation	2. Consider the following grouping: • Group A: nose, pharynx, larynx • Group B: bronchus, bronchioles, alveolus	C	MC	1
		If the grouping is based on the role in air entry, the most appropriate interpretation is ... a. Both groups function equally as sites of gas exchange [remaining answer options b–e not visible in the source figure – author to supply the complete item]			

Examples of the concept mastery test items are presented in Table 7.

Table 7. Examples of Concept Mastery Questions

Learning Objective	Bloom's Taxonomy Concept Mastery Indicator	Question	Answer	Item Type	Weight
Students are expected to be able to correctly analyze the mechanism of human respiration.	C3	1. During expiration, the intercostal muscles relax, so that ... a. The ribs are lifted b. The ribs are lowered c. The chest cavity volume increases d. Air pressure decreases e. Air exits the lungs [remaining items not visible in the source figure – author to supply the complete set]	B	MC	1

Based on the validation results from experts and practitioners, it can be concluded that the developed test instrument has fulfilled the validity criteria with a very valid category. Therefore, the test instrument is feasible to be used in the next stage to measure students' abilities, particularly critical thinking skills and conceptual understanding of the human respiratory system material. Overall, the validation results indicate that all developed Guided Inquiry-based learning devices fulfilled the predetermined validity criteria and were categorized as very valid. The expert and practitioner validation confirmed that the products possess adequate quality regarding content, instructional design, language, media integration, and assessment components. Therefore, the developed learning devices are appropriate for classroom implementation after minor revisions. Nevertheless, further studies are required to examine their practicality and effectiveness in improving students' critical thinking skills and conceptual understanding under actual classroom conditions.

The findings of this study are also in line with Kusuma et al. (2026) who emphasized that Guided Inquiry learning provides meaningful opportunities for students to develop scientific process skills and higher-order thinking through structured investigations. Therefore, validated learning devices that integrate Guided Inquiry and interactive media are expected to support more effective biology learning implementation. From a practical perspective, the developed learning devices have the potential to support the implementation of the Independent Curriculum by facilitating student-centered biology learning through Guided Inquiry activities integrated with interactive multimedia. The Articulate Storyline platform enables teachers to visualize abstract concepts more effectively, increase students' engagement, and encourage active participation during biology learning. Therefore, these learning devices may serve as practical references for

biology teachers in developing interactive instructional materials that promote critical thinking skills and conceptual understanding.

4. Conclusion

This study concludes that the Articulate Storyline-based learning devices developed to support students' critical thinking skills and conceptual understanding of the human respiratory system material have met the validity criteria. Based on the assessments of both expert and practitioner validators, the teaching module, student worksheet (LKPD), and test instrument were each categorized as very valid, indicating that these products meet the standards of content accuracy, instructional design, language, media integration, and assessment quality required for classroom use. Therefore, the developed learning tools are considered suitable for use as biology learning tools for the human respiratory system material at SMA Negeri 1 Tilango and SMA Negeri 1 Gorontalo. This study contributes to biology education by providing a validated set of Guided Inquiry-based learning devices integrated with Articulate Storyline, offering an innovative instructional alternative that combines inquiry-based learning with interactive multimedia. The developed devices support student-centered learning, promote critical thinking skills, enhance conceptual understanding, and facilitate the implementation of the Independent Curriculum in senior high schools, while also serving as practical references for biology teachers in developing technology-enhanced instructional materials. Although the developed learning devices demonstrated a very high level of validity, this study was limited to the development stage and did not examine their practicality or effectiveness in classroom implementation. Future research is therefore recommended to evaluate the practicality and effectiveness of these learning devices through field testing involving larger samples, and to investigate their impact on students' critical thinking skills, conceptual understanding, learning outcomes, scientific literacy, and other higher-order thinking skills.

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