

Development of Breathing Cartoon-Based Learning Media to Enhance Students' Higher-Order Thinking Skills at Madrasah Ibtidaiyah 21 Aceh Besar

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Abstract

This study explores the development and effectiveness of breathing cartoon-based instructional media to address the lack of suitable teaching materials for the human respiratory system at Madrasah Ibtidaiyah Negeri 21 Aceh Besar. Teachers primarily utilize lower-order thinking skills questions, which may limit students' ability to develop higher-order thinking skills. The study employed a research and development approach to bridge this gap, following the Borg and Gall model to design, validate, and assess the instructional media. Expert validation results indicated a 97% feasibility score, classifying the media as highly suitable for classroom implementation. Teacher responses yielded an 84.6% engagement rate, while student responses reached 95.33%, both categorized as highly engaging.

Pretest and posttest data from fifth-grade students demonstrated that 12 students scored above 90, achieving a high N-gain ($g > 0.7$), while five students obtained a moderate N-gain ($0.3 < g < 0.7$). The average N-gain score of 0.81 (81.41%) confirmed the media's high effectiveness. These findings suggest that breathing cartoon-based instructional media is pedagogically feasible and highly effective in enhancing students' high order thinking skills, reinforcing the need for interactive and innovative learning tools in science education.

Keywords: higher-order thinking skills, breathing cartoon

A. Introduction

Globalization and rapid technological advancements present significant challenges for the education sector in cultivating individuals equipped with Higher-Order Thinking Skills (HOTS). HOTS is often perceived as a complex and difficult skill compared to conventional learning, particularly by students who are accustomed to rote memorization. However, in reality, HOTS-based learning emphasizes problem-solving and analytical thinking, enabling students to approach complex questions with logical reasoning rather than relying solely on memorization. Despite its importance in preparing students for the demands of the modern world, many learners across various educational levels continue to struggle in developing HOTS (Dalman & Junaidi, 2022). The appropriate integration of learning media in educational settings can significantly enhance students' ability to think critically and analytically (Amanda, 2024; Astuti et al., 2024; Juli et al., 2024; Sari et al., 2024).

Given the growing need for innovative teaching strategies, educators must adopt a more dynamic approach in designing and implementing instructional materials, using media as a tool (Astuti et al., 2024). This includes refining curricula, syllabi, and teaching materials to align with the evolving needs of students and the demands of contemporary education (Gustina, 2021; Nihayatul Fadlilah et al., 2024; Nissa, 2022; Rahmawati et al., 2023). By doing so, educators can better support students in acquiring the cognitive skills necessary to navigate complex problems and thrive in an increasingly competitive world.

Based on the needs analysis conducted in Grade V at MIN 21 Aceh Besar, the researcher identified a significant issue: the lack of adequate learning media to effectively illustrate the human respiratory system in the IPAS (Integrated Science) subject. Although IPAS teachers have incorporated basic projector-based media in the learning process, this approach has proven to be unsatisfactory. The conventional use of projectors does not fully meet the criteria for effective learning media, as it has become too common and lacks the capacity to engage students in a more interactive and immersive manner (Fauziana et al., 2021; Handayani et al., 2023; Najoan & Makawawa, 2023; Nissa, 2022; Zebua, 2024).

Furthermore, an analysis of semester exam questions revealed that the assessment primarily consists of lower-order thinking skill (LOTS) questions, which focus on basic recall and comprehension rather than critical analysis or problem-solving. This approach contradicts the learning objectives outlined in the *Merdeka Curriculum*, which emphasizes the development of higher-order thinking skills (HOTS) (Ahmad Ashfia, 2024; KINTOKO et al., 2024; Manik & Ngurah, 2020). As a result, students are not adequately challenged to apply their knowledge in complex, real-world contexts, hindering their cognitive development and overall academic growth. Addressing this gap requires the integration of innovative learning media that can enhance students' understanding and foster higher-level cognitive skills in line with modern educational standards (Dalman & Junaidi, 2022; Dwijayanti, 2021; Handayani et al., 2023; Manik & Ngurah, 2020; Titin et al., 2023).

Higher Order Thinking Skills (HOTS) refer to advanced cognitive abilities that encompass analysis, evaluation, and creation. According to recent research, HOTS involve critical, creative, and analytical thinking processes in interpreting information and data to solve problems (Ahmad Ashfia, 2024; Junaidi, 2019). These higher-order cognitive skills enable learners to process information critically and analytically, enhancing their ability to develop effective solutions (Anggita et al., 2023; Dwijayanti, 2021; Fauziana et al., 2021; Tasrif, 2022). The successful implementation of the *Merdeka Curriculum* relies on various supporting components, including educational facilities and instructional materials. Facilities, in this context, refer to all resources that facilitate and enhance the learning process. Learning facilities encompass everything available in schools that can be utilized to support and streamline teaching and learning activities, ultimately ensuring the achievement of educational goals effectively.

Breathing Cartoon is a learning medium developed by the researcher and is a unique instructional tool named by the researcher. The term *breathing* originates from English, meaning "to breathe," while *cartoon* in Indonesian refers to "cardboard." Thus, the term *Breathing Cartoon* can be interpreted as "breathing cardboard." This learning media is specifically designed to illustrate the mechanism of the human respiratory process in a tangible and interactive manner.

Breathing Cartoon-based learning media is an innovative tool aimed at providing students with a more engaging and in-depth learning experience in understanding the human respiratory system. This product is designed to present complex explanations in an appealing way, particularly regarding the mechanisms of inspiration and expiration. Through interactive and realistic visualizations, *Breathing Cartoon* is expected to help students develop a more comprehensive understanding of the respiratory process, making learning more effective and enjoyable.

B. Research Methods

The research methodology employed in this study follows the Research and Development (R&D) approach, specifically adopting the Borg and Gall model. Borg and Gall define Educational R&D as: "*An industry-based development model in which the findings of research are used to design new products and procedures, which are then systematically field-tested, evaluated, and refined until they meet specified criteria of effectiveness, quality, or similar standards* (Sudaryono, 2021; Sugiyono, 2016)."

This model emphasizes a systematic process of developing and refining educational products to ensure their effectiveness and applicability in real learning environments. By implementing this approach, the study aims to develop and validate the *Breathing Cartoon* learning media through rigorous testing and evaluation, ensuring that it meets high educational standards and effectively enhances students' understanding of the human respiratory system.

The research procedure in this study has been condensed into seven steps due to time constraints and situational limitations. According to *Puslitjaknov* in the book *Research and Development Methods*, the R&D process can be simplified into seven stages, as Borg and Gall acknowledge that researchers often face limitations in funding and time. This adaptation ensures that the research remains feasible while still maintaining the essential stages of product development, testing, and evaluation (Sukmadinata, 2005). By streamlining the process, the study can effectively develop the *Breathing Cartoon* learning media while adhering to practical constraints.

Table 1. Seven out of Ten Stages in Research and Development According to Borg and Gall

No	Prosedur	Activities
1	Potential issues	Identified Potential issues
2	Collecting data	The formulation of the Learning Objective Flow (ATP) and lesson planning.
3	Design produk	Creating a learning media called "Breathing Cartoon."
4	Validate product	To validate "breathing cartoon" media.
5	Revise product	Improving the product after validation by media experts.
6	Product testing	Conducting a trial on Grade V students of MIN 21 Aceh Besar.
7	Final Product	The product can be used permanently.

Sources: Research and Development (Sugiyono, 2016)

In this research and development, the researcher uses two types of validation: media validation and material validation, namely: media validation, concept validation, questioner for teacher and student, HOTS test.

1. Data Collection Techniques

In this development research, the data collection techniques employed by the researcher encompassed two primary forms of validation: media validation and **content (material) validation**. Each type of validation was conducted using specifically designed instruments, as described below:

a. **Media Validation Instrument**

The media validation instrument was developed to assess the quality and appropriateness of the instructional media designed in the form of a "breathing cartoon"-based learning tool. This validation sheet consisted of 19 structured statements, each of which was categorized into four key dimensions: visual design, functionality, interactivity, and instructional effectiveness. These dimensions were selected to ensure a comprehensive evaluation of the media's technical and pedagogical quality. The expert validators were asked to evaluate each item using a Likert scale and to provide qualitative feedback where necessary.

b. **Content Validation Instrument**

The content validation instrument, often referred to as the material expert validation form, was constructed to evaluate the relevance, accuracy, and pedagogical appropriateness of the instructional content embedded within the developed product. This form contained a series of statements designed to capture expert judgments on how well the material aligned with educational objectives, curriculum standards, and learners' cognitive levels. The validators, typically subject-matter experts in education or curriculum development, provided both quantitative ratings and qualitative suggestions for content improvement.

c. **Students' Learning Outcomes on Higher-Order Thinking Skills (HOTS)**

To examine the effectiveness of the breathing cartoon-based instructional media in enhancing students' higher-order thinking skills (HOTS), this study employed a pretest-posttest design. The **pretest** was conducted to assess students' initial HOTS before the media was implemented, while the **posttest** was given after the learning activities were completed. This approach aimed to measure the improvement in students' cognitive abilities as a result of using the developed media.

Data Analysis of Media and Content Validation

The analysis of the validation results for both the instructional media and learning materials was conducted by calculating the scores assigned by expert validators. The formula used for this analysis is as follows:

$$P = \frac{f}{n} \times 100\%$$

To strengthen the feasibility assessment data, a qualification level for feasibility criteria was developed based on the analysis of average scores. The qualification criteria are presented in the table below:

Table 2. Product Validity Criteria (Anggun Farisa, 2023)

Interval Score	Validity Criteria
76% - 100%	Highly Valid
56% - 75%	Moderately Valid
40% - 55%	Less Valid
0% - 39%	Invalid

Analysis of Students' Learning Outcomes on HOTS

The N-Gain formula was used to measure the improvement between students' pretest and posttest scores. The progress achieved before and after the instructional intervention was calculated using the gain factor (N-Gain), as represented by the following formula:

$$G = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}}$$

Table 3. N-Gain Classification (Rusly Hidayah, 2021)

Precentage	Interpretation
$g > 0,7$	High
$0,3 < g < 0,7$	Moderate
$g < 0,3$	Low

Tabel 4. N-Gain Value and Effectiveness Level (Rusly Hidayah, 2021)

N-Gain Score	Eligibility Level
> 76	Highly Effective
56-75	Moderately Effective
40-55	Less Effective
< 40	Ineffective

C. Result and Discussion

1. Results of the Breathing Cartoon-Based Learning Media Design

This study utilizes the Borg and Gall development model with seven steps, namely:

a. **Potential and Problem Stage**, The development research begins with identifying problems encountered by the researcher before conducting a comprehensive study. The issues found in this research relate to learning tools such as teaching materials, including learning media and test questions administered to students.

Based on initial observations in Grade V at MIN 21 Aceh Besar, there is a lack of available teaching materials, particularly learning media, for teaching the science subject (IPAS) on the human respiratory system. The researcher found that the science teacher in Grade V employs common teaching techniques but lacks the use of concrete learning media to explain the material effectively. The test questions

given to students also primarily assess lower-order thinking skills, focusing on understanding and remembering (C₁, C₂). Based on these identified issues, the researcher sees the potential to develop a breathing cartoon-based learning media to enhance students' higher-order thinking skills (HOTS).

b. Data Collection

Data collection is crucial to understanding user needs regarding The product to be developed through research and development of breathing cartoon learning media. This stage involves gathering all relevant information to serve as a foundation for planning the developed product, ensuring it addresses the existing issues.

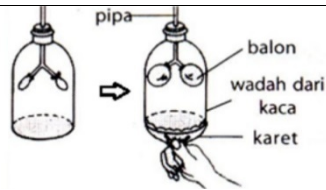
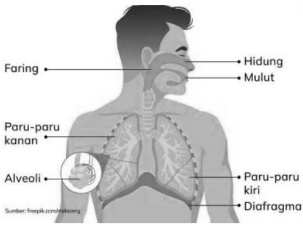
The preparation includes all tools and materials necessary for developing the media, as well as instructional materials such as teaching modules, high-order thinking skill (HOTS) test indicators (C₄, C₅, and C₆), and other resources needed for designing the breathing cartoon-based learning media.

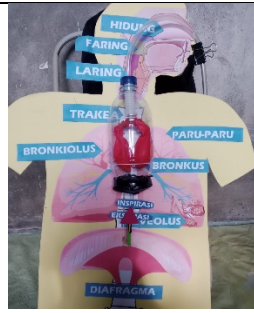
c. Product Design

Following the data collection step, the next phase is product design. The purpose of product design is to outline the features and structure of the breathing cartoon-based learning media that will be developed. The final product in this context is an interactive learning media focusing on the human respiratory system. The design is created to be as engaging as possible to capture students' attention during learning activities. The following sections outline the design, tools, materials, and steps for creating the breathing cartoon-based learning media:

1. Design of the Breathing Cartoon-Based Learning Media

Table 5. Design of Learning Media Based on Breathing Cartoon and Its Description

Picture Design	Description
	The design of the explanation of the human lung mechanism with the diaphragm.
	The design of the explanation of each organ in the human respiratory system in sequential order.



The design of the explanation of each organ in the human respiratory system in sequential order, including the mechanism of the lungs with the diaphragm.

Design Validation

The purpose of validating the breathing cartoon-based learning media is to assess the feasibility of the product before its implementation in research. The feasibility evaluation of this learning media includes material criteria, physical aspects, technical aspects, and its relevance to learning, each of which is assessed by validators. The results of the validation of the breathing cartoon-based learning media design are as follows:

Table 6. Results of the Validation Media of Breathing Cartoon-Based Learning

No	Aspects Assessed	Criteria	Validator	
			1	2
1	Physical	1. The suitability of the breathing cartoon media size and shape..	3	3
		2. The design of the learning media aligns with the taught material.	3	3
		3. The colors used in the media are attractive and varied.	4	3
		4. The entire media is assembled in a detailed and appealing manner (the learning media components match the parts of the human respiratory system	4	4
2	Material	1. The breathing cartoon media is durable and not easily damaged during use.	4	4
		2. The chosen materials align with the mechanism of the subject matter (human respiratory organs).	4	3
		3. The materials used for making the media are long-lasting.	3	3
		4. Utilizes recycled materials.	4	4
3	Technical	1. The breathing cartoon media is safe for anyone to use.	3	3
		2. The breathing cartoon media is practical and easy to carry anywhere.	3	4
		3. Simple and easy to manage..	4	4
		4. Can be manipulated and assembled/disassembled.	3	4
		5. Easy to produce.	4	4
		6. The material aligns with the students' context.	4	4

4	Suitability in learning	1. Aligns with the learning objectives and outcomes.	4	4
		2. Matches the taught subject matter.	3	3
		3. Facilitates and clarifies the understanding of science concepts.	3	4
		4. Encourages student engagement in the learning process.	4	3
		5. Increases students' interest in learning.	4	4
Scor			69	68
Average Skor			68.5	
Persentase			90%	
Criteria			highly feasible	

The breathing cartoon-based learning media is primarily focused on presenting the sequential arrangement of human respiratory organs and explaining the basic mechanisms of inspiration and expiration. However, it lacks the capacity to comprehensively address broader aspects of the human respiratory system, such as preventive measures for maintaining respiratory health and the identification and understanding of respiratory disorders.

While the development of breathing cartoon-based learning media has shown potential in enhancing students' higher-order thinking skills (HOTS), this study is not without limitations. A significant shortcoming is the limited discussion on the constraints and challenges that emerged during the field-testing phase. Consequently, critical aspects such as risk evaluation, user adaptability, technological limitations, and potential obstacles in broader classroom implementation were not fully examined. This gap restricts a comprehensive understanding of the media's practical effectiveness in varied educational settings. Future research is encouraged to incorporate a more rigorous evaluation of implementation challenges, which would contribute to refining the media design and supporting its scalability and sustainability across different contexts.

Several obstacles were encountered during both the development and implementation of the breathing cartoon-based learning media. In the development phase, challenges included simplifying complex respiratory concepts without losing accuracy and addressing technical limitations such as design tools and media compatibility. During implementation, issues arose related to classroom infrastructure, varying levels of student readiness, and limited teacher familiarity with digital media. These challenges highlight the need for further refinement and support to ensure effective and scalable use in diverse educational settings.

The obtained scores are then grouped into evaluation interpretation criteria for feasibility in the "highly feasible" category, along with several comments from media experts. Some additional components and minor modifications need to be made according to the suggestions from the media validator.

Table 7. Results of the Validation Concept of Breathing Cartoon-Based Learning Media

No	Aspect	Criteria	Validato r	
			V ₁	V ₂
1	Relevance to the Learning Objective Flow	1. Clarity of the learning objective flow (ATP).	4	4
		2. Clarity of learning outcomes (CP).	3	3
2	Relevance to Learning Objectives	1. Alignment of the material with learning objectives.	4	4
		2. Clarity of learning objectives.	4	4
3	Content Components	1. Completeness, breadth, and depth of the material..	4	3
		2. Usefulness of the presented material.	3	4
		3. Accuracy in material selection.	4	3
		4. Alignment of the material with the curriculum.	3	4
		5. Suitability of the material to students' context.	4	4
		6. Accuracy of the material concepts from a scientific perspective.	4	3
		7. The selected material is relevant to real-life situations (realistic).	4	4
4	Clarity of Material	1. Clarity of the material and teaching resources.	3	4
		2. Clarity of language that is easy to understand.	4	3
		3. Clarity of images in the material.	3	4
		4. Accuracy of the material concepts.	3	4
		5. Accuracy of the material and teaching resources.	4	4
5	Coherence of Material	1. The material is organized in a systematic structure.	4	3
		2. Coherence between chapters and subchapters within the learning content.	4	4
		3. The learning material is appropriate for students' level.	4	4
Score			70	70
Average Score			70	

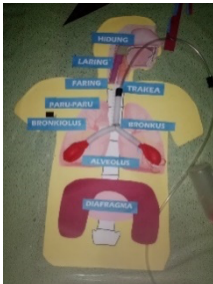
Percentage

97%

The obtained scores are then categorized based on evaluation interpretation criteria for feasibility at the "highly feasible" level. The material to be taught is ready for the next stage, with minor adjustments based on feedback from the material validator.

Design Revise

Table 8. The Result of Media Validation

First Design	Design Revision Validator I	Design Revision Validator II
		

Product Testing

Learning Outcomes on Students' HOTS

Data collection is carried out to measure the extent of students' thinking levels through the administration of a pretest and a posttest. The function of the pretest is to determine students' initial mastery of the material before being given treatment using breathing cartoon-based learning media. Meanwhile, the posttest is given to assess students' comprehension of the respiratory system in humans after the learning process using the breathing cartoon-based learning media. At this stage, the researcher aims to measure the improvement in students' higher-order thinking skills (HOTS) by testing them with pretest and posttest questions that meet Bloom's taxonomy criteria (HOTS). The results of students' pretest and posttest scores are presented in Table 9 as follows:

NO	Code	Pretest	Posttest	difference	Ideal Skor	N-Gain	Percentage
1.	S1	70	85	15	25	0.6	60%
2.	S2	55	80	25	40	0.6	62.5%
3.	S3	30	90	60	65	0.9	92.3%
4.	S4	55	75	20	40	0.5	50%

5.	S5	50	90	40	45	0.8	88.88%
6.	S6	60	75	15	35	0.4	42.85%
7.	S7	55	95	40	40	1	100%
8.	S8	55	90	35	40	0.8	87.5%
9.	S9	45	90	45	50	0.9	90%
10.	S10	70	95	25	25	1	100%
11.	S11	55	90	35	40	0.8	87.5%
12.	S12	60	90	30	35	0.8	85.71%
13.	S13	65	90	25	30	0.8	83.33%
14.	S14	65	95	30	30	1	100%
15.	S15	60	95	35	35	1	100%
16.	S16	40	90	50	55	0.9	90.90%
17.	S17	55	80	25	40	0.6	62.5%
Average						0.81	81.41%

Based on the pretest results, it can be concluded that fifth-grade students have not yet mastered higher-order thinking skills (HOTS) questions. The posttest results, after implementing the breathing cartoon-based learning media, consisted of 15 multiple-choice questions. Twelve students scored above 90, with a high N-gain criterion ($g > 0.7$), while five students achieved scores with a medium N-gain criterion ($0.3 < g < 0.7$). The average N-gain score was 0.81 (81.41%), which falls into the "highly feasible" category. Therefore, it can be concluded that the use of breathing cartoon-based learning media is effective in improving the higher-order thinking skills (HOTS) of fifth-grade students.

D. Simpulan

Based on the research findings and discussion, the conclusions of this study are as follows:

1. The development of breathing cartoon-based learning media follows the Borg and Gall approach, starting with identifying potentials and problems, which includes analyzing the needs of teachers, students, and the curriculum. The data collection stage involves gathering all necessary materials for product creation. The product design stage focuses on developing the breathing cartoon-based learning media. Product validation is conducted by expert validators, followed by product revision based on their feedback. The product testing phase involves implementing the media in the research setting. Finally, the final product stage ensures that the breathing cartoon-based learning media is ready for continuous use.
2. The feasibility test results for the breathing cartoon-based learning media show that media experts rated it at 90%, while subject matter experts gave a

score of 97%. The overall average score from the validation team was 93.5%, categorizing the media as "highly feasible.

E. Thank You Note

The author extends sincere appreciation to the entire academic community of MIN 21 Aceh Besar for their support and assistance throughout the research process, particularly in facilitating the necessary permissions and research activities. Special gratitude is extended to the team of teachers and students for their valuable contributions. Additionally, the author acknowledges the team of faculty members who generously contributed their expertise as validators for the media and materials, playing a crucial role in the development and validation of the research instruments.

F. Author Contribution Statement

This study was conducted by DN as the principal author, with ZH serving as the co-author. MH was responsible for data analysis, while NV contributed to the development of the research instruments. The successful completion of this research would not have been possible without the collaboration of various stakeholders, underscoring the essential contributions of all involved in the research process.

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