

Enhancing Students' Scientific Literacy on Competence Aspect through Flipchart Media: *A Development Study on Human Respiratory System Learning*

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Abstract

Background: The level of science literacy among junior high school students regarding the human respiratory system remains low, as abstract concepts are difficult to grasp due to the limited learning media provided by teachers. This study aims to develop science literacy-based flipchart media to improve the scientific competence of eighth-grade students at MTsS Al-Washliyah Sei Langgei. **Methodology:** Using the Research and Development (R&D) framework, the study followed the 4D sequence of Define, Design, Develop, and Disseminate. Subject and media experts, science educators, and 24 students from seventh grade participated in this research. Data collected through expert validation forms, teacher and student practicality questionnaires, and pretest–posttest assessments. The data were analyzed quantitatively through validation percentages and N-Gain to assess effectiveness, as well as qualitatively through descriptive narratives of the comments and suggestions of experts and teachers. **Findings:** The results showed that the flipchart was highly valid (subject matter experts 96.43%; media experts 98.44%), highly practical (teachers 96.59%; students 98.13%), and effective (N-Gain 0.71). **Contribution:** These findings confirm that science literacy-based flipcharts are effective in improving students' conceptual understanding and scientific skills, facilitate teachers in delivering material, and can be used as an alternative medium and reference for the development of other science learning media.

Keywords: Flipchart; Science Literacy; Scientific Competence; R&D; Respiratory System



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INTRODUCTION

Education in the 21st century is characterized by an emphasis on cultivating learners' competencies to prepare them for the dynamic challenges of globalization, particularly those emerging from rapid progress in technology, science, and information. In this educational paradigm, students are expected to develop the four essential skills of critical, creative, communicative, and collaborative thinking (4C), along with the capacity to apply technology for addressing real-life issues (Mardhiyah et al., 2021). Within this framework, scientific literacy is regarded as a core competency that enables students to comprehend and utilize scientific principles in daily contexts and to engage meaningfully in a knowledge-oriented society (Yuliati, 2017). Therefore, strengthening science literacy in the learning process is an important issue in 21st-century education, especially in science subjects that are oriented towards the development of scientific thinking skills.

However, the results of the PISA international assessment show that the science literacy level of Indonesian students is still low, ranking 69th out of 81 countries (OECD, 2019). This condition indicates that science learning in schools has not fully developed students' scientific and contextual thinking skills. One of the causes is the lack of learning media that can bridge abstract concepts to make them more concrete and easier to understand. Therefore, media is needed that is not only visually appealing, but also can increase students' cognitive engagement with the learning material.

One medium that can be used to support this goal is a flipchart. A flipchart is a visual medium in the form of large sheets of paper containing information or images, arranged in sequence and turned over one by one as needed for presentation (Negara & Hendratno, 2014; Ansori, 2018). The use of flipcharts allows teachers to convey learning concepts in a systematic, interactive, and visually appealing manner. Compared to digital media that requires technological tools, flipcharts have the advantage of being easy to use, cost-effective, and flexible in various classroom conditions (Susilana & Riyana, 2009). In addition, flipcharts encourage students to think actively and engage in visual observation and discussion, which has the potential to improve science literacy skills.

Human respiratory system material is one of the science topics in eighth grade junior high school that often poses a challenge for students. This difficulty arises because the material contains many biological terms and abstract physiological processes, such as gas exchange mechanisms or respiratory organ functions that cannot be observed directly (Ritonga, 2016; Ilmi & Erman, 2019). Research shows that students often have difficulty remembering the names of respiratory organs, sequencing the processes of inspiration and expiration, and explaining their functions logically (Hasanah et al., 2023). These difficulties indicate a cognitive challenge in the form of students' limitations in connecting scientific concepts with real-life experiences. Several studies also report that the lack of contextual visual media makes it difficult for students to visualize the structure and function of respiratory organs (Sukowati et al., 2017; Pratiwi et al., 2019).

In this context, flipcharts can be a solution because they facilitate the visual representation of the human respiratory process through sequential and descriptive

images. The step-by-step visualization presented in flipcharts allows students to understand the respiratory process gradually and concretely, while stimulating their ability to explain scientific phenomena based on evidence. The competencies of scientific literacy outlined by [OECD \(2015\)](#) encompass three main aspects: (1) the explanation of scientific phenomena, (2) the evaluation and design of scientific investigations, and (3) the interpretation of scientific data and evidence. In accordance with these dimensions, flipcharts are not merely utilized as instructional media but are also employed as tools that foster students' contextual understanding, enhance scientific reasoning, and strengthen their literacy in science.

Based on interviews with eighth-grade science teachers at MTsS Al-Washliyah Sei Langgei, it was found that the learning process is still dominated by lecture methods, with minimal use of innovative learning media. Complex material such as the human respiratory system is often delivered conventionally, making it difficult for students to understand the concepts, causing them to become less active and not optimally involved in the learning process. The results of observations also reinforce this finding, where students tend to be passive during learning and rarely engage in exploratory activities or scientific discussions. The effectiveness of the learning process can be significantly enhanced through the use of appropriate instructional media, particularly when it is developed based on a science literacy approach that stimulates critical thinking, deepens understanding of scientific processes, and connects learning content to real-life contexts. Consequently, learning media should be designed not only to be engaging and interactive but also to actively strengthen students' scientific competencies and foster the advancement of their science literacy skills.

Research on human respiratory system learning has been conducted extensively, but it generally focuses on learning models and digital media, without paying attention to strengthening science literacy, especially students' scientific competence. [Mukarramah \(2019\)](#) used the Talking Stick model with audiovisual media, but did not develop new media and did not focus on scientific skills. [Larasati et al. \(2011\)](#) used effective cooperative learning-based animated multimedia, but it was not suitable for schools with limited technology and did not focus on scientific competence. Meanwhile, [Malahayati \(2022\)](#) developed a flipchart medium that was considered feasible, but did not test its impact on science literacy. These three studies indicate that there is no flipchart media specifically developed to improve students' scientific competencies. To address this gap, the development of flipchart media grounded in science literacy principles for the topic of the human respiratory system was undertaken in this study.

Based on the above description, it can be inferred that the selection of suitable learning media plays a crucial role in facilitating students' comprehension of human respiratory system concepts in a more tangible and scientifically grounded way. The creation of flipchart-based instructional media is regarded as a potential approach to enhance students' scientific literacy—particularly in competencies involving the explanation of phenomena, analysis of evidence, and formulation of scientific investigations. Accordingly, this research is centered on the development and evaluation of flipchart media aimed at fostering students' science literacy on the topic of the human respiratory system. The outcomes of this study are anticipated to provide

meaningful contributions to the advancement of innovative and contextual science learning models that emphasize the reinforcement of 21st-century skills.

METHOD

The study took place at MTsS Al-Washliyah Sei Langgei and employed a Research and Development (R&D) methodology. The main objective was the creation of flipchart learning media grounded in scientific literacy, developed through a structured research and development process. In carrying out this study, the 4D model—comprising the stages of Define, Design, Develop, and Disseminate—was adopted as outlined by [Amir & Parumbuan \(2018\)](#).

Research Design

The objective of this Research and Development (R&D) study was the production of flipchart-based learning media that demonstrate validity, practicality, and effectiveness in enhancing students' scientific literacy, particularly in terms of scientific competence. The study was carried out by applying the 4D development model, which includes four sequential phases. The first stage, *Define*, aims to identify needs and problems in learning. The second stage, *Design*, involves developing a preliminary design for the flipchart media product. The third stage, *Development*, includes expert validation, revision, and product testing. The fourth stage, *Disseminate*, aims to test the acceptability of the media on a limited basis in schools.

Research Subjects

The research subjects consisted of several parties involved according to their respective roles. A subject matter expert assessed the suitability of the content and concepts in the material on the human respiratory system, while a media expert assessed the appearance, appeal, and usefulness of the media. In addition, a science teacher assessed the practicality of the media in learning. Furthermore, 24 eighth-grade students participated in the media trial phase to assess its effectiveness.

The media testing was conducted in two stages, namely limited testing and extensive testing. Limited testing was carried out on some students to obtain feedback and make initial improvements to the product, while extensive testing involved all 24 students. Each stage was carried out in two meetings, each lasting 80 minutes, with the aim of ensuring the effectiveness of flipchart media in supporting learning activities.

Instruments and Validation

Several instruments were employed in this study, consisting of validation sheets for subject matter and media experts, practicality questionnaires for teachers and students, as well as pretest and posttest assessments designed to evaluate the effectiveness of the developed learning media. The content validity of all instruments was obtained through assessment by two expert validators, with a validity coefficient of more than 0.80, which is classified as highly valid ([Sugiyono, 2019](#)). In addition, The reliability of the instruments was assessed through the application of the

Cronbach's Alpha formula, yielding an r-value exceeding 0.80, which demonstrates that the instruments possessed a high level of reliability (Arikunto, 2019).

Research Procedure

This research procedure follows four stages in the 4D model. The Define stage is carried out through front-end analysis with teacher interviews to determine learning needs, learner analysis through student questionnaires, concept analysis based on syllabi and textbooks, and task analysis from curriculum documents. During the Design phase, the creation of science literacy-based flipchart learning media was carried out to align with students' needs and the content of the human respiratory system. In the Develop phase, validation was performed by subject matter and media experts, followed by product revisions based on their feedback, and subsequently, limited and broader trials were implemented. The final stage, Disseminate, involves the limited distribution of the revised flipchart media at MTs Al-Washliyah Sei Langgei, involving eighth-grade students to assess the media's acceptability and its contribution to science learning.

Data Analysis

The data utilized in this research comprised both qualitative and quantitative types data. Qualitative data were gathered from the feedback and suggestions of subject matter experts, media experts, and science teachers. These data were then descriptively and narratively analyzed through processes of reduction, categorization, and interpretation. Meanwhile, quantitative data was obtained from the results of media validation, practicality, and effectiveness, which were analyzed using a Likert scale to determine the level of product feasibility using a specific formula as shown in Table 1.

Table 1. Likert Scale Assessment (Erianti et al., 2023)

Score	Qualification
4	Strongly agree
3	Agree
2	Less agree
1	Disagree

This study employed data analysis techniques encompassing analyses of feasibility, practicality, and effectiveness. The developed flipchart was subjected to feasibility and practicality assessments through the application of the following formula (Salsabila & Tambunan, 2022).

$$\text{Analysis (\%)} = \frac{\text{score obtained}}{\text{maximum score}} \times 100 \dots\dots\dots (1)$$

The validator first evaluates the data, after which the researchers calculate it and display the obtained results in Table 2. Responses from science teachers and students were used to obtain the practicality test data, which were subsequently classified into practicality categories as shown in Table 3.

Table 2. Product Eligibility Criteria (Aulia et al., 2022)

Category	Percentage Score (%)
Highly desirable	75 – 100
Suitable	50 – 75
Less Suitable	25 – 50
Unsuitable	0 – 25

Table 3. Product Practicality Criteria (Rozi et al., 2021)

Category	Percentage Score (%)
Very Practical	75 – 100
Practical	50 – 75
Less Practical	25 – 50
Not Practical	0 – 25

To evaluate the attainment of the flipchart media development goals, researchers carried out an effectiveness test analysis. The level of effectiveness of the flipchart media was then assessed by applying the formula proposed by Oktavia et al., (2019). The effectiveness of the developed flipchart was evaluated by analyzing data obtained from students' pretest and posttest outcomes. Subsequently, the resulting dataset was systematically organized and classified in accordance with the practicality criteria summarized in Table 4.

$$N\text{ Gain} = \frac{\text{pretest score} - \text{posttest score}}{\text{maximum score} - \text{pretest score}} \dots\dots\dots (2)$$

Table 4. N gain score range (Nora & Suryanti, 2023)

Score Range	Criteria	Level of effectiveness
N-gain < 0.7	High	Effective
$0.3 \leq \text{N-gain} \leq 0.7$	Currently	Quite Effective
N - gain 0.3	Low	Less Effective

RESULT AND DISCUSSION

This study developed a flipchart as the primary learning medium. The research applied a Research and Development (R&D) approach based on the 4D model, which includes the stages of Define, Design, Develop, and Disseminate. In this study, the dissemination stage was implemented in a limited manner, focusing solely on introducing the developed flipchart to eighth-grade students at MTs Al-Washliyah Sei Langgei.

Define Stage

The Define stage, several analyses were performed, including front-end, learner, concept, and task analyses (Ariyanti, 2022). Through interviews conducted with science teachers, the front-end analysis identified that students found it challenging to comprehend the concept of the respiratory system when it was delivered

solely through verbal explanations without the aid of flipchart media. The learner analysis, obtained via questionnaire responses, indicated that approximately 70% of students experienced difficulties in understanding the material. Therefore, the developed media needed to provide clear visual representations, structured material organization, and interactive features to enhance students' science literacy. Meanwhile, the concept analysis involved reviewing the syllabus, textbooks, and curriculum documents to establish the content scope and depth, and the task analysis detailed the expected competencies, learning steps, and objectives aligned with the Core (KI) and Basic Competencies (KD).

Design Stage

The Design stage aims to create an initial flipchart design according to learning needs (Zahara et al., 2024). Needs analysis shows that around 70% of students have difficulty understanding the concept of the respiratory system, and teachers state that the material is difficult to understand if it is only delivered verbally. Based on these findings, the media was designed to provide clear visualization of concepts, systematic presentation of material, and interactivity to support science literacy. The researchers then collected relevant material, set learning objectives, and designed the flipchart using the Canva application, including determining the images, colors, font size, and storage boxes. The resulting prototype was validated by subject matter experts and media experts; valid media was tested on students, while invalid media was revised until it was suitable for use.

Development Stage

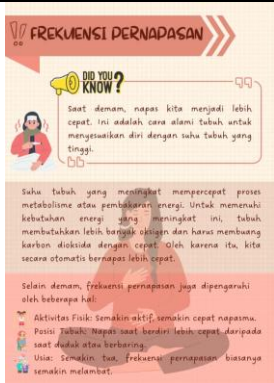
Before the testing phase was carried out, the flipchart media underwent a development stage that involved validation from both media and subject matter experts. Comments and suggestions from the experts can be seen in Table 5, where revisions made include improving the appearance of images that were previously unclear to make them brighter, improving the layout that was originally mixed with images, making it difficult to read, to make it neater by separating the text from the images, and organizing information that was initially dense and unclear to make it more systematic so that it is easy to follow.

This development process went through several stages, starting with expert validation, followed by the first stage of revision, then declared valid for extensive testing until completion. Furthermore, the media was also declared valid through limited testing followed by the second stage of revision until finally obtaining a final product that was suitable for use in learning.

Subject Matter Expert Feasibility Analysis

Assessment of the flipchart media design was carried out by subject matter expert validators, who evaluated several aspects such as learning design, content, and language. Following the revision process based on their feedback, the results of the flipchart's feasibility assessment are presented in Table 6.

Table 5. Feedback of Flipchart's Media Assessment

Before Revision	After Revision
 The text layout is mixed with images, making it difficult to read	 The layout is neater, with text separated from images so that it is easy to read
 The information on the slide is still dense, making the flow unclear	 The information is organized more systematically so that the flow is easy to understand

Tabel 6. Results of Expert Validation

Aspect	Percentage (%)	Category
Learning Design, Content & Language	96.43	Highly Desirable

The graphic design and presentation aspects of the flipchart were assessed by media experts, and the outcomes of their evaluation are presented in Table 7. Referring to the data in Tables 6 and 7, the flipchart media on the human respiratory system material aimed at enhancing students' science literacy in scientific competency aspects was deemed highly feasible, as indicated by the subject matter experts' score of 96.43%. In addition, the media experts' evaluation produced a feasibility percentage of 98.44 %, further confirming the validity of the developed flipchart. The feedback and recommendations provided by the validators were utilized to assess the media's feasibility prior to field implementation. The validity evaluation covered several components, including instructional design, content accuracy, linguistic quality, visual elements, and presentation format (Saragih & Tanjung, 2023).

Table 7. Media Expert Validation Results

Aspect	Percentage (%)	Category
Graphical presentation	98.44	Highly Desirable

The Practicality of Flipcharts

The practicality data of the flipchart media was collected through response questionnaires completed by science teachers and eighth-grade students at MTsS Al-Washliyah Sei Langgei after the media was implemented in classroom learning. As stated by [Malahayati \(2022\)](#), the practicality level of flipcharts is determined based on questionnaire responses from both students and teachers. The level of practicality can be observed from the learning process that employs flipcharts, which demonstrates effective and efficient outcomes. This indicates that every instructional medium possesses its own advantages. The practicality results obtained from science teachers are presented in Table 8.

Table 8. Teacher Response Results

Respondents	Percentage (%)	Category
7th grade science teacher	96.59	Very Practical

From the questionnaire responses provided by science teachers, it was revealed that the flipchart media developed for the topic of the human respiratory system was highly practical for use in learning activities, achieving a practicality score of 96.59 %. The flipchart was classified as very practical since it could be effectively applied during classroom instruction as well as utilized by students for independent study. Moreover, student feedback played an essential role in evaluating this media, as learners directly engaged with it during the learning process. A total of 24 students participated in filling out the flipchart practicality questionnaire, and the calculated results from their responses are presented in Table 9.

Table 9. Student Response Results

Respondents	Percentage (%)	Category
24 Students	98.13	Very Practical

As shown in Table 9, the flipchart was classified as highly practical, with an obtained score of 98.13 %. Furthermore, it was discovered in this study that the flipchart effectively supported the learning process since its objectives were aligned with the predetermined Basic Competencies (KD).

Effectiveness of Flipchart Media

[Malahayati \(2022\)](#) stated that the effectiveness of flipchart media was determined through students' test results and learning effectiveness assessment sheets. During the trial phase, both pretests and posttests were administered. The pretest was conducted prior to the use of the flipchart media to identify students' initial understanding, while the posttest was carried out afterward.

In the present study, effectiveness testing involved administering pretest and posttest items to 24 eighth-grade students. The test instruments were developed based on indicators of scientific competence. The resulting effectiveness data were processed using the N-Gain formula, the outcomes of which are presented in Table 10.

Table 10. Results N-Gain

Number of Students	Pre-test	Post-test	N-Gain	Category
24 Students	40.91	83.25	0.71	Effective

Referring to Table 10, the students' mean score increased from 40.91 on the pretest to 83.25 on the posttest. An N-Gain value of 0.71 was obtained, indicating that the flipchart media was categorized as effective. These findings demonstrate that the use of flipcharts contributes to the enhancement of students' science literacy. Furthermore, to obtain a more detailed overview of the outcomes, an analysis of effectiveness was carried out for each scientific competency indicator, with the results presented in Table 11.

Table 11. N-Gain Results per Scientific Competency Indicator

Scientific Competency Indicators	Pre-test	Post-test	N-Gain	Category
Explaining Scientific Phenomena	38.75	81.25	0.70	Effective
Explaining Scientific Issues	42.00	85.00	0.72	Effective
Explaining Scientific Evidence	41.50	83.50	0.69	Quite Effective
Total	40.91	83.25	0.71	Effective

The findings of this study indicate that students' scientific literacy, particularly in the aspect of scientific competence, was effectively enhanced through the implementation of flipchart media in learning activities on the human respiratory system. The indicator explaining scientific phenomena increased from an average score of 38.75 on the pretest to 81.25 on the posttest with an N-Gain of 0.70, which is classified as effective. This improvement shows that flipchart media can facilitate students' understanding by linking everyday phenomena—such as coughing, hiccups, yawning, asthma, and hypoxia—with the mechanisms of the respiratory organs, so that students can connect concrete experiences with scientific concepts. Similar results have also been reported in earlier studies, where the use of interactive visual media was found to enhance students' conceptual understanding and their ability to describe scientific phenomena (Hidayati, 2020; Putra, 2021).

A notable improvement was observed in the indicator related to explaining scientific issues, with the mean score rising from 42.00 to 85.00 and an N-Gain value of 0.72, categorized as effective. This indicates that the use of flipcharts enhances students' comprehension of how environmental problems—such as pollution and cigarette smoke—are connected to respiratory health. In other words, this medium not only conveys concepts but also helps students relate the material to real-life contexts, thereby strengthening science literacy. These results support Santoso (2019) findings,

which show that visual media relevant to everyday life can improve students' ability to explain scientific issues.

Meanwhile, the indicators show that scientific evidence obtained an N-Gain of 0.69, which is classified as fairly effective. This improvement occurred because the flipchart presented material on the exchange of oxygen and carbon dioxide in the alveoli through diffusion and respiratory volume, which helped students understand the basics of scientific evidence. However, because the presentation was in the form of visual illustrations and brief explanations, students' understanding was not as deep as in the indicators of scientific phenomena and issues. This shows that although flipcharts are quite supportive, scientific evidence indicators require additional methods, such as practical work or simple simulations, to strengthen scientific thinking skills. This finding is in line with [Rahmawati \(2020\)](#) research, which emphasizes the need for a combination of visual media and practical activities to improve understanding of scientific evidence.

The effectiveness of flipchart media in enhancing students' science literacy is reflected by an average N-Gain of 0.71. This result demonstrates that the medium functions as a high-quality learning resource capable of reinforcing conceptual understanding, improving the ability to explain scientific issues and phenomena, and linking real-life experiences to scientific principles. Consequently, the use of flipchart media is considered pivotal in facilitating science instruction aimed at cultivating scientific and critical thinking skills, while extending the insights of prior studies concerning the role of interactive visual media in fostering science literacy.

CONCLUSION

The flipchart learning media designed for the topic of the human respiratory system was verified to be valid, practical, and effective. Validation conducted by material and media experts yielded scores of 96.43 % and 98.44 %, respectively, whereas practicality assessments by teachers and students achieved 96.59 % and 98.13 %. The medium's effectiveness was evidenced by an N-Gain value of 0.71, categorized as effective. These outcomes reveal that the implementation of flipcharts contributes to enhancing students' scientific literacy, facilitates teachers in presenting content in a more engaging and contextual way, and promotes a deeper grasp of scientific concepts. However, since this research was carried out in a single school involving only 24 eighth-grade participants, the generalization of the results should be approached cautiously. The use of flipchart media is therefore suggested for junior high school science instruction and may serve as a reference for the creation of other media grounded in scientific literacy principles.

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