Bioedukasi
Jurnal Biologi dan Pembelajarannya
Vol. 23 No 2, June 2025, page 322-332
e-ISSN: 2580-0094; p-ISSN:1693-3931
DOI: 10.19184/bioedu.v23i2.53734
bioedukasi.jurnal.unej.ac.id/index.php/BIO

Development of a Science Literacy-Based Digital Flipbook on the Circulatory System Material for Grade XI at MA Laboratory UINSU Medan

Dwi Kinanti Ayunda[1], Rohani[2]
[1, 2] Biology Education, Faculty of Tarbiyah and Teacher Training, State Islamic University of North Sumatra, Medan, Indonesia

Article Info
Article history:
Received June 21, 2025
Revised June 25, 2025
Accepted June 25, 2025

Keywords: (A-Z)
circulatory system
digital flipbook
scientific literacy

ABSTRACT
This study aimed to develop a digital flipbook as a learning medium based on scientific literacy for circulatory system material, designed to meet the criteria of validity, practicality, and effectiveness. The research employed a Research and Development (R&D) approach using the 4D model, although it was carried out only up to the development phase due to time and resource constraints. The trial participants were students of class XI IPA 1 at MA Laboratorium UINSU Medan. Data collection instruments included teacher interviews, student needs analysis questionnaires, validation sheets from media and material experts, teacher and student response questionnaires, and 20 validated multiple-choice test items. The findings indicated that the flipbook was highly valid (97% media validation, 97.7% material validation), highly practical (91.3% student responses, 89.2% teacher responses), and effective, as shown by an increase in the average score from 35.21 to 82.39 and an N-Gain score of 0.72, which falls into the high/effective category. Therefore, the scientific literacy-based digital flipbook is considered suitable for use in the teaching and learning process.

Corresponding Author:
Dwi Kinanti Ayunda
Biology Education Study Program, Faculty of Tarbiyah and Teacher Training State Islamic University of North Sumatra, Medan,Indonesia
Email: kinantiayundalubis@gmail.com

1. INTRODUCTION

Education is a means to develop human potential and help individuals shape their characther, as outlined in the provisions of Law Number 20 of 2003 on the National Education System in Indonesia. Education must bring about change and shape students to have critical and logical thinking skills according to their areas of expertise. Moreover, learners are encouraged to generate meaningful contributions, find solutions to contemporary challenges, and respond effectively to societal and technological changes. The ability to adapt to developments in the era can be obtained through various means, one of which is through scientific literacy, which is an important aspect to prepare students to face global challenges (Auliaty et al., 2021).

The ability to grasp scientific knowledge, articulate it effectively in both verbal and written forms, and apply relevant scientific skills is known as scientific literacy. Scientific literacy is essential in daily life to solve problems based on scientific knowledge that has been acquired (Lestari et al., 2022). Scientific literacy is a goal that must be achieved. One of the subjects that focuses on science is biology Biology is a subject that requires the application of the scientific method in its learning process. Therefore, students need to have scientific literacy knowledge (Alfionora & Hasnah Putri, 2021).

Nevertheless, research findings reveal that The level of scientific literacy among students in Indonesia remains relatively low (Nurmazia Firahma Tillah, 2025). OECD, (2023) reported that based on PISA 2022 data, the global average score was 485, while Indonesia only achieved a score of 383, ranking 67th out of 81 countries. Although Indonesia's ranking improved from 71st place in 2018, its score actually dropped by 13 points and still lags 102 points behind the global average, indicating a decline in students' scientific literacy skills. These results are consistent with the study by Rahmadani (2022), which showed that 66% of Grade X students at SMAN 1 Kuripan had scientific literacy in biology categorized as low. A similar condition was also found in North Sumatra, at SMA Negeri 2 Kota Pinang, where the average scientific literacy score of Grade X students reached 50.76, with male students scoring 47.78 and female students scoring 52.27 (Harahap & Harahap, 2022)

In general, students' scientific literacy is limited to recognizing simple scientific knowledge without being able to connect scientific topics or apply complex concepts in everyday life, even though education should prepare them to contribute to building an open, decent, and dynamic society (Hasasiyah et al., 2020). In line with this, Zulanwari (2023) emphasized that that insufficient scientific literacy is also influenced by learning processes that are not yet oriented towards its development. This is consistent with facts in the field, where, based on interviews and observations of 23 students, about 80% stated that teachers had never carried out scientific literacy activities during the learning process, resulting in students' low scientific literacy skills. This, in turn, affects their low academic achievement, with an average score of 47 compared to the minimum passing grade (KKM) of 75 in biology subjects. The low level of scientific literacy among students at MA Laboratorium UINSU Medan is caused by the absence of learning media containing scientific literacy content as a tool for education. According to observations, students expressed the need for learning media that includes scientific literacy content as a source of learning. Currently, the only learning resource available to students is the standard textbook.

An effort to overcome learning obstacles at MA Laboratorium UINSU Medan is to adapt teaching materials that attract students' interest. This is done by implementing technology-based learning media, namely a digital flipbook, because the school facilities at MA Laboratorium UINSU Medan are also equipped with adequate ICT (Information and Communication Technology) media, such as projectors, laptops, and computers. One of the selected media that can be utilized is the development of a scientific literacy-based flipbook. A flipbook is a digital book that uses three-dimensional e-book technology, allowing users to flip through pages like a physical book. The development of a scientific literacy- The use of a digital flipbook is vital as one of the learning resources for students. It is expected that the presence of this digital flipbook will make classroom learning more varied and less monotonous (Hamid & Alberida, 2021). The development of teaching materials in the form of a flipbook equipped with images, background music, videos, as well as learning themes and subthemes will make students more interested and motivated to learn (Diana et.,al 2022).

Many researchers have developed scientific literacy-based digital flipbooks, such as (Machsun & Indana, 2023), who developed a scientific literacy-based flipbook on cell metabolism material; (Mahara, 2022), who developed a scientific literacy-based flipbook on colloid material; (Ritonga et al., 2022), who developed a digital flipbook on the excretory system material for Grade XI high school students; and (Prasetyaningrum 2020), who developed a flipbook on the digestive system material. However, no one has yet developed a scientific literacy-based digital flipbook on the circulatory system material in biology learning. Therefore, the aim of this study is to develop a scientific literacy-based digital flipbook for the circulatory system material. It is expected that this digital flipbook will help students learn and better understand the lessons, especially regarding the circulatory system.

Based on the previously stated problem and background, the researcher has chosen the title "Development of a Scientific Literacy-Based Digital Flipbook on Circulatory System Material for Grade XI Students at MA Laboratorium UINSU Medan." The objective is to create learning media that are valid, practical, and effective. This digital flipbook is expected to enhance students' learning outcomes and support teachers in delivering instructional material on the circulatory system.

2. RESEARCH METHOD

This research utilizes the Research and Development (R&D) approach, which is a structured process consisting of several phases aimed at producing new products or improving existing ones. According to Okpatrioka (2023), this method falls under the category of developmental research. In this study, the 4D model was applied, encompassing the stages of define, design, develop, and disseminate (Riani Johan et al., 2023).This study was carried out only up to the development stage due to time and resource constraints.

Figure 1. Stages of the 4-D Model by Thiagarajan (1974)

The research procedure began with the Define stage, which consists of: (1) Front-end analysis, where the researcher identifies and establishes the fundamental research problem to develop the desired product. (2) Learner analysis, in which a needs assessment questionnaire is distributed to students. (3) Concept analysis, which involves conducting interviews with biology teachers about the biology content and challenges in biology teaching, followed by determining the material to be developed. (4) Task analysis, to identify the tasks within the content that are necessary for the learning process. (5) Learning objective analysis, which helps summarize the findings from the concept and task analyses to define the behavior of the objects being studied. Additionally, this stage serves to ensure the research remains focused on its original objectives during the product development process.

The design phase focused on organizing the content and structuring the product to be developed. This phase involved: (1) preparing the material, which was aligned with the circulatory system topic and adapted to the Grade XI Science textbook under the K13 curriculum used at MA Laboratorium UINSU Medan; (2) selecting appropriate media, based on students' needs identified through prior problem analysis; and (3) determining the format, where the scientific literacy-based digital flipbook was designed using the Canva platform, incorporating relevant features to support learning.

Development stage: This stage consists of expert validation, which includes material validators and media validators. Following this, a product trial is conducted by distributing the developed product to Grade XI Science classes at MA Laboratorium UINSU Medan to assess the effectiveness of the product based on evaluations from both teachers and students.

Research Instruments

The participants in this research comprised 23 students from Grade XI Science 1 at MA Laboratorium UINSU Medan during the 2025/2026 academic year. The sample was chosen through purposive sampling, a technique that selects participants based on predetermined criteria. In this study, the criteria included students who had previously learned the circulatory system topic and were willing to engage fully in the research process. This group was utilized to evaluate the practicality and effectiveness of the digital flipbook developed based on scientific literacy principles.

To assess the scientific literacy-oriented digital flipbook media, a series of trials were conducted to evaluate its validity, practicality, and effectiveness. Subject matter and media experts carried out the validation using structured validation sheets, focusing on the appropriateness of the content and the visual design of the media. Furthermore, the practicality test was conducted through response questionnaires distributed to teachers and students after using the digital flipbook in the learning process. The effectiveness test was conducted by administering pre-tests and post-tests consisting of 20 multiple-choice questions with five answer options to determine the improvement in student learning outcomes after using the digital flipbook media.

Data Analysis Technique

The product validity analysis was conducted to test the validity of the product through questionnaires distributed to media experts and material experts. The questionnaire used a Likert scale, in which the variables were measured and broken down into variable indicators. The following are the score categories on the Likert scale according to Sugiyono (2015).

Table 1. Likert Scale

Category	Score
Strongly Agree	5
Agree	4
Neutral	3
Disagree	2
Strongly Disagree	1

Source: (Sugiyono, 2015)

Validation Data Analysis

The validation involved two experts: a media expert and a material expert. The analysis of the validation results from these two experts was processed using the formula by (Samitra & Harmoko, 2021) as follows.

$$\boldsymbol{Persentase} = \frac{\boldsymbol{Total\ Score\ Obtained}}{\boldsymbol{Maximum\ Possible\ Score}}\ \boldsymbol{X}\ \mathbf{100}\%$$

The results of the validation from the two experts are categorized in the table below:

Table 2. Criteria for Validity of Learning Media

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

Source: Samitra & Harmoko (2021)

Practicality Data Analysis

The analysis of practicality was obtained through a teacher questionnaire consisting of 13 items and a student response questionnaire, also comprising 13 items, both focused on evaluating the use of the developed learning media. The practicality data of the scientific literacy-based digital flipbook was analyzed using the formula proposed (Milala et al., 2021) as follows.

$$\boldsymbol{Persentase = \frac{Total\ Score\ Obtained}{Maximum\ Possible\ Score}\ X\ 100\%}$$

The following is the categorization of the practicality range for the developed media:

Table 3. Practicality Criteria for Learning Media

Prensentase	Category
81-100%	Very Practical
61-80%	Practical
41-60%	Fairly Practical
21-40%	Less Practical
0-20%	Not Practical

Source**:** Milala et al., 2021

Effectiveness Data Analysis

The effectiveness analysis was conducted by testing student learning outcomes through pre-tests and post-tests consisting of 20 multiple-choice questions at levels C1-C5, which were calculated using the N-Gain formula by (Kolopita et al., 2022).

$$\boldsymbol{N\ Gain = \frac{Posttest\ Score - Pretest\ Score}{Ideal\ Score - Pretest\ Score}}$$

The classification of the effectiveness of using scientific literacy-based digital flipbook media is based on category levels according to the N-Gain score, as shown in the table below:

Table 4. N-Gain Normality Criteria

Skor N-Gain	Classification	Description
$0{,}70 \leq n \leq 1{,}00$	High	Effective
$0{,}30 \leq n \leq 0{,}70$	Medium	Moderately Effective
$0{,}00 \leq n \leq 0{,}30$	Low	Less Effective

Source: Kolopita et al. (2022)

3. RESULT AND DISCUSSION

Based on the research that has been conducted, scientific literacy-based digital flipbook learning media was developed on the circulatory system material for Grade XI Science students at MA Laboratorium UINSU Medan. This scientific literacy-based digital flipbook was developed using the 4D model. However, in this study, development was only carried out up to the develop stage due to time and resource constraints. The disseminate stage requires a longer period as it involves large-scale implementation and continuous evaluation.

1. Define

The first step taken before conducting the research was a needs analysis. The define stage consists of the following steps.

a. Front end Analysis

At this stage, interviews were conducted regarding the biology learning process at MA Laboratorium UINSU Medan. This study used interview sheets to identify the needs of biology learning at the school. The

interview results indicated that the biology learning process at the school still relied on textbooks, the method used by the teacher was mainly lecture-based, students were still dependent on the teacher to obtain learning materials, and the biology material delivered had not yet been directed towards scientific literacy.

b. Learner Analysis

This stage was carried out to gain an understanding of students' abilities. Based on the needs questionnaire, it was found that students preferred biology learning to be presented in an interesting and varied manner. The questionnaire analysis showed that students agreed with the development of scientific literacy-based digital flipbook biology learning media on the circulatory system material.

c. Concept Analysis

At this stage, the development of Tik Tok-based videos was arranged systematically, and the basic skills required for understanding the material were identified. The analysis determined that the digestive system would serve as the primary material.

d. Task Analysis

The scientific literacy-based digital flipbook was systematically arranged, and the basic skills required were identified. The analysis results determined the circulatory system as the main material.

e. Learning Objective Analysis

The learning objectives were formulated based on an analysis of the expected learning outcomes. Within the scientific literacy-based digital flipbook, the objectives include: (1) enabling students to explain the concept of the circulatory system through interactive digital flipbook activities. circulatory system; 2) Through literacy activities, students are able to identify the structure and function of blood components; 3) Through digital flipbook activities, students are able to explain the mechanism of the human circulatory system; 4) Through video discussion activities, students are able to analyze the blood clotting process; 5) Through video viewing and literacy activities, students are able to accurately determine blood types based on the ABO system and their relation to blood transfusion; 6) Through literacy activities, students are able to integrate prevention efforts and the application of technology in the treatment of human circulatory system disorders; 7) Through discussion activities, students are able to present study reports on the human circulatory system accurately.

2. Design

The design stage was carried out to prepare the materials and design the product to be developed. This stage included: (1) text preparation: reviewed based on the circulatory system material to be developed, which had been adjusted to the student textbook of the K13 curriculum for Grade XI Science at MA UINSU Medan; (2) media selection: adjusted to the students' needs based on the problem analysis that had been conducted; (3) format selection: the flipbook-based learning media was designed using the Canva application, incorporating elements and fonts designed to be as attractive as possible with an appealing color combination.

3. Develop

The product development was carried out in two stages: the initial design before the learning device was validated, and the revised design of the learning device based on expert feedback. The product validation activity was conducted to identify the strengths and weaknesses of the product in order to produce a higher-quality product. The validity of the product was assessed by a media expert and a material expert.

Table 5. Validation Results of Media

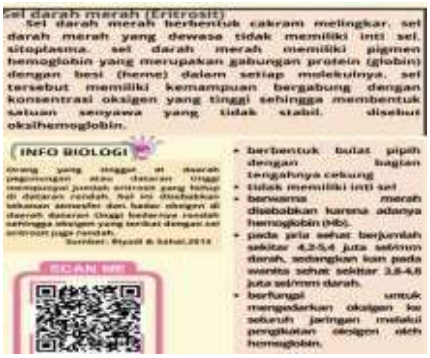
Aspects Assessed	Assessment Score	Maximum Score	Percentage
a. Accessibility	5	5	100
b. Graphical Aspect	72	75	96
c. Linguistic Aspect	20	20	100
Total Score	**97**	**100**	97
Average Percentage		**97**	
Category		**Highly Valid**	

The results of this study indicate that the validation process required one round of revision. Upon receiving input from the validator, the researcher made enhancements, particularly to improve the video's visual presentation. According to the media expert's evaluation—which covered three aspects: accessibility, visual design, and language the digital flipbook learning media achieved a validity score of 97%. Based on the validity criteria, this score is classified as "very valid."

Based on the validator's observations, the aspects of accessibility, graphics, and language in the digital flipbook were declared highly valid not only because of the high scores but also because they met the standards of modern learning media design theory. First, the perfect accessibility score (100%) reflects the inclusive principles of Universal Design for Learning (UDL), which encourages learning media to be equipped with flexible font settings, visual contrast, and intuitive navigation -in line with research on the development of web-based learning media, which emphasizes that UDL improves the accessibility and validity of digital media overall. Second, the high graphic score (96%) demonstrates the application of consistent layout, color choices,

and proportional images that are both aesthetic and functional-as shown in research on the development of scientific approach-based e-modules (Isti Hermawanti, 2022), which highlights the importance of layout consistency to enhance readability and student engagement. Third, the perfect language score (100%) indicates the use of accurate and clear language in accordance with multimodal learning principles, aimed at reducing students' cognitive load, as found in a study on the Impact of Digital Learning Media on Learning Motivation (Rusdi herlina, 2025) which stresses the importance of communicative and concise language in digital materials. Therefore, the validity of this digital flipbook is reflected not only in its high scores but also in its fulfil ment of quality criteria in terms of inclusive accessibility, consistent graphic aesthetics, and effective language use according to current theories and scientific practices.

Table 7. Revision of the Development of Scientific Literacy-Based Digital Flipbook

Design Results (Before Revision)	Design Results (After Revision)
(1)	(2)
	
Before the revision, the digital flipbook did not include the names of the author and the advisor, and the cover was red.	After the revision, the scientific literacy-based digital flipbook included the names of the author and the advisor, and the cover had been changed to a more appropriate color.
	
Before the revision, the table of contents was still red, making it unclear.	After the revision, the table of contents became clearer, and the color was changed to a more appropriate one.
	
Before the revision, the font was unclear, and it still used a barcode.	After the revision, the font was clear, and a link was provided for easier access.

Design Results (Before Revision)	Design Results (After Revision)
	
Before the revision, the author's and advisor's biographies were not included.	After the revision, the author's and advisor's biographies were included.

Figure 2. Practicality Test

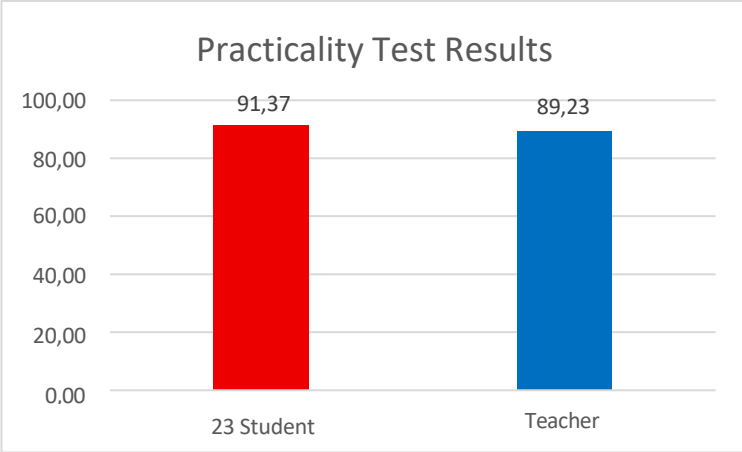


Table 9. Practicality Test Results

Respondent	Number of Items	Score	Percentage
Teacher	13	79	89,2
Students	13	1366	91,3
Criteria			**Very Practical**

Data from the biology teacher's questionnaire showed that overall, the media was considered very practical with a score of 89.2% (Table 9). The teacher stated that this digital flipbook was very helpful in delivering material because of its systematic content structure and navigation features that facilitated teaching without the need for extensive additional explanations. The teacher also appreciated the media's responsive design and compatibility with the school's technology devices, thus supporting its use in both face-to-face and online learning. In addition, the teacher mentioned that this media helped save time in delivering material because the content was complete with images, illustrations, and supporting explanations. Similarly, responses from Grade XI Science 1 students indicated that the media was very practical with a score of 91.3%. The students expressed that the media was interesting and made learning easier because it was enriched with clear visualizations and simple language. Moreover, the digital flipbook was considered helpful for independent learning as it could be accessed flexibly through various devices, allowing them to study anytime and anywhere. The students also felt more motivated because the media was not boring and helped them understand the connection between theory and its application in everyday life. Therefore, this media is considered practical and suitable for use because it not only meets technical practicality standards but also supports the effectiveness and efficiency of the learning process both in class and for independent study.

This is in line with the study by (Simatupang et al., 2020) which stated that the use of digital flipbook learning media made teachers more effective in delivering economic learning material. Specifically, the digital flipbook learning media provides practical contributions to teachers in conducting lessons, enhancing teaching effectiveness, and improving student learning outcomes. The feasibility scale of this digital flipbook learning media refers to (Juni Agus Simaremare & Emelda Thesalonika, 2022) which explained that the average assessment by experts including media experts, language experts, content experts, and student respondents. ranged from 85% to 95%, categorizing it as highly feasible for digital flipbook learning media development. The

use of digital flipbook learning media also requires students to be ready for independent learning in order to achieve maximum learning outcomes (Samiati et al., 2022). From this perspective, the existence of digital flipbook learning media enables students to better understand learning materials more effectively.

Figure 3. Effectiveness Test

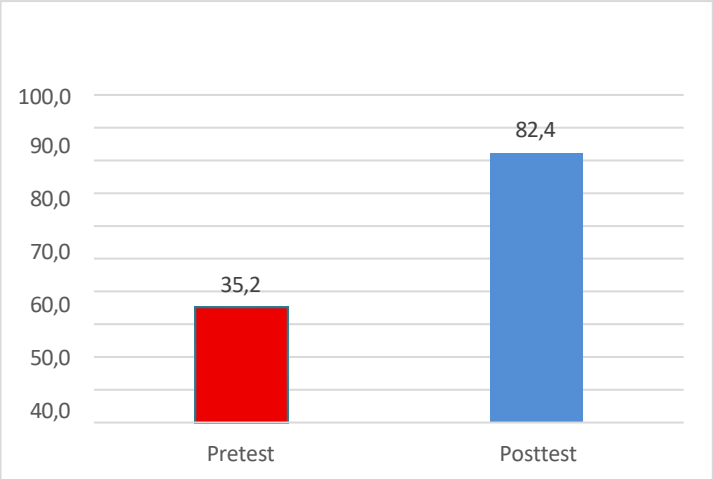


Table 10. Effectiveness Test Results

Average Pre-test	Average Post-test	Pre-test - Post-test Difference	Ideal Score-Pre-test	N-Gain Score	Category
35,21	82,39	47,17	64,783	0,726	Effective

The effectiveness of the product can be assessed from the results of the pre-test and post-test administered to the students. Based on the pre-test completed by 23 Grade XI Science 1 students at MA Laboratorium UINSU Medan, the average score was 35.21. Based on the post-test results, the students obtained an average score of 82.39. The pre-test and post-test scores show an increase in the students' average scores. From these data, the normalized gain score was calculated at 0.72. A normalized gain score of 0.72 falls into the high category.

This success can be linked to the characteristics of the scientific literacy-based digital flipbook learning media, which includes animated videos, images, music, narration, and text, making it suitable for visual-auditory learning styles. Furthermore, the language used in the digital flipbook is simple, and the scientific terms included in the flipbook are accompanied by explanations that enable students to understand biological terminology more easily. In the context of biology learning, the scientific literacy-based digital flipbook serves as an effective learning tool to improve student learning outcomes through the presentation of images, animated videos, narration, and easily understood text.

The specific features of the digital flipbook such as animated videos of the blood circulation process, illustrative images, systematic narration, and easy-to-understand text directly contribute to enhancing students' scientific literacy components. For example, the animated videos help students visualize the blood circulation process more concretely, making it easier for them to identify scientific problems such as arterial blockages or valve disorders. This aligns with the findings of (Sunami & Aslam, 2021) who stated that animated video-based learning media help students gain a deeper understanding of scientific concepts through visual observation. In addition, the systematic narration and accompanying illustrations guide students in understanding the relationships between concepts such as the structure and function of the heart which strengthens their ability to logically explain scientific phenomena. This is supported by research by (Wulandari et al., 2021), which found that combining visuals and narration in digital learning media improves students' ability to formulate scientific explanations and reduces cognitive load. Therefore, the design of this flipbook not only makes the material more engaging but also effectively helps students identify problems and explain scientific phenomena, thereby substantially strengthening their scientific literacy.

The results of this study are in line with the findings of (Azzahra et al., 2023)regarding the effectiveness of flipbook media, which showed that students' learning motivation before using flipbook media in history subjects obtained a pre-test result of 68.27%, falling into the moderate category. Meanwhile, the students' post-test results in history subjects after using the flipbook media showed a learning motivation score of 79%, which falls into the high category. Thus, flipbook media has proven to be more effective in improving the learning outcomes of Grade XI high school students in history subjects.

The characteristics of the digital flipbook comprising animated videos, images, narration, and simple text align with the principles of *Cognitive Load Theory* (Sweller) and the *Cognitive Theory of Multimedia Learning* (Mayer). According to Sweller, the success of multimedia design depends on its ability to reduce unnecessary cognitive load (*extraneous load*), maintain intrinsic load appropriate to the complexity of the material, and enhance *germane load* to build knowledge schemas. The videos and images in this flipbook visually present parts of the circulatory system, thereby reducing redundant verbal explanations and enhancing the processing of visual information. The narration and easy-to-understand text are also designed according to Mayer's *dual-channel* principle, which integrates visual and auditory channels to optimize information storage in both short-term and long-term memory.

(Suwarno, 2020) revealed that video-based learning multimedia effectively manages cognitive load by minimizing irrelevant elements and enhancing *germane load* through an emphasis on key schemas, supporting the idea that concise flipbook videos can improve student understanding. Meanwhile, (Sunandar et al., 2024), in the context of biology learning, noted that the use of visuals and systematic layouts in digital media can lower *extraneous cognitive load*, preventing students from experiencing information overload when learning complex topics such as the circulatory system. Thus, this flipbook design effectively reduces cognitive load, optimizes information processing, and improves learning effectiveness.

4. CONCLUSION

Based on the findings, the digital flipbook grounded in scientific literacy for circulatory system material was found to be valid, practical, and effective in enhancing the learning process. Its feasibility is evidenced by a very high level of validity 97% in terms of media and 97.7% in terms of content. Regarding practicality, the flipbook was deemed highly practical by both students (91.3%) and teachers (89.2%). Furthermore, its effectiveness was reflected in the significant improvement in students' average scores, rising from 35.21 in the pre-test to 82.39 in the post-test, with an N-Gain of 0.72, classified as high. These outcomes indicate a positive impact on learning quality and suggest that the flipbook can be used as an alternative instructional resource interesting and relevant, and can be adapted by teachers in various educational institutions. The limitation of this study lies in the development stage, which only reached the Develop phase, so large-scale implementation has not yet been carried out. Therefore, further research is needed to test the Disseminate stage and to expand the development of scientific literacy-based digital flipbook media on other circulatory system materials.

6. ACKNOWLEDGEMENT

The author wishes to extend heartfelt appreciation to Mrs. Rohani, S.Ag., M.Pd., for her guidance as the academic advisor; Mrs. Rahmadina, M.Pd., for her role as the examiner; Dr. Mhd. Rafi'i Ma'arif Tarigan, M.Pd., for validating the media; and Mrs. Rasyidah, M.Pd., for validating the content. Their insightful suggestions and constructive feedback greatly contributed to the evaluation of the media's feasibility. The author also sincerely thanks all the teachers, students, school staff, and fellow peers for their unwavering support and encouragement throughout the completion of this study research.

REFERENCES

Alfionora, R., & Hasnah Putri, N. (2021). Implementasi Literasi Sains pada Pembelajaran Biologi. *Prosiding SEMNAS BIO 2021 Universitas Negeri Padang.* , 370–379.

Auliaty, Y., Siregar, R., & Alawiyah, N. (2021). Pengembangan Media Pembelajaran Interaktif Alat Indra Pendengaran Berbasis Literasi Sains Pada Muatan Ipa Untuk Kelas Iv Sekolah Dasar. *Educational Technology Journal*, *1*(2), 31–42. https://doi.org/10.26740/etj.v1n2.p31-42

Azzahra, A., Putri, A. E., Firmansyah, A., Mirzachaeru, E., & Chalimi, I. R. (2023). Efektivitas Penggunaan Media Flash Flipbook Terhadap Motivasi Belajar Peserta Didik Dalam Pembelajaran Mata Pelajaran Sejarah Kelas XI SMA Negeri 11 Pontianak. *Jurnal Pendidikan Dan Konseling*, *5*(1), 5975–5982.

Diana et., al 2022. (2022). Muallimuna : jurnal madrasah ibtidaiyah. *Jurnal Madrasah Ibtidaiyah*, *1*, 99–112.

Hamid, A., & Alberida, H. (2021). Pentingnya Mengembangkan E-Modul Interaktif Berbasis Flipbook di Sekolah Menengah Atas. *Edukatif : Jurnal Ilmu Pendidikan*, *3*(3), 911–918. https://doi.org/10.31004/edukatif.v3i3.452

Harahap, I. H., & Harahap, H. S. (2022). Analisis literasi sains siswa pada materi ekosistem. *Jurnal Bionatural*, *9*(2), 32–36. https://ejournal.stkipbbm.ac.id/index.php/bio/article/view/136

Hasasiyah, S. H., Hutomo, B. A., Subali, B., & Marwoto, P. (2020). Analisis Kemampuan Literasi Sains Siswa

SMP pada Materi Sirkulasi Darah. *Jurnal Penelitian Pendidikan IPA*, *6*(1), 5–9. https://doi.org/10.29303/jppipa.v6i1.193

Isti Hermawanti. (2016). *Pengembangan Media Pembelajaran E-Modul Usaha Dan Energi Berbasis Pendekatan Saintifik Untuk Meningkatkan Kemampuan Berpikir Kritis Peserta Didik*. 1–23.

Simaremare, J. A. & hesalonika, E. (2022). Development of Early Grade Indonesian E-Modules Using the Kvisoft Flipbook Maker Application. *Jurnal Iqra' : Kajian Ilmu Pendidikan*, *7*(2), 286–300. https://doi.org/10.25217/ji.v7i2.2678

Kolopita, C. P., Katili, M. R., & Yassin, R. M. T. (2022). Pengaruh Media Pembelajaran Terhadap Hasil Belajar Siswa Pada Mata Pelajaran Komputer dan Jaringan Dasar. *Inverted: Journal of Information Technology Education*, *2*(1), 1–12. https://doi.org/10.37905/inverted.v2i1.13081

Lestari, I., B.K Gultom, O., & Saputri Zebua, F. (2022). Penerapan Literasi Sains Dalam Pembelajaran Fisika Di Era Society 5.0. *Jurnal Inovasi Pendidikan Sains Dan Terapan (INTERN)*, *1*(2), 92–98. https://doi.org/10.58466/intern.v1i2.1449

Machsun, S. F., & Indana, S. (2023). Pengembangan Flipbook Berbasis Literasi Sains untuk Melatihkan Keterampilan Berpikir Kritis Peserta Didik Pada Materi Metabolisme Sel. *Bioedu: Berkala Ilmiah Pendidikan Biologi*, *12*(1), 16–31. https://ejournal.unesa.ac.id/index.php/bioedu

Mahara, E. (2022). Pengembangan Media Flipbook Berbasis Literasi Sains Pada Materi Koloid Di Sma Negeri 1 Bandar. *Fakultas Tarbiyah Dan Keguruan Universitas Islam Negeri Ar-Raniry Banda Aceh*.

Milala, H. F., Endryansyah, E., Joko, J., & Agung, A. I. (2021). Keefektifan Dan Kepraktisan Media Pembelajaran Menggunakan Adobe Flash Player. *Jurnal Pendidikan Teknik Elektro*, *11*(02), 195–202. https://doi.org/10.26740/jpte.v11n02.p195-202

Nabila Andjaresta Prasetyaningrum, Hadiansiah2, A. M. (2020). Pengembangan Media Pembelajaran Flipbook Terhadap Hasil Berpikir Kritis Siswamateri Sistem Pencernaan. *Suparyanto Dan Rosad*, *5*(3), 248–253. Http://Repository.Radenintan.ac.id

Nurmazia Firahma Tillah, H. S. (2025). *Analisis Kemampuan Literasi Sains Siswa Smp Berdasarkan Indikator Dan Level Literasi Sains*. *12*(1), 137–154.

OECD. (2023). Program For International Student (PISA) 2022 Assessment and Analytical Framework. In *OECD (Organisation for Economic Co-operation and Development) Publishing*. https://www.oecd-ilibrary.org/education/pisa-2022-assessment-and-analytical-framework_dfe0bf9c-en

Okpatrioka. (2023). Research And Development (R&D) Penelitian Yang Inovatif Dalam Pendidikan. *Dharma Acariya Nusantara: Jurnal Pendidikan, Bahasa Dan Budaya*, *1*(1), 86–100. https://doi.org/10.47861/jdan.v1i1.154

Rahmadani, F., Setiadi, D., Yamin, M., & Kusmiyati, K. (2022). Analisis Kemampuan Literasi Sains Biologi Peserta Didik SMA Kelas X di SMAN 1 Kuripan. *Jurnal Ilmiah Profesi Pendidikan*, *7*(4b), 2726–2731. https://doi.org/10.29303/jipp.v7i4b.1059

Riani Johan, J., Iriani, T., & Maulana, A. (2023). Penerapan Model Four-D dalam Pengembangan Media Video Keterampilan Mengajar Kelompok Kecil dan Perorangan. *Jurnal Pendidikan West Science*, *01*(06), 372–378.

Ritonga, A. P., Andini, N. P., & Iklmah, L. (2022). Pengembangan Bahan Ajaran Media. *Jurnal Multidisiplin Dehasen (MUDE)*, *1*(3), 343–348. https://doi.org/10.37676/mude.v1i3.2612

Herlina, R. (2025). *Pengaruh Media Pembelajaran Digital Terhadap Motivasi Belajar Siswa Sekolah Dasar*. *10*.

Samiati et al. (2022). Development of a Digital Flipbook based on the Teachings of Ki Hajar Dewantara Tri N in Thematic Learning in Elementary School. *International Seminar Commemorating The 100 Th*

Anniversary of Tamansiswa, 283–291. https://seminar.ustjogja.ac.id/index.php/ISECN/article/view/127%0Ahttps://seminar.ustjogja.ac.id/index.php/ISECN/article/download/127/61

Samitra, D., & Harmoko, H. (2021). Uji Validasi dan Kepraktisan Lembar Kerja Mahasiswa Berbasis Keterampilan Proses Sains. *BIOEDUSAINS:Jurnal Pendidikan Biologi Dan Sains*, *4*(2), 146–154. https://doi.org/10.31539/bioedusains.v4i2.2500

Simatupang, H., Purnama, D., & Simatupang, Z. (2020). The Development of Best Practice Handbook Learning Strategy Based on Flip Book to Support Blended Learning Processes. *Journal of Physics: Conference Series*, *1462*(1). https://doi.org/10.1088/1742-6596/1462/1/012014

Sugiyono. (2019). *Metode Penelitian Pendidikan*. CV. Alfabeta.

Sunami, M. A., & Aslam, A. (2021). Pengaruh Penggunaan Media Pembelajaran Video Animasi Berbasis Zoom Meeting terhadap Minat dan Hasil Belajar IPA Siswa Sekolah Dasar. *Jurnal Basicedu*, *5*(4), 1940–1945. https://doi.org/10.31004/basicedu.v5i4.1129

Sunandar, A., Karwatisari, R., Rahmat, A., Winarno, N., & Hamdiyati, Y. (2024). *High school students ' cognitive load on biology learning : A case study*. *7*(2), 141–152.

Suwarno, M. (2020). Cognitive Load Theory in The Development of Multimedia Mathematics Learning. *Alauddin Journal of Mathematics Education* , *2*(2), 117–125. http://journal.uin-alauddin.ac.id/index.php/ajme

Wulandari, A. R., Masturi, M., & Fakhriyah, F. (2021). Pengaruh Media Pembelajaran Berbasis Youtube terhadap Hasil Belajar IPA Siswa di Sekolah Dasar. *Edukatif : Jurnal Ilmu Pendidikan*, *3*(6), 3779–3785. https://doi.org/10.31004/edukatif.v3i6.1251

Zulanwari, Z. A., Ramdani, A., & Bahri, S. (2023). Analisis Kemampuan Literasi Sains Siswa SMA Terhadap Soal-Soal PISA Pada Materi Virus dan Bakteri. *Journal of Classroom Action (JCAR)*, *5*, 210–216. http://jppipa.unram.ac.id/index.php/jcar/index