



## Development of PBL-based digital flipbook on human excretory system for SMA/MA students

Syakira Amalia Hasibuan<sup>1</sup>, Rahmadina<sup>2</sup>

<sup>1,2</sup>Universitas Islam Negeri Sumatera Utara, Kota Medan, Indonesia

[syakiraamaliahsb@uinsu.ac.id](mailto:syakiraamaliahsb@uinsu.ac.id)<sup>1</sup>, [rahmadina@uinsu.ac.id](mailto:rahmadina@uinsu.ac.id)<sup>2</sup>

### ABSTRACT

The rapid advancement of technology demands innovation in developing interactive and effective learning media. This study aims to develop digital flipbook learning media based on Problem-Based Learning (PBL) for teaching the human excretory system, to improve students' conceptual understanding and learning outcomes. The development process employed the 4D model, which includes the stages of defining, designing, developing, and disseminating. The flipbook was validated by material and media experts and further tested by teachers and students to evaluate its feasibility, practicality, and effectiveness. The findings indicate that the PBL-based digital flipbook is valid, practical, and effective in supporting students' comprehension through interactive presentations, visual illustrations, and the integration of contextual problems. Furthermore, the flipbook enhances student motivation and engagement throughout the learning process. Therefore, this digital flipbook serves as an innovative alternative learning medium to support biology education, particularly for abstract topics such as the excretory system, and can also function as an accessible self-learning resource at any time and from anywhere.

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### ABSTRAK

Perkembangan teknologi menuntut adanya inovasi dalam penyediaan media pembelajaran yang interaktif dan efektif. Keberagaman metode pembelajaran membuat guru dapat melakukan pengembangan media pembelajaran yang cocok untuk kegiatan belajar di kelas. Penelitian ini bertujuan mengembangkan media pembelajaran flipbook berbasis Problem Based Learning (PBL) pada materi sistem ekskresi manusia untuk meningkatkan pemahaman konsep dan hasil belajar peserta didik. Proses pengembangan dilakukan menggunakan model 4D yang mencakup tahap pendefinisian, perancangan, pengembangan, dan penyebaran. Media divalidasi oleh ahli materi dan ahli media, kemudian diuji pada guru serta peserta didik untuk menilai aspek kelayakan, kepraktisan, dan efektivitasnya. Hasil penelitian menunjukkan bahwa flipbook berbasis PBL dinyatakan valid, praktis, dan efektif dalam membantu peserta didik memahami materi melalui penyajian interaktif, ilustrasi visual, serta integrasi permasalahan kontekstual. Flipbook ini juga meningkatkan motivasi belajar dan keterlibatan peserta didik selama proses pembelajaran. Dengan demikian, media pembelajaran flipbook berbasis PBL dapat dijadikan alternatif inovatif untuk mendukung pembelajaran biologi, terutama pada materi yang bersifat abstrak seperti sistem ekskresi, sekaligus menjadi sumber belajar mandiri yang mudah diakses kapan saja dan di mana saja.

**Kata Kunci:** flipbook; media pembelajaran; pembelajaran berbasis masalah; sistem ekskresi

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## INTRODUCTION

Technology has now influenced every aspect of human life, including education. With technological advancements, the educational process through technology is expected to become more efficient. Education is no longer limited to physical classrooms but also embraces the digital world. Nowadays, a wide range of information is available digitally (Aisyah *et al.*, 2025). Digital media can be accessed through the internet and other devices such as smartphones, laptops, and computers to support the learning process (Yuniarti *et al.*, 2023). The use of digital technology in education opens up opportunities for better learning, enhances knowledge, supports problem-solving skills, and deepens student learning. Educational technology provides interactive materials, simulations, games, and assessment tools specifically designed to engage students in the learning process (Rosyiddin *et al.*, 2023; Permana *et al.*, 2024). Currently, many learning materials are used in technology-based education, such as 3D models, interactive videos, virtual laboratories, e-books, and other digital learning materials (Talaksoru *et al.*, 2024). In biology learning, media play a very important role. Biology not only explains concepts but also emphasizes application through real interactions. Biology material is conceptual, for example, such as the functions of the body that are not visible, which makes it difficult for students to understand these concepts. One of the biology topics that is difficult for students to understand is the excretory system. The difficulty in the excretory system material stems from the involvement of multiple organs and the many terms used to describe how each organ works (Mardiana *et al.*, 2023). In addition, there is still a lack of utilization of facilities in schools for biology learning, such as the use of appropriate learning media for the excretory system material (Nurwita *et al.*, 2024). Therefore, a teaching and learning process that is more in line with the needs of students is required to improve learning outcomes (Suryani & Lufri, 2021).

Learning media are defined as effective communication technologies and play an important role in the educational process (Zaki & Dian, 2020). As a tool to support the learning process of students, media can also serve as a learning resource for them. Innovation in the development of learning media is needed because students experience boredom when learning only with books. (Hadiapurwa *et al.*, 2023). The learning media used by teachers also play an important role in every learning process. It is important to use learning media because it can enhance students' understanding. However, many teachers still use the old teaching paradigm without using media, even though various media are available to support the learning process (Mukarromah & Andriana, 2022). Asari, in his book titled "Media Pembelajaran Digital (Digital Learning Media)," states that in today's digital era, educators must be able to use learning media that utilize digital technology. Therefore, the availability of learning media is very important and must be utilized in schools. The use of learning media is believed to improve students' learning outcomes. Students' learning outcomes are greatly influenced by the learning process created by the teacher. Students' learning outcomes are the results obtained through exams, assignments, and participation in the learning process (Andryannisa *et al.*, 2021). Learning outcomes are the achievements attained by students in the form of evaluations after going through the learning process. Learning outcomes serve as a reference for assessing and reporting students' academic achievements (Motoh *et al.*, 2022).

One digital learning medium that can be used in teaching is the flipbook. This media resembles a virtual album containing teaching materials in colored columns. Its advantages include the ability to create effects of opening or flipping book pages, creating the sensation of reading a real book. The flipbook gives the effect of turning the pages of a book, giving the impression of reading a real book. Making this flipbook is also very easy, yet the final result is more than just a book (Rahayu *et al.*, 2021). Flipbook media is suitable for increasing students' interest in the learning process (Lakapu *et al.*, 2023). Flipbook media was chosen as a solution to the existing problems because this media can accommodate various types of student learning methods. Previous research stated that most students learn with the help of mobile phones, so this flipbook can be utilized and accessed by the students (Dewi & Wayan, 2022). In fact, in another finding, the flipbook was stated to be valid and suitable for development. (Agustina, 2020). However, previous

research only measured the students' interest and did not measure cognitive aspects of the students, such as learning outcomes.

The use of conventional and teacher-centered learning models also tends to cause boredom in learning, which is caused by the passive involvement of students in the learning process, making them less motivated to engage in continuous learning. (Suharti, 2024). Media functions as a means of delivering material, while a learning model is a method applied to teach and support students' understanding. (Sofikarim *et al.*, 2023). For the teaching and learning process to be well-directed, an engaging learning model is needed. The Problem Based Learning (PBL) model is an approach that can create an active learning environment by presenting a problem, thereby improving learning outcomes. (Dita *et al.*, 2021).

The preliminary observation on February 20, 2025, at one of the Islamic Senior High Schools (MA) in Medan City, through interviews with the biology teacher and eleventh-grade science students (XI IPA 3), revealed that students often have difficulty understanding biology material because the teaching media are limited to printed books and slides. The limited availability of projectors is an obstacle that results in a lack of use of visual aids. The school allows students to bring smartphones, but they are not used effectively. In addition, teaching is still conducted conventionally through lectures, which makes learning activities less interesting and results in poor student understanding. Previous research has shown that poor student understanding can also be influenced by teacher-centered (conventional) learning processes, which cause teachers to dominate learning activities. The analysis of teacher and student needs questionnaires revealed difficulties in understanding biology material, particularly the excretory system. The use of learning media is very important for this material (Lestari & Irawati, 2020).

Based on the identified issues, this study aims to develop a PBL-based flipbook learning medium on the human excretory system for 11th-grade students. This study discusses the limitations of educational media, which still focus on printed books, PowerPoint, and conventional learning, resulting in passive students. PBL-based flipbooks are chosen because they allow for the presentation of interactive and contextual content and encourage active student participation. Therefore, this media is expected to enhance students' conceptual understanding and learning outcomes related to the excretory system.

## LITERATURE REVIEW

### Learning Media

Learning media are tools that help teachers demonstrate a subject to students so that students can gain new information and perspectives (Ummah & Mustika, 2024). The word mediator comes from the Latin word *medius*, which means intermediary. Media can be in the form of visual aids, textbooks, activities, or projects. Specifically, learning media is defined as graphics, pictures, or tools for organizing, arranging, and communicating visual or verbal messages (Akbar *et al.*, 2021). Learning media is an important part of teaching and learning. Teachers often use it as a tool to present information in a way that is easy for students to understand. Media is a tool used by teachers in classroom teaching and learning. Media can also convey messages, evoke emotions and desires in students, thereby stimulating individual learning. The use of educational media becomes a crucial focus for teachers as learning facilitators. Conventional learning processes can result in a lack of interest and motivation in students. However, it would be more effective if teachers used facilities that support teaching, increase students' interest in interacting and participating, and help them better understand the material being taught. One solution is the use of learning media. In learning activities, learning media are needed to support the teaching and learning process in the classroom (Pamungkas & Koeswanti, 2021).

## Flipbook

A flipbook is an interactive digital book that can be accessed through electronic systems and is organized in an orderly and systematic manner according to the user's needs. Based on its definition, a flipbook is a digital book that can present text, images, sound, and video. This aims to enhance students' interest and the learning process. In addition, flipbooks have animation effects that create the experience as if students feel they are opening a physical book (Juliani & Ibrahim, 2023). Flipbooks in Portable Document Format (PDF) can be uploaded to the Heyzine Flipbook website, which is a free website for converting PDFs into flipbooks that offers an electronic library effect, allowing them to be opened on any page like a book. The use of flipbooks enables students to access them anywhere and anytime via smartphones. Teachers share links that allow students to open and download them for free (Manzil *et al.*, 2022). The use of flipbooks as a learning aid can also enhance students' potential and motivation to learn. Flipbooks have also been proven effective in improving the quality of learning, including learning about science (Sari *et al.*, 2024).

## Problem-Based Learning (PBL)

Problem-Based Learning (PBL) is a learning model that uses a situational approach. This learning method encourages teachers to connect the material being taught with real-life situations and motivates students to apply what they have learned in their personal, family, and community life (Muhartini *et al.*, 2023). The PBL model is a learning process based on problem-solving (Apriana *et al.*, 2024). Erviana, in her book "Model Pembelajaran Berbasis Realitas Virtual untuk Meningkatkan Waktu Belajar Peserta didik (Virtual Reality-Based Learning Models to Improve Student Learning Time)," explains that one of the benefits of PBL is that this learning model allows students to participate more in learning activities, gain practical knowledge, and be able to solve problems with other students (Walangadi *et al.*, 2023). The PBL model is a learning activity that emphasizes student interaction, including activities such as discussions, debates, and collaboration in problem-solving. This teaching method aims to develop students' problem-solving skills through logical and reasoned solutions (Muhsam & Muh, 2022). Considering the current situation, the PBL model can be chosen as a method to improve learning outcomes.

## METHODS

This study applies the 4D model development design, which consists of four main stages: Define, Design, Develop, and Disseminate. This model was chosen because it is considered suitable for designing digital learning media in the form of a flipbook oriented towards a PBL approach, particularly for the human excretory system material for 11th-grade high school students. The Define stage focuses on needs analysis, the Design stage on media design, while the Develop stage focuses on product development and validation by media and subject matter experts. The study was only conducted up to the Develop stage and was not continued to the Disseminate stage because the purpose of this research focuses on the development of learning media. Validation aims to ensure that the media align with the PBL approach and meet the criteria for content, appearance, and language feasibility. Revisions are made based on expert input. The practicality test is conducted with teachers and students to assess media application. The effectiveness test is carried out on students' pretest and posttest scores to determine learning improvement after using the flipbook media. The study was conducted on a limited scale from June 16-17, 2025, at MAPN 4 Martubung, specifically in class XI IPA 3, which consisted of 32 students, and involved one biology teacher teaching in class XI.

The research instruments used included media and material validation sheets, which function to assess the feasibility of content, appearance, and the use of language in learning media, with assessments using a Likert scale. In addition, a practicality questionnaire was also prepared to evaluate the ease of use and

implementation of the media by teachers and students. Efektivitas media dievaluasi melalui perbandingan hasil belajar peserta didik sebelum dan sesudah menggunakan flipbook. Proses penilaian kevalidan dilakukan oleh ahli media dan ahli materi, sementara penilaian kepraktisan diperoleh dari guru dan peserta didik. Selanjutnya, efektivitas media diukur melalui hasil pretest dan posttest. Teknik analisis data mengombinasikan pendekatan kualitatif dan kuantitatif. Data kualitatif diperoleh dari wawancara dengan guru biologi, peserta didik yang terlibat, serta masukan dari para ahli. Sementara itu, data kuantitatif dianalisis menggunakan skala Likert yang disajikan melalui angket untuk mengukur tingkat validitas, kepraktisan, dan efektivitas media pembelajaran.

## RESULTS AND DISCUSSION

The development of flipbook learning media by applying the PBL learning model is carried out to improve student learning outcomes, particularly on the topic of the human excretory system in grade XI of the MA in Medan City. The development process for this flipbook media uses the 4D model. The following is an explanation of the stages of developing PBL-based flipbook learning media in this study.

### Define

This process also aims to determine whether the developed product will meet the needs of its users. There are five activities carried out in the define stage:

1. Front-end analysis: At this stage, interviews were conducted with biology teachers regarding the learning process. Questionnaires were also filled out to assess the teachers' needs in the learning process. The results of the interviews and questionnaires revealed that biology lessons are often carried out using a lecture-based approach, making the learning less interactive. Limited facilities result in insufficient use of media.
2. Learner analysis: At this stage, an analysis is conducted to understand the students' abilities in the learning process. The results of the student needs survey showed that students enjoy varied biology learning, ranging from the use of interactive learning media to learning models that relate to everyday life. Students are also interested in the use of digital media, thus supporting the development of PBL-based flipbook learning media.
3. Concept analysis: This concept analysis aims to examine the informative content that will be created in the flipbook using a Problem Based Learning (PBL) approach. The content to be included is the excretory system.
4. Task analysis: This stage is carried out to analyze the main tasks that students must master so that they can achieve the Competency Achievement Indicators (IPK) that have been established. The competency achievement indicators are created in accordance with the Basic Competencies (KD) for the human excretory system material that has been included in the Lesson Plan (RPP).
5. Formulation of learning objectives (specifying instructional objectives): Formulating learning objectives according to the IPK to monitor changes in students' learning outcomes after using the PBL-based flipbook.

### Design

The flipbook was designed using the Canva application. This stage focused on designing learning media oriented towards the PBL approach. The flipbook content structure is systematically arranged, consisting of: an introduction to the PBL approach, *Kompetensi Inti* or Core Competencies (KI), *Kompetensi Dasar* or Basic Competencies (KD), learning objectives, competency tests, concept maps, material reflections,

glossary, bibliography, and author biodata. The main content focuses on the topic of the human excretory system, which is compiled based on several scientific references and supplemented with supporting videos from YouTube. The flipbook is also designed by integrating PBL elements, which include:

1. Bio Mind Breaker: Problem-triggering feature to stimulate students' curiosity
2. Bio Activity: Investigative activities that encourage students to search for and process information
3. Bio Education: Presentation of phenomena as the core of material explanation
4. Bio Knowledge: Description of the main material
5. Bio Info: Provision of relevant additional information

The flipbook design prioritizes the integration of visuals, text, and interactivity to support student engagement and the achievement of biology learning objectives. The appearance uses a combination of soft colors, clear typography, and interactive navigation. The content is complemented with concept maps, anatomical illustrations, process diagrams, and explanatory videos, making the material presentation more engaging and easier to understand.

## Develop

The Develop stage is a continuation of the design stage, which involves developing the flipbook into a product. During its development, the flipbook will go through a validation stage by media experts and content experts to ensure that the content presented in the flipbook is systematically arranged and in accordance with the PBL approach. Then, in the next stage, the flipbook is also assessed for its practicality by biology teachers and students to determine the ease of use of the flipbook media. The effectiveness of the developed media will be seen from the improvement in student learning outcomes based on N-Gain.

## Media Validation by Experts

The validation process in Table 1 was carried out by experts on the developed flipbook. This assessment aimed to ensure that the product created has appeal in terms of appearance and presentation. The validation results showed a percentage of 74%, which falls into the "Valid" category. Therefore, the flipbook is deemed suitable for development, although revisions need to be made according to the feedback from the media experts.

**Table 1.** Media Validation Results Before and After Revision by Media Experts

<b>Validation Assessment Data by Media Experts Before Revision</b>				
<b>Aspects Being Assessed</b>	<b>Score Obtained</b>	<b>Maximum Score</b>	<b>Percentage (%)</b>	<b>Criteria</b>
Display	40	55	72,72%	Valid
Presentation	27	35	68 %	Valid
<b>Sum</b>	<b>67</b>	<b>90</b>	<b>74%</b>	<b>Valid</b>
<b>Validation Assessment Data by Media Experts After Revision</b>				
Display	53	55	94 %	Very Valid
Presentation	35	35	100%	Very Valid
<b>Sum</b>	<b>88</b>	<b>90</b>	<b>97,77%</b>	<b>Very Valid</b>

Source: Research, 2025

After revision according to the advice of media experts, a significant validation result of 97.77% was found, so the value was categorized as "Very Valid," which marked that this learning media was suitable for use

without revision. Experts provide feedback and suggestions on validation sheets to guide the review of the product under development. In the second validation, the evaluation data showed an increase. After a review based on the validation score after the revision it can be concluded that the instructional product meets the criteria assessed on the validation sheet, thus making it an excellent product to develop. Figure 1 is an initial view of the flipbook developed.



Figure 1. Cover Layout, Features, Author Profile, and Glossary in the Flipbook According to Media Expert Recommendations  
Source: Research, 2025

The input and suggestions provided by media experts include improving the appearance of the flipbook, such as adding the author's name to the cover, correcting the title's writing, changing the font, using italics for features in the flipbook, and adding a glossary and author biography.

### **Material Validation by Experts**

The validation results in **Table 2**, conducted with content experts, showed a value of "68%," which is categorized as "Valid." This result indicates that the media can be developed, although it should follow the suggestions from the content experts. The content experts provided input and suggestions, including changes to the material considered not aligned with the PBL approach, and they also gave guidance on the content in the flipbook to ensure it aligns with the PBL approach.

Validation by subject matter experts gave a score of 68%, which is considered "Valid." This result indicates that the media can be developed, but on the condition that revisions are made according to the guidelines from the subject matter experts. The experts provided information and feedback, including a review of content deemed not in accordance with PBL and guidance on the revisions that need to be made.

**Table 2.** Results of Material Validation Before and After Revision by Subject Matter Experts

<b>Validation Assessment Data by Subject Matter Experts Before Revision</b>				
<b>Aspects Being Assessed</b>	<b>Score Obtained</b>	<b>Maximum Score</b>	<b>Percentage (%)</b>	<b>Criteria</b>
Display	19	25	76 %	Valid
Presentation	27	40	67,5%	Valid
Language	5	10	50%	Quite Valid
<b>Sum</b>	<b>51</b>	<b>75</b>	<b>68%</b>	<b>Valid</b>
<b>Validation Assessment Data by Subject Matter Experts After Revision</b>				
Display	25	25	100 %	Very Valid
Presentation	38	40	95%	Very Valid
Language	10	10	100%	Very Valid
<b>Sum</b>	<b>73</b>	<b>75</b>	<b>97,33%</b>	<b>Very Valid</b>

*Source: Research, 2025*

The review was conducted according to the instructions, and a subject matter expert accurately assessed the flipbook content. The expert also provided suggestions to adjust the content included in the flipbook to the current context, making it easier for students to understand. The reviewed media received a score of 97.33% with a rating of "Very Valid," making it material worthy of further development without revision.

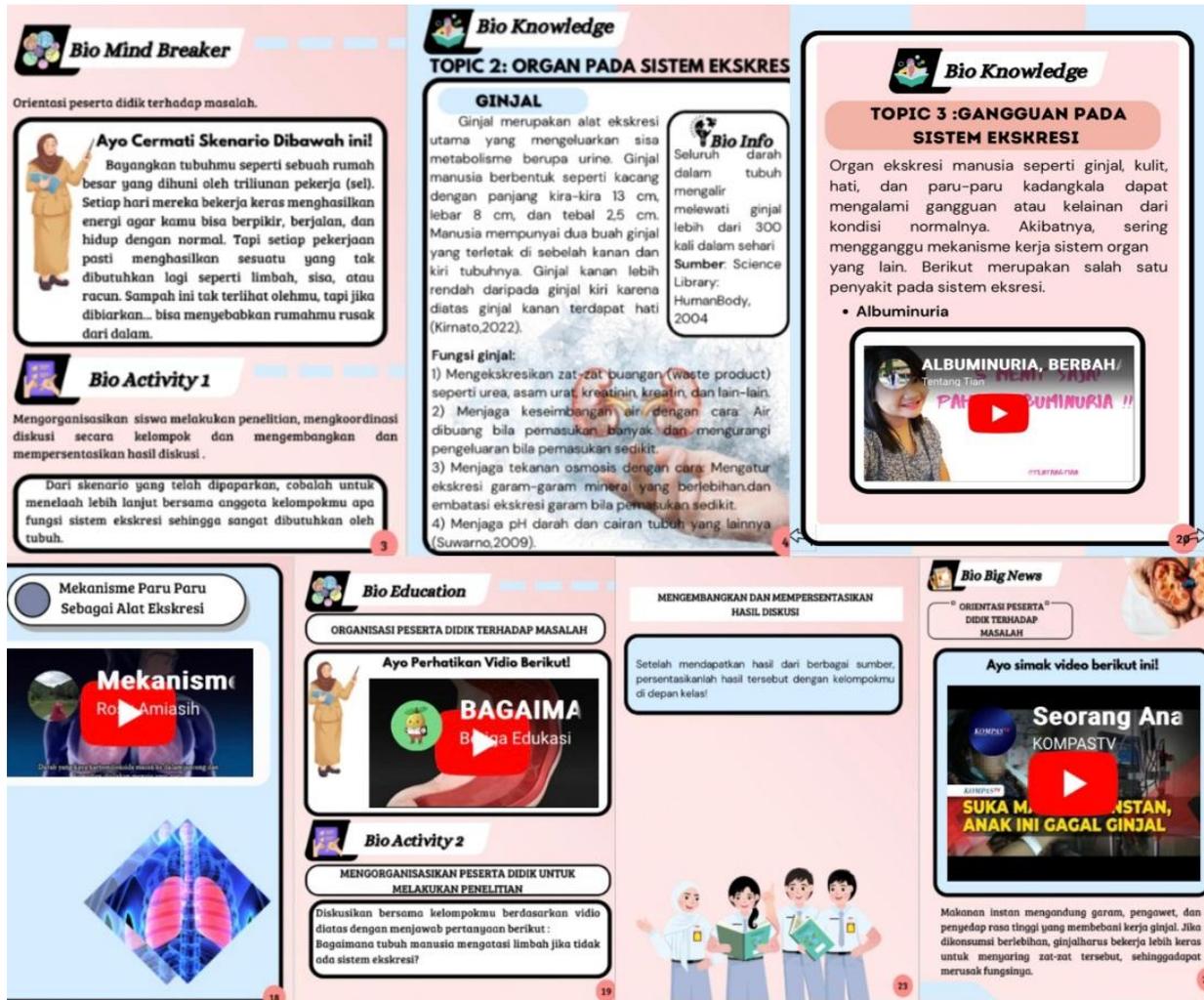


Figure 2. Tampilan Materi pada Flipbook Sesuai dengan Saran Ahli Materi  
Source: Research, 2025

According to subject matter experts, the flipbook content in **Figure 2** is already in line with the PBL context. The topics presented in this media are derived from everyday life, thereby encouraging student participation. The material is presented systematically and revised based on suggestions from subject matter experts, making it suitable for student development.

### Practicality Analysis of Media

The practicality analysis conducted by teachers is presented in several statements with assessments of the material content aspect, presentation aspect, language aspect, and application aspect. Then, the practicality analysis by students is presented in **Table 3** with assessments of content eligibility aspect, display aspect, and application aspect.

Table 3. Results of Practicality Data for Teachers

Practicality Assessment Data for Teachers				
Aspek Yang Dinilai	Aspects Being Assessed	Maximum Score	Percentage (%)	Criteria
Content	23	25	92 %	Very Practical

<b>Practicality Assessment Data for Teachers</b>				
<b>Aspek Yang Dinilai</b>	<b>Aspects Being Assessed</b>	<b>Maximum Score</b>	<b>Percentage (%)</b>	<b>Criteria</b>
Display	23	25	92%	Very Practical
Language	23	25	92%	Very Practical
Application	25	25	100%	Very Practical
<b>Sum</b>	<b>94</b>	<b>100</b>	<b>94%</b>	Very Practical
<b>Practicality Assessment Data for Students</b>				
Content eligibility	662	800	82,75%	Very Practical
Display	672	800	84%	Very Practical
Application	692	800	86,75%	Very Practical
<b>Sum</b>	<b>2026</b>	<b>2400</b>	<b>84,41%</b>	<b>Very Practical</b>

*Resource: Research, 2025*

The results of teacher responses to the developed media reached 94%, so based on that score, the media is categorized as ‘Very Practical.’ The media has been effective in addressing problems in biology learning on the excretory system material. The results obtained from the student response questionnaire reached 86.75%, so the media is categorized as ‘Very Practical.’ Students opined that the media is interesting, easy to use, and helps them understand the excretory system material. The results of teacher responses showed that the flipbook media is practical and easy to use. The flipbook also received positive feedback from students.

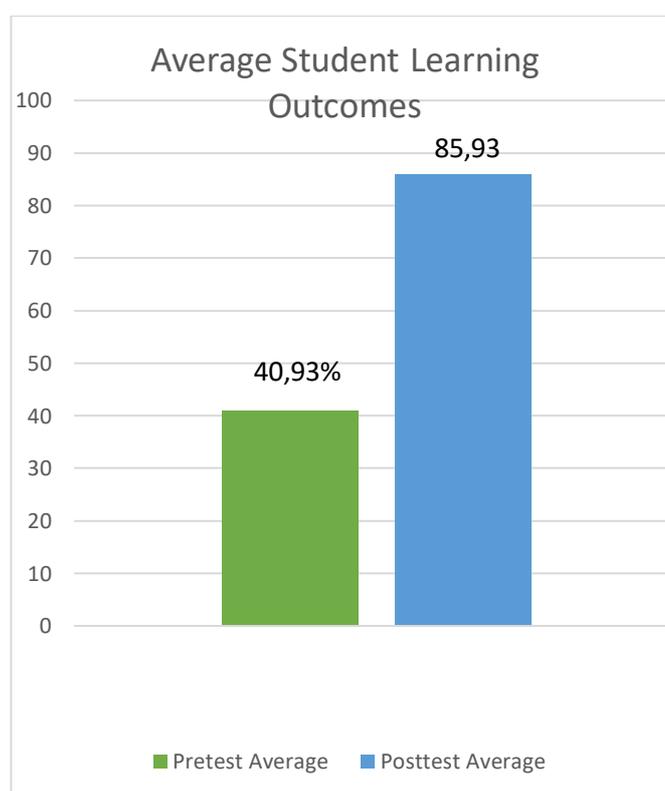
### **Effectiveness Based on N-Gain**

The effectiveness evaluation results in Table 4 show that the development of students’ skills when using the flipbook learning media system is categorized as high, with an N-Gain value of 0.76. Considering the criteria used, the flipbook learning media is deemed effective in improving students’ learning outcomes.

**Table 4.** Practicality Data Results for Teachers

<b>Average Pretest</b>	<b>Posttest Average</b>	<b>Posttest-Pretest</b>	<b>Maximum Score - Pretest</b>	<b>N-Gain Shoes</b>	<b>Percentage</b>	<b>Criteria</b>
40.93750	85.93750	45.00000	59.06250	0.76190	76%	Effective

*Source: Research, 2025*



**Figure 3.** Comparison Chart of Average Learning Outcomes  
*Source: Research, 2025*

Based on **Figure 3**, it can be seen that the effectiveness of the flipbook in improving learning achievement, measured through students' learning outcomes in the excretory system field, is assessed using pre-test and post-test results. The initial score was 40.93%, and after using the flipbook, the completion score increased to 85.95%. The evaluation of the flipbook's effectiveness falls into the "high" category, with an N-Gain of 0.76. Therefore, student feedback indicates that the flipbook for learning can enhance students' understanding of the material.

## Discussion

The digital learning media developed in the form of a PBL-based flipbook on the topic of the excretory system has undergone a series of assessments, namely validation, practicality, and effectiveness. The results of all these evaluations showed very good outcomes. The flipbook as a learning medium is considered an effective method for teachers to teach the lesson material. The advantages of the designed flipbook site are its efficiency, effectiveness, and flexibility of use. The flipbook can be easily accessed by students just by using a smartphone. This aligns with the view that flipbooks are considered more efficient because they do not require high costs. Flipbooks are also effective because they can provide animations, photos, text, audio, and video. They are also flexible as they can be used anywhere and anytime (Marvelia & Rukmi, 2022).

The visual content in this flipbook can enhance students' motivation and interest in learning. Students' interest in the media also increases concentration and helps maintain focus during the learning process, which ultimately improves learning outcomes. This flipbook covers many important topics, such as understanding the excretory system, the functions of excretory organs, the mechanisms of excretory organs, and disorders that occur. This PBL-based flipbook also includes activities that support contextual

and interactive learning. Therefore, this flipbook provides interactive and useful information for analyzing material and presenting more detailed information to students (Wijayanti & Isnawati, 2023).

The development of PBL-based flipbooks can improve students' learning outcomes. Students express themselves and answer questions more confidently, making learning more enjoyable and increasing their motivation to master the material and develop learning skills. Therefore, the implementation of the PBL learning model with flipbooks can affect students' learning outcomes. The PBL approach is one way to provide relevant education. This is because students play a role in answering questions related to the selection system (Kusuma & Fitrihindajati, 2024). This is also in line with research showing that PBL-based digital textbooks meet students' learning needs, are easy to use and understand, and stimulate students' problem-solving skills to gain a deeper understanding of the material. (Istiana *et al.*, 2024).

Flipbooks help students better understand material related to the selection system. Flipbooks have been proven effective in improving student learning outcomes. Therefore, PBL-based flipbooks are expected to be a solution to the problems of inadequate media usage and the lack of variety in classroom learning models. Thus, the results of previous discussions indicate that using flipbooks can increase student engagement and activity in the learning process. This is consistent with the statement that the use of flipbooks is very important in today's digital era as a learning tool that can replace conventional learning, allowing teachers to present their material in a more adaptive and engaging way (Purnomo, 2022). Therefore, based on previous research results, this confirms the success of the study in developing PBL-based digital media related to the selection system.

## **CONCLUSION**

This research successfully developed a learning media in the form of a flipbook based on Problem-Based Learning (PBL) for the human excretory system material for 11th-grade high school students. The development process using the 4D model produced media that was validated by experts, practical for teachers and students, and proven effective in improving understanding and learning outcomes. Its attractive design, ease of access through electronic devices, and interactive presentation of the material make this flipbook capable of facilitating more meaningful and contextual learning. This media is not only beneficial for enhancing students' understanding in the classroom but also has the potential to be an alternative independent learning resource outside the classroom. Therefore, this PBL-based digital book is an innovative solution to support the biology learning process, especially for abstract subjects like the excretory system.

Further research is expected to be able to develop similar media for other biology materials or different subjects, thus broadening its scope of use. The distribution of the media to other schools can also be carried out to observe the consistency of results in various learning contexts. In addition, the integration of more varied interactive features, such as adaptive quizzes or 3D simulations, can increase the appeal and effectiveness of the media. Long-term evaluation is also recommended to measure the impact of using the media on enhancing students' critical thinking skills and problem-solving abilities.

## **AUTHOR'S NOTE**

The author hereby explicitly states that there are no conflicts of interest, whether personal, institutional, or financial, that could influence the process of writing, analyzing, or publishing this article. In addition, the author also affirms that all data, information, and content presented in the article are the results of original research conducted with full scientific integrity and are free from any elements of plagiarism. All citations

and references used have been included in accordance with prevailing scientific writing standards to ensure the originality and credibility of this work.

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