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Improving Students' Digital Literacy and Higher-Order Thinking Skills Through the Development of Flipbook Media for Physics Learning

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ABSTRACT
This study aims to develop a feasible and effective flipbook learning medium to improve digital literacy and students' higher-order thinking skills (HOTS) in Physics learning. The study was conducted at SMA Negeri 1 Jonggol, with a sample of 32 students, and was determined using a purposive sampling technique. The research method for module development uses the Research and Development (R&D) type, with the ADDIE development model, which comprises five stages: analysis, design, development, implementation, and evaluation. To improve HOTS using a quasi-experimental method. The research design used a one–group pretest–posttest design. The research instruments include a questionnaire to assess the feasibility of flipbook media, a digital literacy questionnaire, and test questions to measure students' HOTS abilities. The results of the study show that the developed flipbook media is in the very good category, based on student assessments (89.94%) and teacher assessments (86.6%). Students perceived the developed media as engaging due to its integration of images, audio, and video, which facilitates interactive and contextual learning experiences. The improvement in students' digital literacy was categorized as good, with a 80% score, indicating that the flipbook media is effective in enhancing digital literacy across the technical, cognitive, and socio-ethical dimensions. Furthermore, the N-gain score for improving Higher Order Thinking Skills (HOTS) was 0.62, which falls within the moderate category. These findings suggest that flipbook media is an effective instructional innovation for promoting both students' digital literacy and HOTS.

Keywords: *flipbook, HOTS, digital literacy, learning.*

INTRODUCTION

Twenty-first-century skills have fundamentally transformed education, particularly in literacy and technology. Advances in information and communication technology have not only enabled sophisticated digital devices but also demanded changes in how we learn and teach. The digital era demands that students possess new competencies, including digital literacy. Digital literacy is a crucial skill in managing and utilizing digital media and devices. Digital literacy encompasses not only technical skills in operating devices but also critical thinking about the information available digitally (UNESCO, 2022). Digital literacy encompasses the skills to find, evaluate, create information, and use it responsibly to build effective communication in everyday life (Nasrullah et al., 2017). Similarly, digital literacy encompasses an understanding of various

technologies, the ability to apply them, and an awareness of their impact on oneself and others (Liansari & Nuroh, 2018).

Digital literacy is the ability to find, evaluate, create, and communicate information on digital platforms, including computers and mobile devices. It does not replace traditional literacy concepts but rather develops them to remain relevant in improving the ability to access and utilize digital devices such as computers, social media, and the internet (Taufan, 2021). Furthermore, digital literacy encompasses eight essential elements: cultural, cognitive, constructive, communicative, trustworthy, creative, critical, and responsible (Belshaw, 2012).

Digital literacy is increasingly needed as the number of internet users worldwide grows year after year. According to a survey by the Indonesian Internet Service Providers Association, the number of internet users has reached 171.17 million, or 64.8% of Indonesia's total population (Jati, 2021). Unfortunately, the high number of smartphone users among students is not accompanied by an understanding of how to use them. Field evidence from various studies indicates that students' digital literacy remains suboptimal. Research conducted across several secondary schools showed that although students are accustomed to using gadgets, they still have limited ability to evaluate the credibility of digital information and to use it productively in learning activities (Wijaya et al., 2021). It indicates that exposure to technology does not necessarily translate into good digital literacy skills. This finding is reinforced by a report that highlights that many students in developing countries still face limitations in accessing and effectively utilizing digital learning resources, primarily due to limited infrastructure and a lack of engaging, interactive digital learning media (UNESCO, 2022).

One way to improve students' digital literacy skills is to integrate technology into the learning process. One example of this is the use of technology in the learning process, such as the Flipbook application. Flipbooks are digital learning media that present content in the form of interactive e-books, similar to printed books, but with additional features such as animation, video, and hyperlinks that can enrich students' learning experiences. Visually appealing and interactive learning media can increase students' attention, motivation, and learning retention (Arsyad, 2019). Flipbooks can facilitate this because they can present visually rich learning materials and are easily accessible on various digital devices.

Research shows that using flipbooks in learning significantly increases student engagement and helps students understand complex concepts through interactive visualizations (Utami & Nugroho, 2021). Another study found that students who learned using flipbooks showed greater improvements in digital literacy skills than a control group using conventional media (Wahyuni, 2025).

Furthermore, the use of digital technology, such as flipbooks, allows for a more interactive and engaging presentation of material by incorporating multimedia elements such as images, animations, and interactive videos. This advantage makes flipbooks an innovative solution for student-centered learning models, where students control their own learning pace. In other words, flipbooks are not just visual aids but also media that can be used to build critical, creative, and collaborative thinking skills—competencies within the scope of digital literacy in the 21st Century Skills framework (OECD, 2023).

Higher-Order Thinking Skills (HOTS) are one of the 21st-century skills that need to be developed in learning, especially in physics. The revised 2013 curriculum emphasizes that higher-order thinking skills (HOTS) must be integrated into learning (Hanifah, 2019). Therefore, learning must provide space for students to discover knowledge concepts and practice their ability to analyze, evaluate, and create solutions to the complex problems they face. Modern learning emphasizes students' abilities to think critically, communicate, collaborate, and master information technology (Angraini & Sriyati, 2019). Teachers need to innovate to support the development of higher-order thinking skills (HOTS) in the teaching and learning process, starting with learning

methods and techniques, media, teaching materials, and other supporting aspects. This demand then gave rise to ideas about the importance of digital literacy (Abdullah, 2018).

Student learning media was chosen because it offers advantages in developing students' abilities to learn facts, understand general principles, and reason abstractly using realistic reasoning (Yennita et al., 2018). To support these higher-order thinking skills, students need a careful attitude, as this is very important for analyzing a problem in the early stages of the critical thinking process (Paputungan et al., 2022).

From an instructional design perspective, multimedia learning research shows that integrating verbal and visual representations improves understanding of abstract scientific concepts. Mayer (2002) asserts, "People can learn more deeply when they receive an explanation in words and pictures rather than words alone." This principle is particularly relevant for physics materials, which require connecting symbolic equations, graphical representations, and physical phenomena.

Physics, as a science subject, is characterized by its abstract nature, requiring a deep understanding of concepts and strong problem-solving skills. Research shows that mastery of physics concepts is an important foundation for students' learning and problem-solving (Doyan et al., 2024; Sulman et al., 2023). However, in practice, physics learning in schools is often dominated by lecture-based instruction and conventional learning media that do not facilitate active student engagement. Research shows that teacher-centered learning practices and the limited use of interactive digital media contribute to students' low creative and critical thinking skills in physics (Suci Rizki, Pakhrur Razi et al., 2026). Other studies also state that the use of digital technology in science learning remains suboptimal, thus unable to improve students' thinking skills in the digital era fully (Rahmantika et al., 2025). In addition, learning still utilizes static media such as PowerPoint, which contributes to students' low critical thinking skills (Ahzari & Akmam, 2025) and a high need for digital media to support students' thinking skills (Wafa et al., 2025)

One innovative alternative to address these issues is the development of digital flipbooks as a learning tool. Digital flipbooks are technology-based learning tools that present material as interactive books, complemented by text, images, animations, audio, video, simulations, and external links that can enrich the learning experience. This medium can present learning content in a structured, engaging manner and is easily accessible through digital devices such as laptops, tablets, and smartphones.

Research shows that interactive digital flipbooks can improve students' critical thinking skills because students respond positively to their use in learning (Velinda et al., 2024). In fact, the development of digital flipbooks grounded in local wisdom has proven effective in improving students' critical thinking skills (Rini Febriani et al., 2025). Furthermore, flash flipbook media is a digital learning medium that can provide an interactive, immersive learning experience, using text, animation, and interactive features, thereby helping students become more active learners and think critically (Hamidah & Asrohah, 2025). Furthermore, digital flipbooks can also support students' digital literacy development by integrating text, images, and interactive media into a single digital learning medium (Juliana et al., 2025). Thus, flipbooks serve not only as a source of information but also as a tool to facilitate interaction, independent exploration, and the strengthening of students' higher-order thinking skills.

Given the explanations above, it is important to conduct further research on the use of flipbook applications in learning, particularly to improve students' digital literacy and higher-order thinking skills in the digital age. This research is expected to provide theoretical contributions to the development of digital learning media and also have practical implications for improving the quality of learning in schools. Based on the background, the research problems can be formulated as follows: (1) how to develop a feasible flipbook-based learning media for Physics instruction; and

(2) to what extent the developed flipbook media can enhance students' digital literacy and higher-order thinking skills (HOTS).

METHODOLOGY

This research uses a Research and Development (R&D) approach with the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model to produce flipbook learning media. The ADDIE steps are as shown in Figure 1.

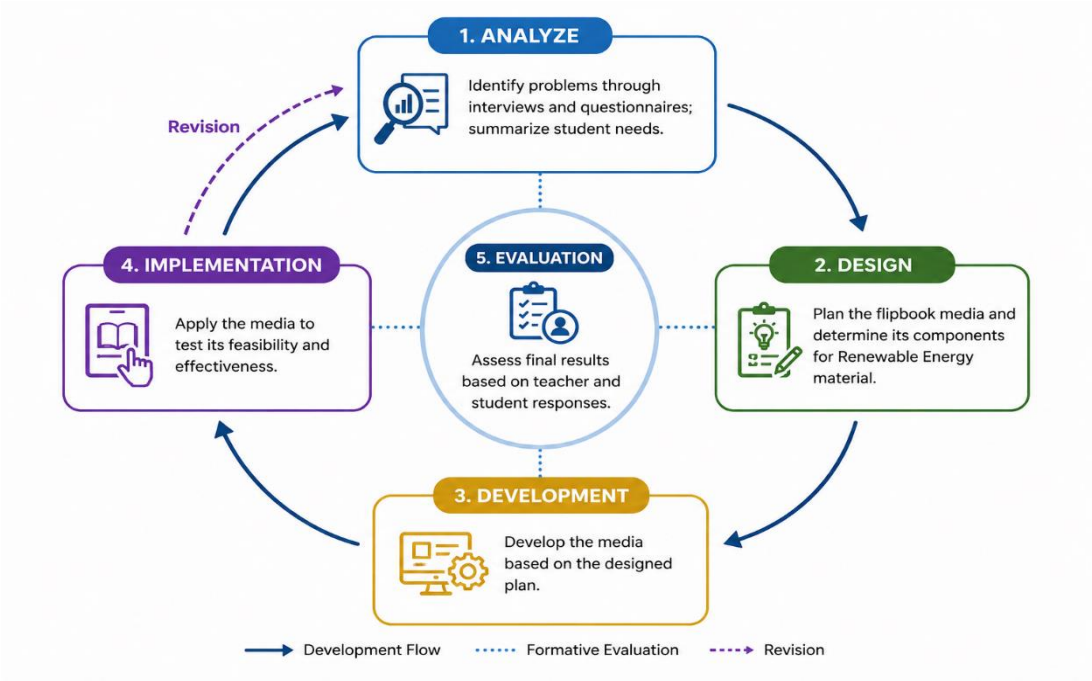


Figure 1. Figure by the Autors

This research was conducted at SMAN 1 Jonggol in the odd semester of 2024/2025. The experimental design used in this study was a one-group pretest-posttest design (Hake, 1998). Using a single class of 32 students is considered adequate for preliminary effectiveness testing, as it meets the minimum sample size for basic statistical analysis. Moreover, the participants exhibit typical characteristics of the target population, enabling analytical generalization to similar educational contexts. In line with common practices in educational research and development, this study focuses on limited-scale implementation; therefore, the findings are not intended for broad generalization but rather to provide initial empirical evidence. To implement this design, the study was conducted with one class, using a pretest and posttest to assess changes in the implementation of the electronic flipbook module before and after treatment. Data collection was conducted by distributing questionnaires and HOTS items to 32 students.

The instruments for this study are (1) a questionnaire, namely, data collection carried out by providing a series of written statements to be answered by respondents to assess the feasibility of flipbook media. Researchers used 12 statements for teachers and 17 for students in writing, which respondents marked with a check mark (√) for each statement. The model used in this questionnaire employs a Likert scale with five response options: strongly agree (point 5), agree (point 4), sufficient (point 3), disagree (point 2), and strongly disagree (point 1). (2). digital literacy questionnaire to measure students' literacy skills (3). The HOTS test is used to determine students' high-level thinking skills by measuring initial achievement before treatment and final achievement after treatment. This treatment shows an increase in high-level thinking skills after using flipbook media for renewable energy material.

RESULT AND DISCUSSION

This research was conducted to develop a flipbook which was implemented through various stages in accordance with the steps of the ADDIE model.

Analysis Stage

In the analysis stage, a needs diagnosis is conducted to enhance learning efficiency and effectiveness. Material analysis involves identifying key content, selecting relevant materials, and organizing them systematically. Learning outcomes are derived from core and basic competencies, which are translated into indicators and learning objectives, while taking into account students' prior knowledge and characteristics.

Design Stage

The design stage involves designing the flipbook's materials and appearance. During the design stage, adjustments are made to the analysis stage to determine the learning flow for presenting the material. The flipbook design involves developing a framework consisting of a cover, foreword, table of contents, core competencies, basic competencies, competency achievement indicators, learning objectives, concept maps, learning materials, learning activities, videos and animations, practice questions, quizzes, and a bibliography.

Development Stage

In the development stage, the design from the previous stage is implemented as a flipbook-based learning media product. This process includes converting and integrating the material into a digital format, developing the layout and structure of the media, and refining interactive features such as embedding images and videos. The media is then published in an appropriate online format, with adjustments to enhance readability and interactivity. This stage results in a flipbook product that is ready for feasibility and effectiveness testing.

Implementation Stage

After the development stage, the media will undergo validation by experts. This validation process aims to assess the media's feasibility and determine whether it can proceed to the trial phase. The feasibility assessment is calculated using the following percentage formula (Purwanto, 2016):

$$NP = \frac{R}{SM} x\ 100\% \quad (1)$$

Description:

NP: percentage figure sought; R: score obtained; SM: maximum score

The material validation was conducted by two validators from the Physics Education Study Program. In comparison, the learning media validation was conducted by two validators from the Physics Education and Guidance and Counseling Study Programs. The results of the flipbook media validation are as follows:

Table 1. Results of Validation by Learning Material Experts

No.	Aspect	Score obtained	Score max	Percentage	Criteria
1	Relevance	8	10	80	Good
2	Completeness	8	10	80	Good
3	View	9	10	90	Very good
	Amount	27	30	90	Very good

Table 2. Results of Learning Media Expert Validation

No.	Aspect	Score obtained	Score max	Percentage	Criteria
1	Ease of using media	9	10	90	Very good
2	Design	5	5	100	Very good
3	Interface	18	20	90	Very good
	Amount	32	35	91.42	Very good

Based on Tables 1 and 2, the validation results indicate that the developed flipbook has high feasibility, with scores of 90% (material expert) and 91.42% (media expert), both categorized as very good. These findings directly address the first research objective, namely, the development of a feasible flipbook-based learning medium for Physics instruction. However, a more detailed analysis reveals variations across aspects. In the material validation, the view aspect (90%) demonstrates strong visual quality, supporting understanding. In comparison, relevance and completeness (80%) indicate that the content still requires refinement to better align with learning objectives and ensure comprehensive coverage. It is important, as content quality plays a crucial role in improving students' digital literacy and higher-order thinking skills (HOTS).

In contrast, the media validation demonstrates consistently high performance across all aspects, particularly in design (100%) and ease of use and interface (90%). These strengths suggest that the media have strong potential to facilitate interaction, exploration, and access to information, key components of developing digital literacy. Compared with the media score, the slightly higher score indicates that the product is stronger in its technical and design aspects, while the instructional content still needs further enhancement. Achieving a balance between content quality and media design is essential to addressing the second research objective: enhancing students' digital literacy and HOTS. Therefore, these validation results provide a solid foundation for proceeding to the limited trial phase to examine the extent to which the media can improve students' digital literacy and HOTS. However, given the limited sample size (2 teachers and 10 students), the findings at this stage should be considered preliminary and not yet generalizable.

Evaluation Stage

The evaluation phase aims to assess the feasibility, practicality, and effectiveness of the developed flipbook media in improving digital literacy and higher-order thinking skills (HOTS) in high school students. The results of the pilot testing with students and teachers are shown in Tables 3 and 4.

Table 3. Data Analysis of Student Questionnaire Results

Indicator	Percentage	Criteria
Flipbook learning media has a very attractive design.	90	Very good
Material according to flipbook media	88	Very good
Flipbook learning media is easy to use	89	Very good
By using flipbook media I find it easier to learn	90	Very good
The animation contained in the flipbook media attracted my attention to learning	94	Very good
Videos in flipbook learning media are in accordance with the learning material	90	Very good
The concepts contained in flipbook media are very easy to understand	95	Very good
The sound on the flipbook is clear	93	Very good
Flipbook media helps me analyze the relationship between physics concepts.	88	Very good
Flipbook media can be accessed anywhere	90	Very good
The vocabulary used in the media is easy to understand	88	Very good
Flipbook learning media is very fun	90	Very good

The questions or activities in the flipbook encourage me to identify the causes and effects of a physical event.	88	Very good
I can explain physics problems presented in flipbooks more systematically.	87	Very good
Flipbook media helps me evaluate the truth of a concept or answer based on the existing explanation	90	Very good
Quizzes in flipbook media train me to assess and choose the most appropriate answer	90	Very good
After using flipbooks, I was able to relate physics concepts to everyday life phenomena.	89	Very good
Avarage	89.94	Very good

Table 4. Data Analysis of Teacher Questionnaire Results

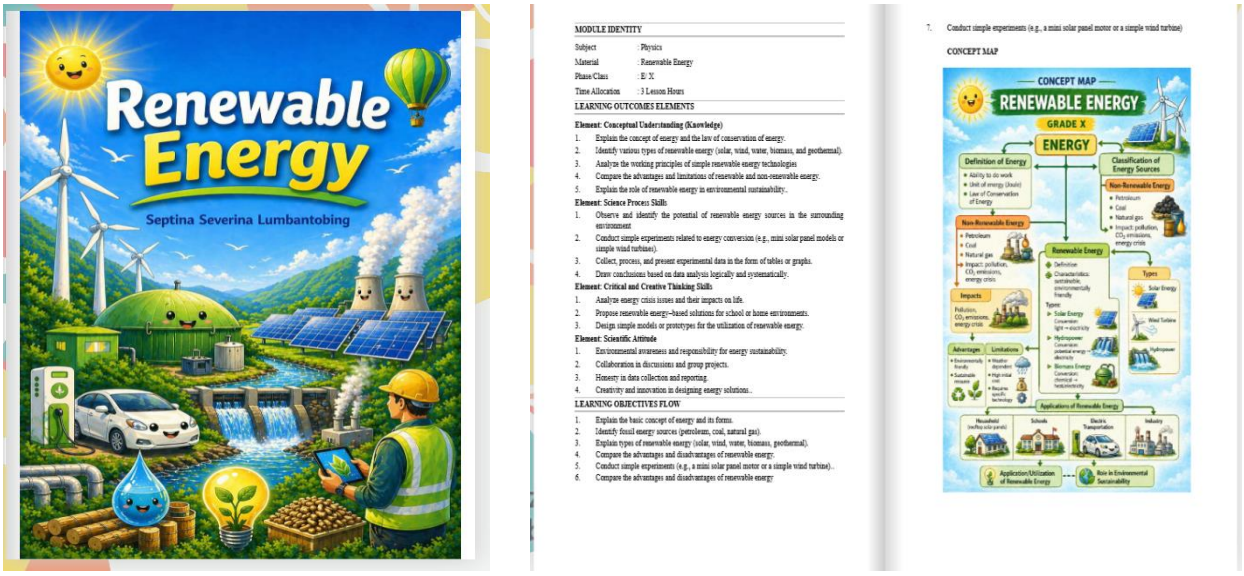
Indicator	Percentage	Criteria
Flipbook media is easy to use in physics learning	90	Very good
The use of flipbook media in renewable energy material helps students understand learning objectives.	80	Good
The description of the learning material, images and videos contained in the flipbook media are clear and easy to teach.	87	Very good
Flipbook learning media is very effective for online learning	90	Very good
Flipbook learning media contains clear and accurate information.	80	Good
Giving assignments/evaluations becomes more interesting by using flipbook media.	90	Very good
The activities and example questions in the flipbook encourage students to identify physics problems and variables.	80	Good
Flipbook media does not help students in achieving learning objectives	88	Very good
Students feel happy when taught using flipbook learning media.	90	Very good
Questions and assignments in flipbook media train students to assess the accuracy of procedures and calculation results.	87	Very good
Flipbook media helps students relate measurement concepts to everyday life phenomena.	85	Very good
Students showed increased engagement and active thinking during learning using flipbooks.	90	Very good
Avarage	86.4	Very good

According to Table 3, the results of the trial evaluation of the flipbook learning media developed by students to enhance higher-order thinking skills (HOTS) were classified as very good, as indicated by the score of 89.94% obtained. Students considered the flipbook media very engaging because it included images, audio, video, and YouTube links. These results indicate that the flipbook learning resource developed for physics is practical and can be used effectively.

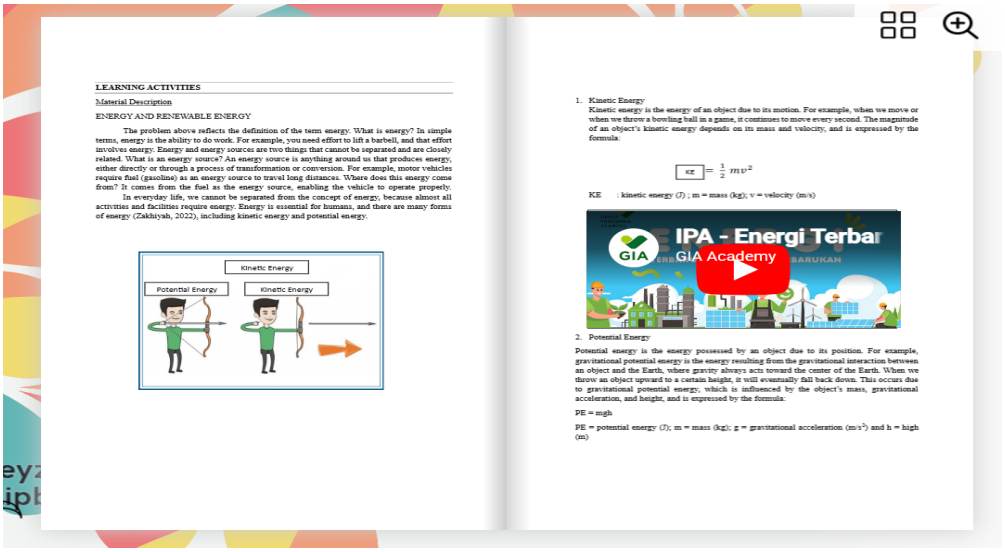
Furthermore, the use of digital flipbooks not only affects the practicality and appeal of the medium but also plays a significant role in improving students' higher-order thinking skills (HOTS). Digital flipbooks allow for visual and interactive presentation of material, thus encouraging students to engage in higher-order thinking activities such as analyzing information, evaluating concepts, and linking theories to contextual phenomena. This finding aligns with research showing that interactive digital flipbooks can facilitate critical thinking through structured, contextual, and easily accessible content presentation (Velinda, Kurnianti, & Hasanah, 2024).

Table 4 shows that teachers' assessment of the developed flipbook learning resource was very good, with a rating of 86.6%. Observers assessed that the developed flipbook learning resource can assist teachers in delivering material on renewable energy and is very practical to use,

both in terms of appearance and functionality, as well as in terms of content and learning. These results align with research showing that the use of HOTS-based interactive e-books significantly improves students' critical thinking and problem-solving skills in science learning (Sari, Lestari, & Kurniawan, 2021). Furthermore, studies in science education indicate that flipbook-based digital learning media are effective in improving students' analytical and evaluation skills because they provide interactive features, contextual exercises, and immediate feedback (Utari, 2024). The appearance of the module used in this study is shown in Figure 2.



(a) (b)



(c)

Figure 2. Example of E-Module Display (a) Cover, (b) Concept Map and (c) Material with Video

Based on the results of processing the digital literacy questionnaire data (15 statements), the overall average percentage was 80%, which is in the good category. This indicates that students have sufficient digital literacy competencies to support physics learning through flipbooks.

Table 5. Distribution of Percentage of Students' Digital Literacy per Indicator

Digital Literacy Indicators	Persentage (%)	Category
Digital Media Access & Operations	82	Good
Evaluation of Digital Information	79	Good
Utilization & Production of Digital Information	81	Good
Digital Communication & Collaboration	78	Good
Digital Ethics & Security	80	Good
Avarage	80	Good

Based on Table 5, the results of the digital literacy questionnaire data processing indicate an overall average of 80%, categorized as good. This achievement indicates that students have adequate digital literacy competencies to support physics learning through flipbooks. In the digital media access and operation indicator (82%), students were able to access, operate, and utilize interactive features independently. The digital information evaluation indicator (79%) showed that students were quite good at understanding the material, comparing sources, and verifying information. Meanwhile, the digital information utilization and production indicator (81%) showed that students were able to use information to solve problems and present material in digital form. These results align with the view (Spires & Bartlett, 2012) that digital literacy includes the ability to access, evaluate, and use information effectively in a learning context.

In addition, the digital communication and collaboration indicator (78%) indicates that students are quite active in online discussions and can collaborate digitally. The digital ethics and security indicator (80%) is also in the good category, indicating student awareness of citing sources and maintaining the security of personal data. These evaluative, collaborative, and ethical dimensions strengthen the cognitive aspect of digital literacy, as stated by Rany et al. (2025), that digital literacy refers not only to technical mastery of digital devices, but also to the ability to understand, analyze, and critically evaluate information in the context of information technology. Overall, the 80% achievement shows that the development of flipbook media effectively improves students' digital literacy across technical, cognitive, and socio-ethical aspects.

Improving Students' Higher Order Thinking Skills (HOTS)

Based on the HOTS test instrument that was distributed to 32 students as research samples, the pretest and posttest results of students' high-level thinking skills were obtained as in Table 6.

Table 6. Pretest and Posttest Scores for High-Order Thinking Skills (HOTS)

	Pretest	Posttest
Mean	50.26	84.13
Median	37	78
Max	60	90
Min	30	60
Std. Deviation	11.4	10.9

Based on the average formula above, the pre-test average was 50.26, and the post-test average was 84.13. It indicates that the post-test score was better than the pre-test score. Thus, it can be concluded that students' high-level skills differ after using flipbook media. From Table 5, we can see that the average student score on the pre-test was 50.26 out of 100. This score indicates that students' higher-order thinking skills are still in the low category. The low pre-test results are because students are still not trained in higher-order thinking skills related to renewable energy materials, so when the questions are modified, they often result in confusion for students.

Furthermore, students' learning style, which tends to rely on memorization rather than understanding the material, affects their ability to solve problems. Sometimes students answer correctly not because they understand the concept but because they memorize it. Consequently, when presented with the same concept but with different questions, almost all students are unable

to answer correctly. The result of this learning style is evident in the minimum score of students on the pretest, which is only 30.00, and the maximum score is only 60.00

However, after treatment using electronic modules in the Flipbook application, the average posttest score increased to 84.13. Providing e-modules in Flipbooks to students is an alternative to help develop students' higher-level skills, as these e-modules also include videos and animations. When students do not understand the material solely through text, they can deepen their understanding by watching videos or animations. Flipbooks also include assignments and evaluations that can stimulate and train students in higher-level thinking, making them more skilled at solving existing problems. The combination of text, video, and animation in e-modules helps students build relationships among concepts.

The use of digital flipbooks can improve students' critical thinking skills by helping them connect concepts and solve problems (Prasasti & Anas, 2023). Research findings also showed that in Cycle I, 46.67% of students achieved learning success, which increased to 90% in Cycle II, indicating a significant improvement in learning outcomes through HOTS-oriented learning assisted by flipbooks (Yusri & Hariani, 2024). To see the improvement in students' overall high-level thinking skills, the average normalized gain value from students' pretest and posttest data is calculated as shown in Table 6.

Table 7. Normalized Gain Values

Students' Higher Order Thinking Skills	**Pretest**	**Posttest**	**Gain Score**	**Category**
	50.26	84.13	0.62	Moderate

Table 7 shows that the improvement in students' higher-order thinking skills is in the moderate category. Although the improvement in students' higher-order thinking skills is only in the moderate category, students have already made significant progress. With the help of the flipbook e-module, students ultimately better understand the material. They can solve problems because, in addition to presenting the lesson material in text form, the Flipbook e-module is also accompanied by videos and audio that support students' critical thinking. The videos and audio in the Flipbook e-module can be directly linked to other applications, such as YouTube and Google. In addition, learning using the Flipbook e-module can improve student responses by stimulating them when they work on practice questions. Providing repeated practice questions along with reinforcement can make students who have difficulty understanding the lesson material feel interested and happy, thereby improving their understanding of the concept. This statement aligns with findings that learning that emphasizes practice questions on computers provides direct feedback to students especially those who experience difficulties thereby helping them improve their learning process (Chaucan, 2011). In addition, the use of e-modules as learning materials to replace printed books can improve students' critical thinking skills (Sugiharti, 2019). Therefore, it can be concluded that Higher-order thinking skills (HOTS) refer to the ability to use critical and creative thinking to solve problems. Individuals with strong HOTS can analyze, connect, and interpret various issues to develop solutions or generate new ideas. In the revised Bloom's Taxonomy, HOTS is categorized within the cognitive domain and includes the levels of analysis, evaluation, and creation.

CONCLUSION

Based on research using the ADDIE development model, the developed flipbook learning media proved feasible, interesting, and effective in improving students' digital literacy and higher-order thinking skills (HOTS) in Physics learning. The results of the trial with students showed that the flipbook media was in the very good category with a score of 89.94%. Students found this media very interesting because it included images, audio, video, and YouTube links that supported a more interactive, context-rich understanding of the concepts. Teachers' assessments of the

developed learning resources also showed a very good rating of 86.6%, indicating that this medium was suitable for use in the learning process. The increase in HOTS was reflected in the average pre-test score rising from 50.26 (low category) to 84.13 (high category) in the post-test. It indicates that the use of flipbooks significantly improved students' higher-order thinking skills. For the improvement of students' literacy skills, it is in the good category (80%), indicating that the development of flipbook media is effective in supporting comprehensive improvement in students' digital literacy across technical, cognitive, and socio-ethical aspects. The N-Gain score criteria for using flipbooks to improve students' digital literacy and HOTS skills are in the moderate category (N-gain = 0.62). Thus, flipbooks are effectively used as a learning innovation to support students' digital literacy and HOTS. However, the findings should be interpreted cautiously due to several limitations, including the absence of a control group, a relatively small sample size, and a single research context, which limit causal inference and generalizability. Future research should employ more rigorous experimental designs with control groups and larger, more diverse samples. In practice, flipbook media can serve as an interactive learning resource, particularly when integrated with student-centered approaches to enhance learning outcomes.

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