Studies in Learning and Teaching (SiLeT)
Homepage: https://scie-journal.com/index.php/SiLeT
Email: silet@scie-journal.com

p-ISSN: 2722-399X; e-ISSN: 2722-1857
SiLeT, Vol. 6, No. 1, April 2025
Page 263-274
©2025 SiLeT

Effectiveness of Media-Assisted Inquiry Learning Models Interactive Flip Book to Improve Critical Thinking Undergraduate Students

***D M Anggraeni[1], H V Saphira[2]**
[1]Department of Physics, Faculty of Teaching and Education Science, Universitas Katolik Weetebula, Indonesia
[2]Digital Technologies for Learning, Faculty of the Arts, Social Sciences and Humanities, University of Wollongong, Australia

Article Info

Article history:

Received April 5, 2025
Revised April 21, 2025
Accepted April 29, 2025
Available Online April 30, 2025

Keywords:

Inquiry learning model;
Interactive flip book;
Critical thinking skills;

ABSTRACT

This study investigates the effectiveness of an inquiry-based learning model supported by interactive flipbook media in enhancing students' critical thinking skills (CTS) on the topic of optics. The research employed an experimental design with a repeated measures pre-test and post-test format, without a control group. The sample consisted of 40 fourth-semester students enrolled in the Optical Waves course during the 2024/2025 academic year. CTS was assessed using a standardized test instrument. Data were analyzed using paired t-tests or Wilcoxon tests, N-Gain analysis, effect size calculations, and independent t-tests. The findings indicate that the media-assisted inquiry learning model significantly improves students' CTS, as evidenced by: (1) a statistically significant increase in CTS scores; (2) N-Gain values falling within the medium to high range; (3) an effect size of 1.4, categorized as strong; and (4) consistent average N-Gain scores across classes at the 5% significance level. The study concludes that the use of interactive flipbook media within an inquiry-based framework is effective in fostering students' CTS.

https://doi.org/10.46627/silet

INTRODUCTION

Students in higher education must have critical thinking skills (CTS), which are important for academic success and personal development. Students who can think critically can explore information in depth (Kong, 2014; Y. Liu, 2023), understand various points of view and make the right decisions based on analysis of facts and logic (Meirbekov et al., 2022; Rivas et al., 2022). They can investigate information thoroughly (Bonney, C. N. R., & Sternberg, 2016; Halpern, 2013), understand multiple analytical perspectives, and make appropriate decisions based on facts and logic (Allison & Pan, 2011; Z. Liu, 2021). In addition, critical thinking helps students solve problems effectively and innovatively (Okolie et al., 2022; Usmeldi et al., 2017), which is very much needed both in academic contexts and in an increasingly competitive and dynamic world of work. This ability also encourages students to develop creativity and good communication skills (Dias-Oliveira et al., 2024; Saad et al., 2024) to prepare logical arguments and convey ideas systematically in discussions and scientific writing. Furthermore, CTS forms students into individuals who are independent, responsible, and not easily influenced by negative influences (Aston, 2024; Suriano et al., 2025) in the campus environment and the wider community. Therefore, the development of CTS must be the primary focus of the learning process in higher education so that students are ready to face academic, social, and professional challenges with mature mental and intellectual readiness (Ashour et al., 2021; Parra-Pérez et al., 2024).

https://doi.org/10.46627/silet.v6i1.634

CTS necessitates a thorough comprehension of the material and the capacity to critically analyze, evaluate, and solve problems for students (MULNIX, 2012; Putra et al., 2023). An efficient learning model is, therefore, crucial. The inquiry-based learning paradigm has been proven to encourage students' critical and creative thinking (Putri & Wulandari, 2025; Yonwong et al., 2024). The inquiry-based learning model provides opportunities for students to actively research, experiment and discuss in a participatory manner to ensure that they not only passively absorb information but also actively participate in the process of learning concepts and solutions to the problems they face (Khasawneh et al., 2023; Wang et al., 2021). This process requires critical thinking at every stage, from asking questions and obtaining and evaluating data to drawing rational and systematic conclusions.

According to empirical studies, using research models significantly impacts students' critical and creative thinking abilities (Arifin et al., 2025; Lu, 2021). This is because of the inquiry model's capacity to stimulate curiosity (Dias-Oliveira et al., 2024; Sasson Lazovsky et al., 2025) and give students the chance to advance their CTS from simple to sophisticated levels gradually (Ho et al., 2023; Muthmainnah et al., 2022). This idea will undoubtedly boost educational activities and students' desire to learn the material more thoroughly. Furthermore, the inquiry-based learning approach fosters critical and nontraditional thinking in students, which is crucial for conquering the challenges of the fast-paced academic and professional worlds. The lecturer's role as a facilitator in this model aids in developing students' independent analysis and evaluation abilities so that their CTS can grow as best it can.

The development of information technology in the modern digital era has changed the nature of education drastically, especially in terms of media and learning methods. Interactive learning materials are an important additional tool for improving the quality of the teaching and learning process (Ruiz-Rojas et al., 2023; Tuma, 2021). Learning media is an alternative that can support the learning process (Daryanes et al., 2023). One media that is increasingly being used effectively is the interactive flip book. Apart from displaying learning content graphically, this media includes various multimedia elements, such as animation, video, audio, and other interactive elements that attract students' attention (Rahmadani, 2024). Flipbook Interactive is more important in increasing students' motivation than traditional learning materials such as printed books or static presentation slides (Hartomo & Sukmawati, 2024); this media can offer a more interesting and enjoyable learning environment. Students are more likely to investigate course material independently when it looks interesting and dynamic. This positively affects students' active participation in the learning process and enables them to engage with the content instead of just passively absorbing it.

Flipbook Interactive is also a learning media that simplifies complex ideas (Hasibuan et al., 2024). This media helps students understand content more realistically and concretely by combining text, graphics, animation, and video. For example, flip books can use animation or simulation to represent abstract ideas that are difficult to understand when talked about. Students can immediately assess their understanding with interactive quizzes, exercises, and reflection questions, increasing the learning process's effectiveness and significance. Because the media flipbook interactive is compatible with various digital devices, including laptops, tablets, and smartphones, it also offers easy access. Because of this flexibility, students can study anytime and anywhere according to their needs and learning styles. The use of this media familiarizes students with learning independently.

The inquiry model places great emphasis on students' active participation in the learning process (Al Mamun & Lawrie, 2023), where they independently, but still under the supervision of their teacher, systematically identify problems, collect and evaluate evidence, and conclude. Because they must assess information and base their conclusions on gathered facts, this approach fosters critical thinking in children. Therefore, learning media such as flip books can be used as a digital learning tool. Media flipbook interactive offers engaging and easily accessible content with multimedia elements, including practice questions, films, animations, and real-world phenomena

https://doi.org/10.46627/silet.v6i1.634

relevant to the subject matter (Hartomo & Sukmawati, 2024; Hasibuan et al., 2024). This encourages students to think more maturely and critically about the topics studied and makes concepts easier to understand. In addition, students can actively and significantly increase their knowledge by using inquiry using flipbooks.

Many studies have been conducted on inquiry learning models and interactive flipbook media in learning. (Putri & Wulandari, 2025) showed that using flipbook-assisted inquiry learning effectively improves science learning outcomes on energy change forms in grade 4 of elementary school. In addition, the results of research conducted by (Kristianto et al., 2023) found that using smartbook media is very effective as a medium for teaching East Javanese folklore to elementary school students. Flipbook-based e-modules in teaching are effective in elementary education (Sari et al., 2024). In addition, (Masyitha et al., 2023) found that flipbook learning media affects junior high school students' interests, motivations, and learning outcomes. The research findings that combine the inquiry model with flipbook media show that there has not been much measurement of improvements in students' critical thinking skills. Interactive flipbook media is considered unique, easy to access, and relevant to learning needs in the digital era (Marisda, D. H., Tolla, I., & Arsyad, 2025). However, it is generally still limited to elementary and secondary school levels, and has not been widely implemented at the college level. At the same time, we all know that training CTS in college students is an important provision for students facing the challenges of the 21st century. Based on the explanation given, we know that in the modern world, students must have CTS to succeed academically and professionally. However, traditional learning methods often fail to develop these talents. An inquiry-based learning model that emphasizes students' active participation in the inquiry and analysis process can improve students' CTS when used with contemporary instructional materials. Media flip book Interactive learning has the potential to increase student interest in learning and make lessons more straightforward to understand. Apart from that, testing how effective the inquiry learning paradigm is using media flipbook Interactivity in increasing students' CTS is essential.

The novelty in this study is that it raises the effectiveness of the inquiry learning model assisted by interactive flipbook media to improve students' CTS, which offers several novelties, namely focusing on students, specific measurements of CTS, and integration of interactive media. Thus, this study is expected to provide significant contributions in developing innovative learning models that effectively improve students' CTS, while also overcoming the limitations of previous research in terms of subjects, media, and aspects of skills developed. The findings of this research will be beneficial in creating innovative and successful teaching strategies in higher education institutions. Therefore, research is needed that examines in more depth the effectiveness of media-assisted inquiry learning models flip book to increase student CTS. This research aims to test the effectiveness of using the media-assisted inquiry learning model flipbook interactive to increase student CTS.

RESEARCH METHOD

This type of research is experimental research uses one group pre-test and post-test design repeated without control classes. This research uses two (2) classes, where research activities begin with conducting pre-test students in both classes and then continue with learning using the media-assisted inquiry learning model flipbook interactive for three (3) meetings. The final activity of this research is conducting a post-test. The design plan in this research is presented in Table 1.

Table 1. Design research

Class A	Class B
O_1 X O_2	O_1 X O_2

https://doi.org/10.46627/silet.v6i1.634

Information:
O_1 : Test results pre-test
X : Learning uses a media-assisted inquiry model flipbook interactive
O_2 : Test results post-test
Class A, B : Classes used in research

The participants in this study were fourth-semester students from the Physics Education program at the Faculty of Teacher Training and Education (FKIP), Weetebula Catholic University, during the 2024/2025 academic year. These students were enrolled in a course covering OPTICS material. A saturated sampling technique was employed, meaning the entire population was used as the sample. The total sample consisted of 40 students (30 female and 10 male), aged between 19 and 21 years, divided equally into two classes: Class A and Class B, each with 20 students. The primary instrument used to assess CTS was a test comprising eight questions. Prior to implementation, the CTS test underwent validation and reliability testing. Validity was assessed using Aiken's V method in Microsoft Excel, while reliability was evaluated using the Kappa Statistic via SPSS 21. The results confirmed that the instrument was both valid and reliable, making it appropriate for measuring CTS in this study.

The CTS indicators were adapted from (Fascione, 2011) and (Jatmiko et al., 2018), focusing on four core components: analysis, interpretation, evaluation, and inference. Data analysis began with prerequisite tests, including the Shapiro-Wilk test for normality and the Levene test for homogeneity. Following these, a paired t-test was conducted to determine significant differences between pre-test and post-test scores at a 5% significance level. Additionally, N-Gain analysis was performed to evaluate the consistency of learning gains across both classes, also at a 5% significance level. The N-Gain was calculated using a standard formula:

$$\text{N} - \text{Gain} = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}}$$ (Hake, 1998)

Information: N-Gain = normalized gain value; Spost = post-test score; Spre = pre-test score; Smax = maximum CTS value.

Criteria for value calculation results N-Gain can be seen in Table 1.

Table 2. N-gain criteria

N-Gain	Criteria
0.70 ≤ N-Gain	High
0.30 ≤ N-Gain < 0.70	Medium
N-Gain < 0.30	Low

Source: Hake (1998)

The final data analysis is calculating effect size. This calculation aims to assess the level of impact of using the assisted inquiry learning flipbook interactive in increasing student CTS. The equation used to calculate the value effect size is:

$$\text{Effect size} = \frac{means\ of\ post\ test\ score - means\ of\ pre\ test\ score}{standard\ deviation}$$

Value calculation results in effect size categorized according to categories effect size in Table 3.

Table 3. Effect size category

Interval	> 1,00	0,51 – 1,00	0,21 – 0,50	0,00 – 0,20
Category	Strong effect	Moderate effect	Modest effect	Weak effect

Source: Hasyim (2024)

The inquiry learning model assisted by Flipbook interactive media can be effective if: (1) students' CTS scores increase at a statistically significant level of 5.00%. (2) The average N-Gain is in the least moderate category. (3) The average N-Gain for each class is not different (consistent) at the 5.00% significance level. (4) The effect size with the lowest value is classified as medium. SPSS version 26 was used for data analysis in this study.

RESULTS AND DISCUSSION

Result

This study aims to evaluate the effectiveness of an inquiry-based learning model supported by interactive flipbook media in enhancing students' CTS. The model's effectiveness was assessed by comparing students' performance on pre-test and post-test assessments. Table 4 presents the average scores for the pre-test, post-test, and the normalized gain (N-Gain), which collectively reflect the improvement in CTS because of the intervention.

Table 4. Average values pre-test, post-test, and n-gain

		Description					
		Lowest Score	Highest Score	Average Score	Number of Undergraduate Students	Average N-Gain	Average N-Gain 2 Classes
Class A	Pre-Test	10.00	45.00	32.05	20	0.71	
	Post-Test	42.00	85.00	75.00	20		0.72
Class B	Pre-Test	25.00	60.00	40.00	20	0.74	
	Post-Test	45.00	82.00	73.00	20		
Category							High

Table 4 presents the average scores from the pre-test, post-test, and the corresponding normalized gain (N-Gain) values. The results indicate that Class A achieved an average N-Gain of 0.71, while Class B recorded a slightly higher average of 0.74. Both values fall within the high category. The combined average N-Gain across both classes is 0.72, also categorized as high. Further details regarding the average N-Gain values for each critical thinking skill (CTS) indicator are provided in Table 5.

Table 5. Average values n-gain each CTS indicator

		CTS Indicator				Average
		Analysis	Interpretation	Inference	Evaluation	
Class A	Pre-Test	40.00	45.00	35.00	44.00	41.00
	Post-Test	80.00	85.00	78.00	75.00	79.50
	N-Gain	0.73	0.71	0.72	0.68	0.71
	Category	High	High	High	Moderate	High
Class B	Pre-Test	50.00	35.00	25.00	27.00	34.25
	Post-Test	82.00	80.00	75.00	80.00	79.25
	N-Gain	0.71	0.71	0.70	0.74	0.71
	Category	High	High	High	High	High

https://doi.org/10.46627/silet.v6i1.634

Based on the data in Table 5, it shows that for class A, the average is obtained N-Gain highest in analysis indicators with a value N-Gain of 0.73 (high category) while the value N-Gain lowest on evaluation indicators with a value N-Gain of 0.68 (medium category). The average score for class B, on the other hand, was N-Gain lowest on inference indicators (value N-Gain = 0.70; medium category) and highest on evaluation indicators (value N-Gain = 0.74; high category). Generally speaking, classes A and B's average N-Gain value of 0.71 falls into the high category. We performed normality and homogeneity tests on the research data to continue analyzing the prerequisite tests after examining the average value N-Gain. Table 6 displays the results of the homogeneity and normality tests.

Table 6. Normality and homogeneity test results

	Normality Test (Shapiro-Wilk), $\propto = 0.05$			Homogeneity Test (Levene Test), $\propto = 0.05$		
	Statistic	Significant	Conclusion	Data	Significant	Conclusion
Class A	0.89	0.92	Normal	N-Gain	0.85	Homogen
Class B	0.72	0.75				

As shown in Table 6, the research data met the assumptions of normality and homogeneity. The Shapiro-Wilk test results indicated significance values of 0.754 for Class B and 0.921 for Class A, both exceeding the 5% threshold, confirming that the data in both classes are normally distributed. Additionally, the Levene test for homogeneity yielded a significance value of 0.850, also above the 5% level, indicating that the data are homogeneous. Based on these results, the dataset satisfies the assumptions required for parametric testing.

Subsequently, a paired sample t-test was conducted using SPSS version 26 to determine whether there was a significant improvement in students' CTS scores. The results of this analysis are summarized in Table 7.

Table 7. Results of paired data t-test *pre-test* and *post-test* CTS

Class	Statistic Test	T	Df	Sig. (2-tailed)	**α**	Conclusion
A	t-paired two	-12.86	19	0.00	< 0.05	There is a
B	tailed	-6.52	19	0.00	< 0.05	difference

Table 7 presents the results of the paired t-test comparing pre-test and post-test scores. The negative t-value indicates that post-test scores were significantly higher than pre-test scores, suggesting an improvement in students' CTS following the implementation of the interactive flipbook-assisted inquiry learning model. To determine whether there was a significant difference in the average N-Gain between Class A and Class B, an independent samples t-test was conducted using SPSS version 26. The results of this analysis are shown in Table 8.

Table 8. Test results independent-t samples test data n-gain CTS

Uji Statistic Test	Data	Sig.	Information
Independent t-Test	N-Gain	0.18	There is a difference

As shown in Table 8, the independent samples t-test produced a two-tailed significance (Sig.) value of 0.185. Since this value is greater than the 0.05 threshold, it indicates that there is no statistically significant difference in the average N-Gain between Class A and Class B. This suggests that the improvement in students' critical thinking skills was consistent across both

groups. The next stage of data analysis involves calculating the effect size to assess the magnitude of the intervention's impact. The results of the effect size analysis are presented in Table 9.

Table 9. Calculation results *effect size*

Mean of Posttest Score	Mean of Pre-test Score	Standard Deviation	Effect Size	Category
74	36,02	27,13	1,4	Strong effect

The data presented in Table 9 show that the effect size from this research is included in the category of strong effect, with a value effect size of 1,4. The purpose of calculating effect size is to measure the magnitude of the influence of a treatment or intervention on a variable. By obtaining a value effect size of 1,4, using the media-assisted inquiry learning model flipbook interactive has a powerful influence on increasing student CTS.

Discussion

The findings of this study indicate that the inquiry-based learning model supported by interactive flipbook media is effective in enhancing students' CTS. As shown in Table 4, the average N-Gain for both Class A and Class B was 0.72, which falls within the high category. This demonstrates a significant improvement in CTS because of the instructional approach used. Further analysis in Table 5 reveals that the average N-Gain for each CTS indicator—analysis, interpretation, evaluation, and inference—also generally falls within the high category for both classes. However, two indicators showed slightly lower gains: the evaluation indicator in Class A and the inference indicator in Class B, both of which were categorized as medium. Tables 7 and 8 support these findings, showing that post-test scores were significantly higher than pre-test scores and that the average N-Gain between the two classes was statistically consistent. Additionally, the effect size analysis presented in Table 9 yielded a value of 1.4, which is classified as a strong effect. This confirms that the use of interactive flipbook-assisted inquiry learning has a substantial and positive impact on students' CTS development.

The results of each CTS indicator show that the inquiry learning model effectively increases students' CTS when used with interactive flipbooks. These results are consistent with research by (Batlolona et al., 2019), who found that the use of flipbook media in the educational process was carried out by connecting CTS indicators to the media. This is done so that learning focuses more on students' critical, practical, functional thinking and active learning. Apart from that, research conducted by (Chen et al., 2023) concluded that using an inquiry learning model assisted by interactive media effectively increased CTS and student learning motivation. We know that the inquiry learning model is a learning model that helps students be active in the learning process (Wale & Bogale, 2021). The following presents examples of student answers related to evaluation indicators in the OPTIC material.

Indicator evaluation test :
"A driver uses a car's high beams to see the road at night. Explain how high beams can help a driver see the road at night".
This is one of the answers from students

Pretest: *At night, the car will turn on the spotlight to help the driver see the road. The lights will make the road bright, and the light from the spotlight will help the driver see the road, other vehicles, or obstacles in front of the car.*

https://doi.org/10.46627/silet.v6i1.634

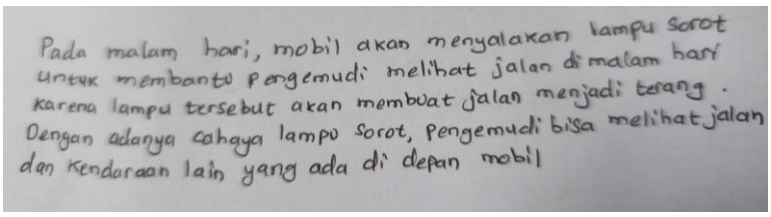


Figure 1. Student work results in pretest

Posttest: *Car headlights help drivers see the road at night by emitting focused and intense light, so that the area in front of the vehicle becomes bright and visible. In car headlights, light from the light source is reflected by a concave mirror-shaped reflector with a flat or curved surface. The light that comes to the surface of this reflector is reflected according to the law of reflection, so that the light rays are directed forward in one focused direction (regular reflection). Thus, the headlight produces an intense and directional beam of light, allowing drivers to see the road clearly at a greater distance.*

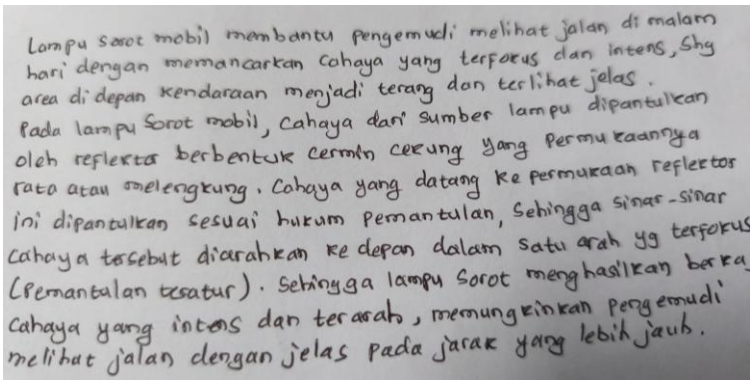


Figure 2. Student work results in posttest

Based on the data in Figures 1 and 2, there is a change in the pattern of students' answers in evaluating a given problem. This strengthens why applying the interactive flipbook-assisted inquiry learning model can improve students' CTS. After the treatment given to students using the interactive flipbook-assisted inquiry learning model, students' evaluation abilities have increased, as seen from the students' mindset when answering questions related to evaluation indicators.

According to this study's findings, students' CTS can be raised during the learning process by combining the inquiry learning model with interactive flipbooks to support learning materials. A more contextualized and meaningful learning experience can be achieved by combining interactive flip book-assisted media with the inquiry model (Marisda, D. H., Tolla, I., & Arsyad, 2025). Students must be able to actively investigate and resolve problems when learning with the inquiry model (Kitot et al., 2010; Nisa, E. K., Koestiari, T., Habibbulloh, M., & Jatmiko, 2018). The existence of interactive flipbook media helps provide rich and interactive learning resources that students can access easily (Herianto et al., 2022). This combination supports students' critical thinking processes by presenting material that stimulates curiosity and analysis, providing practice questions and reflection facilities that facilitate evaluation and synthesis, and using multimedia that can help students understand concepts in depth. In addition, the easily accessible flipbook media allows learning not to be limited to class space and time so that students can learn independently and repeatedly, strengthening students' CTS.

The use of interactive flipbooks in this lesson is a learning medium that is presented to students during learning on OPTICS material using an inquiry model learning design. Students in both classes are directed to find solutions to the problems given regarding the learning material. Flipbooks with content, practice questions, sample questions, and interactive

audiovisuals aid students in understanding the material so they can finish their assignments. Students' CTS is trained through their learning process, which includes analysis, interpretation, evaluation, and inference indicators. Therefore, one suggestion for training students' CTS is to create a learning process using an inquiry learning model aided by interactive flip book media. This is because interactive flip book media and the inquiry learning model successfully improve students' CTS.

Using inquiry learning models assisted by flipbook media in physics material effectively improves students' CTS. The guided inquiry model encourages students to learn actively through in-depth exploration and investigation of physics concepts, such as in the Optics material. The interactive flipbook media developed is equipped with animations, videos, images, and interactive questions that provide direct feedback, making it easier for students to understand abstract and complex physics concepts visually and contextually. Using guided inquiry-based flipbooks also increases students' learning motivation and active involvement in learning, which contributes to improving CTS. Thus, integrating the inquiry learning model and interactive flipbook media helps students develop analytical and CTS in understanding various physics concepts, while encouraging students to be active in the investigative and reflective learning process, due to the characteristics of physics learning that emphasize exploration and scientific problem solving.

CONCLUSION

Based on the data analysis and discussion, the inquiry-based learning model supported by interactive flipbook media has been shown to effectively enhance students' critical thinking skills (CTS). The results revealed a statistically significant improvement in CTS scores at the 5% significance level. The average N-Gain values were 0.71 for Class A and 0.74 for Class B, both categorized as high. Additionally, the effect size was calculated at 1.4, indicating a strong impact. The consistency of the average N-Gain across both classes further supports the effectiveness of this instructional approach. Therefore, implementing an inquiry-based learning model with interactive flipbooks can be considered a viable strategy for improving students' CTS.

However, this study has several limitations. Some CTS indicators remained in the medium category—specifically, the evaluation indicator in Class A and the inference indicator in Class B—suggesting room for further improvement. Moreover, the sample size was relatively small and limited to a single institution, which may affect the generalizability of the findings. Future research should involve a larger and more diverse sample across different institutions and countries. Additionally, this study focused solely on OPTICS content; further investigations should explore the application of this learning model across various subject areas to assess its broader effectiveness.

REFERENCES

Al Mamun, M. A., & Lawrie, G. (2023). Student-content interactions: Exploring behavioural engagement with self-regulated inquiry-based online learning modules. *Smart Learning Environments, 10*(1), 1. https://doi.org/10.1186/s40561-022-00221-x

Allison, J., & Pan, W. (2011). Implementing and evaluating the integration of critical thinking into problem based learning in environmental building. *Journal for Education in the Built Environment, 6*(2), 93–115. https://doi.org/10.11120/jebe.2011.06020093

Arifin, Z., Sukarmin, S., Saputro, S., & Kamari, A. (2025). The effect of inquiry-based learning on students' critical thinking skills in science education: A systematic review and meta-analysis. *Eurasia Journal of Mathematics, Science and Technology Education, 21*(3), em2592. https://doi.org/10.29333/ejmste/15988

Ashour, S., El-Refae, G. A., & Zaitoun, E. A. (2021). Post-pandemic higher education: Perspectives from university leaders and educational experts in the United Arab Emirates. *Higher Education for the Future, 8*(2), 219–238. https://doi.org/10.1177/23476311211007261

Aston, K. J. (2024). 'Why is this hard, to have critical thinking?' Exploring the factors affecting critical thinking with international higher education students. *Active Learning in Higher Education, 25*(3), 537–550. https://doi.org/10.1177/14697874231168341

Batlolona, J. R., Diantoro, M., Wartono, & Latifah, E. (2019). Creative thinking skills students in physics on solid material elasticity. *Journal of Turkish Science Education, 16*(1), 48–61. https://doi.org/10.12973/tused.10265a

Bonney, C. N. R., & Sternberg, R. R. J. (2016). Learning to think critically. In *Handbook of research on learning and instruction*. Routledge.

Chen, C.-J., Tsai, H.-J., Lee, M.-Y., Chen, Y.-C., & Huang, S.-M. (2023). Effects of a Moodle-based E-learning environment on E-collaborative learning, perceived satisfaction, and study achievement among nursing students: A cross-sectional study. *Nurse Education Today, 130*, 105921. https://doi.org/10.1016/j.nedt.2023.105921

Dias-Oliveira, E., Pasion, R., Vieira da Cunha, R., & Lima Coelho, S. (2024). The development of critical thinking, team working, and communication skills in a business school–A project-based learning approach. *Thinking Skills and Creativity, 54*, 101680. https://doi.org/10.1016/j.tsc.2024.101680

Facione, P. A. (2011). *Critical thinking: What it is and why it counts*. The California Academic Press.

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics, 66*(1), 64–74. https://doi.org/10.1119/1.18809

Halpern, D. F. (2013). *Thought and knowledge: An introduction to critical thinking*. The California Academic Press.

Hartomo, R. M., & Sukmawati, W. (2024). The effect of digital flipbook media on improving science literacy on human digestive system materials among elementary school students. *Jurnal Penelitian Pendidikan IPA, 10*(9), 6260–6270. https://doi.org/10.29303/jppipa.v10i9.7994

Hasibuan, S., Kasih, I., Daulay, D. E., Sinulingga, A., & Fahrian, M. A. (2024). Development of flip book-based learning media for sports physiology in physical education students at university. *AL-ISHLAH: Jurnal Pendidikan, 16*(2). https://doi.org/10.35445/alishlah.v16i2.4053

Hasyim, F., Prastowo, T., & Jatmiko, B. (2024). Critical thinking-independent learning: A model of learning to improve students' critical thinking skills. *European Journal of Educational Research, 13*(2), 747–762. https://doi.org/10.12973/eu-jer.13.2.747

Herianto, Wilujeng, I., & Lestari, D. P. (2022). Effect of interactive multimedia e-books on lower-secondary school students' curiosity in a science course. *Education and Information Technologies, 27*(7), 9619–9639. https://doi.org/10.1007/s10639-022-11005-8

Ho, Y.-R., Chen, B.-Y., Li, C.-M., & Chai, E. G.-Y. (2023). The distance between the humanities and medicine: Building a critical thinking mindset by interdisciplinary dialogue through mind mapping. *Thinking Skills and Creativity, 50*, 101420. https://doi.org/10.1016/j.tsc.2023.101420

Khasawneh, E., Hodge-Zickerman, A., York, C. S., Smith, T. J., & Mayall, H. (2023). Examining the effect of inquiry-based learning versus traditional lecture-based learning on students' achievement in college algebra. *International Electronic Journal of Mathematics Education, 18*(1), em0724. https://doi.org/10.29333/iejme/12715

Kitot, A. K. A., Ahmad, A. R., & Seman, A. A. (2010). The effectiveness of inquiry teaching in enhancing students' critical thinking. *Procedia - Social and Behavioral Sciences, 7*, 264–273. https://doi.org/10.1016/j.sbspro.2010.10.037

Kong, S. C. (2014). Developing information literacy and critical thinking skills through domain knowledge learning in digital classrooms: An experience of practicing flipped classroom strategy. *Computers & Education, 78*, 160–173. https://doi.org/10.1016/j.compedu.2014.05.009

Kristianto, J. V., Hunaifi, A. A., & Santi, N. N. (2023). Development of smartbook learning media fictional story material based on East Java folk stories for class 4 primary school students. *Jurnal Eduscience, 10*(3), 755–767. https://doi.org/10.36987/jes.v10i3.4745

Liu, Y. (2023). Matches and mismatches between university teachers' and students' perceptions of E-learning: A qualitative study in China. *Heliyon, 9*(6), e17496. https://doi.org/10.1016/j.heliyon.2023.e17496

Liu, Z. (2021). Sociological perspectives on artificial intelligence: A typological reading. *Sociology Compass, 15*(3). https://doi.org/10.1111/soc4.12851

Lu, D. (2021). Students' perceptions of a blended learning environment to promote critical thinking. *Frontiers in Psychology, 12*. https://doi.org/10.3389/fpsyg.2021.696845

Marisda, D. H., Tolla, I., & Arsyad, M. (2025). Developing and validating an interactive flipbook E-book to foster critical thinking in modern physics education. *TWIST, 20*(1), 279–288. https://doi.org/10.5281/twist.10049652#381

Masyitha, D., Suyanta, S., Jumadi, J., & Maghfiroh, S. (2023). Development of flipbook-assisted practical guide on measurement physics materials to increase junior high school student learning motivation. *Jurnal Penelitian Pendidikan IPA, 9*(1), 31–35. https://doi.org/10.29303/jppipa.v9i1.1732

Meirbekov, A., Maslova, I., & Gallyamova, Z. (2022). Digital education tools for critical thinking development. *Thinking Skills and Creativity, 44*, 101023. https://doi.org/10.1016/j.tsc.2022.101023

Mulnix, J. W. (2012). Thinking critically about critical thinking. *Educational Philosophy and Theory, 44*(5), 464–479. https://doi.org/10.1111/j.1469-5812.2010.00673.x

Muthmainnah, Ibna Seraj, P. M., & Oteir, I. (2022). Playing with AI to investigate human-computer interaction technology and improving critical thinking skills to pursue 21st century age. *Education Research International, 2022*, 1–17. https://doi.org/10.1155/2022/6468995

Nisa, E. K., Koestiari, T., Habibbulloh, M., & Jatmiko, B. (2018). Effectiveness of guided inquiry learning model to improve students' critical thinking skills at senior high school. In *Journal of Physics: Conference Series*, 012049.

Okolie, U. C., Igwe, P. A., Mong, I. K., Nwosu, H. E., Kanu, C., & Ojemuyide, C. C. (2022). Enhancing students' critical thinking skills through engagement with innovative pedagogical practices in Global South. *Higher Education Research & Development, 41*(4), 1184–1198. https://doi.org/10.1080/07294360.2021.1896482

Parra-Pérez, L. G., Valdés-Cuervo, A. A., Urias-Murrieta, M., & Addo, R. (2024). Mexican college students' perspectives on teaching practice and critical thinking development. *Cogent Education, 11*(1). https://doi.org/10.1080/2331186X.2024.2385866

Putra, P. D. A., Sulaeman, N. F., Supeno, & Wahyuni, S. (2023). Exploring students' critical thinking skills using the engineering design process in a physics classroom. *The Asia-Pacific Education Researcher, 32*(1), 141–149. https://doi.org/10.1007/s40299-021-00640-3

Putri, D. R., & Wulandari, D. (2025). Development of smart book media based on guided inquiry to improve IPAS learning outcomes. *Jurnal Penelitian Pendidikan IPA, 11*(3), 206–215. https://doi.org/10.29303/jppipa.v11i3.10715

Rahmadani, E. (2024). Innovation of flipbook teaching materials in supporting student learning independence. *Elementary School Forum (Mimbar Sekolah Dasar), 11*(1), 176–189. https://doi.org/10.53400/mimbar-sd.v11i1.61620

Rivas, S. F., Saiz, C., & Ossa, C. (2022). Metacognitive strategies and development of critical thinking in higher education. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.913219

Ruiz-Rojas, L. I., Acosta-Vargas, P., De-Moreta-Llovet, J., & Gonzalez-Rodriguez, M. (2023). Empowering education with generative artificial intelligence tools: Approach with an instructional design matrix. *Sustainability, 15*(15), 11524. https://doi.org/10.3390/su151511524

Saad, A., Elbashir, A., Abdou, R., Alkhair, S., Ali, R., Parangusan, H., Ahmad, Z., & Al-Thani, N. J. (2024). Exploring of the gender variations in 4C skills among primary students. *Thinking Skills and Creativity, 52*, 101510. https://doi.org/10.1016/j.tsc.2024.101510

Sari, I. P., Rohmani, R., & Nisa', K. (2024). Analysis of the effectiveness of using flipbook-based E-modules in science learning in elementary schools. *IJORER: International Journal of Recent Educational Research, 5*(6), 1367–1382. https://doi.org/10.46245/ijorer.v5i6.615

Sasson Lazovsky, G., Raz, T., & Kenett, Y. N. (2025). The art of creative inquiry—From question asking to prompt engineering. *The Journal of Creative Behavior, 59*(1). https://doi.org/10.1002/jocb.671

Suriano, R., Plebe, A., Acciai, A., & Fabio, R. A. (2025). Student interaction with ChatGPT can promote complex critical thinking skills. *Learning and Instruction, 95*, 102011. https://doi.org/10.1016/j.learninstruc.2024.102011

Tuma, F. (2021). The use of educational technology for interactive teaching in lectures. *Annals of Medicine and Surgery, 62*, 231–235. https://doi.org/10.1016/j.amsu.2021.01.051

Usmeldi, Amini, R., & Trisna, S. (2017). The development of research-based learning model with science, environment, technology, and society approaches to improve critical thinking of students. *Jurnal Pendidikan IPA Indonesia, 6*(2), 318–325. https://doi.org/10.15294/jpii.v6i2.10680

Wale, B. D., & Bogale, Y. N. (2021). Using inquiry-based writing instruction to develop students' academic writing skills. *Asian-Pacific Journal of Second and Foreign Language Education, 6*(1), 4. https://doi.org/10.1186/s40862-020-00108-9

Wang, T., Ramdeo, J., & McLaughlin, C. (2021). Experiencing and experimenting: An exploration of teacher agency in an international collaborative teacher professional development programme using experiential learning. *Teaching and Teacher Education, 104*, 103389. https://doi.org/10.1016/j.tate.2021.103389

Yonwong, P., Thongsuk, T., & Hemtasin, C. (2024). Creativity development of secondary school students using four thinking activities blended inquiry-based learning. *International Journal of Instruction, 17*(1), 579–598. https://doi.org/10.29333/iji.2024.17130a

Author (s):

* Desak Made Anggraeni (Corresponding Author)
Department of Physics, Faculty of Teching and Education Science,
Universitas Katolik Weetebula,
Jl. Mananga Aba – Desa Karuni – Sumba Barat Daya, NTT 87254, Indonesia
Email: desak.madeanggraeni@gmail.com

Hanandita Veda Saphira
Digital Technologies for Learning, Faculty of the Arts, Social Sciences and Humanities, University of Wollongong, New South Wales, Australia, 2500
Email: hanandita.saphira346@ouwmail.edu.au