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Designing an Interactive Flip-Mind Module on Temperature and Heat Concepts to Facilitate Critical Thinking-Oriented Learning

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ABSTRACT

Critical thinking skills are essential for students facing the challenges of the Industrial Revolution 4.0 era. This study aimed to develop and analyze the feasibility of the Flip-Mind interactive module, evaluate the improvement of critical thinking skills, and examine students' responses to its use on temperature and heat materials. This study employed a Research and Development (R&D) method, utilizing the 4D model (Define, Design, Develop, and Disseminate), integrating case-based learning and critical thinking components through interactive HTML5-based features to enhance conceptual understanding. This research employed a pretest-posttest control group design with purposive sampling involving grade XI students from a public senior high school. The validation results indicate that the module is in the "very feasible" category. The improvement in critical thinking skills was indicated by an N-Gain value of 62.7% (moderate category), with an average increase in score of 11%. Students' responses to the module's use were in the "outstanding" category with a percentage of 82%. These findings suggest that the Flip-Mind interactive module is a practical and feasible alternative to innovative teaching materials for improving critical thinking skills in physics learning. Theoretically, this study enriches the framework of digital learning innovation by demonstrating the integration of case-based and critical thinking-oriented approaches. Practically, the Flip-Mind module offers an effective pedagogical model that can be adapted for interactive and student-centered physics instruction.

Keywords: Critical Thinking Skills, Flip-Mind, Interactive Module, Temperature and Heat

INTRODUCTION

The rapid advancement of information and communication technology (ICT) in the 21st century has significantly transformed the field of education, thereby enhancing the accessibility and interactivity of learning for students (Wahyuni et al., 2020). With the evolution of education itowards a more digital and interconnected environment, the integration of ICT facilitates personalized learning, enhances communication and collaboration, and enables educators to create authentic learning experiences relevant to real-world situations (Hidayatullah et al., 2021). The changes demonstrate that Information and Communication Technology (ICT) is not merely an additional resource, but a fundamental element that significantly influences the

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learning process in contemporary educational settings (Jaman et al., (2025). The application of ICT enhances student learning efficiency and provides avenues to improve learning results and the quality of instruction (Rahmawati et al., 2022). Therefore, integrating ICT has become a crucial element in the development of modern educational materials, including those used in physics education.

In science education, physics is considered one of the most abstract subjects, requiring students to develop both conceptual understanding and problem-solving skills (Husein et al., 2017; Latifah et al., 2020). Due to its theoretical and abstract characteristics, students often struggle to visualize physical phenomena, which hinders their ability to relate theoretical concepts to practical, real-life situations (Hidayatin et al., 2022). This challenge raises the possibility that conventional teaching methods are insufficient to promote conceptual understanding (Sharma, 2025). As a result, incorporating ICT into physics education can be highly beneficial in helping students actively construct their own knowledge and visualize abstract concepts. To put it another way, ICT makes physics education more relevant and contextual by acting as a link between abstract theory and real-world experience (Sulistyani & Mochama, 2025). From the cognitive learning perspective described by Schunk (2019), the use of learning media plays a significant role in shaping how students process, organize, and internalize new information. Media that provide clear visualizations, interactive elements, and structured explanations help direct students' attention, reduce cognitive load, and support the formation of conceptual schemas. This cognitive mechanism confirms that integrating ICT-based media, such as interactive modules, can significantly enhance students' conceptual understanding, particularly when learning abstract physics concepts.

The development of ICT also underscores the need for students to acquire the "4C": creativity, communication, teamwork, and critical thinking, which are essential 21st-century skills (Redhana, 2019). The development of critical thinking skills can be significantly influenced by the design of interactive and digital learning environments, according to recent studies. For example, Tiruneh et al. (2018) showed that interactive and organized teaching methods successfully promote critical thinking in science education. According to Novitra et al. (2021) and Meirbekov (2022), digital learning tools enhance students' analytical reasoning and engagement when used in conjunction with inquiry-based or problem-based activities. Among these abilities, critical thinking is especially important for learning physics, as it helps students reason, analyze, and draw well-informed conclusions. Critical thinking in physics promotes rational problem analysis, evidence evaluation, and reasoned conclusion drawing (Jamil et al., 2024). Paul and Elder (2008) claim that these procedures demonstrate the traits of a genuine critical thinker, who can evaluate information impartially and pose insightful queries. Learning exercises that call for analysis, synthesis, and evaluation procedures consistent with higher-order thinking can help develop these abilities. However, because innovative and interactive teaching resources are rarely used in traditional classroom settings, such activities are uncommon.

In real classroom settings, the learning process in public senior high schools still relies mainly on printed resources, such as textbooks or traditional modules, which do not effectively encourage students to develop higher-order thinking skills (Harahap & Abidin, 2021). This heavy dependence on printed materials often restricts students' involvement and their ability to explore concepts deeply (Makda, 2025). As a result, teachers tend to focus more on mathematical representations than on fostering conceptual understanding, causing students to view physics as a set of formulas (Siahaan et al., 2020). Consequently, students struggle to apply physics concepts to everyday life, resulting in poor learning outcomes. Observations in the classroom, interviews, and analysis of daily test scores from grade XI students at a public senior high school on the subject of temperature and heat also support this issue, revealing that student performance remains quite low. The factors contributing to this include insufficient and non-interactive teaching materials, teachers primarily offering learning resources such as YouTube videos for self-study, and students having underdeveloped critical thinking skills when tackling physics problems.

This result aligns with the study by Fitriyani et al. (2022), which found that 70% of students had a poor conceptual understanding of heat transfer, largely due to their reliance on traditional learning materials and the limited use of digital or hands-on media. These outcomes underscore the pressing need to develop learning materials that are more interactive, contextually relevant, and focused on promoting higher-order thinking in physics education. Complementing these findings, students' learning behavior also contributes to the persistence of low physics learning outcomes. A survey conducted by Silvia et al. (2019) identified several factors contributing to suboptimal physics learning conditions. One key factor is student behavior, with 84.3% of students showing reluctance to read textbooks before lessons and 70% displaying a tendency to avoid summarizing physics content. These results suggest that students' literacy skills are primarily functional, which limits their capacity to critically analyze and interpret physics concepts. This behavior indicates a lack of independent learning and essential engagement, both of which are crucial for developing higher-order thinking skills (Redhana, 2019). Additionally, 77.1% of students reported difficulties in understanding printed textbooks, implying that current teaching materials are not sufficiently interactive and do not support meaningful learning experiences. This aligns with the findings of Harahap and Abidin (2021), who noted that traditional printed resources often fail to encourage higher-order thinking among students.

This issue emphasizes the urgent need to transition learning materials from print to digital formats, thereby enhancing the learning experience and fostering higher-order thinking skills. Findings by Dwiqi, Sudatha, and Sukmana (2020) reinforce this urgency by showing that teachers still rely heavily on traditional media, particularly printed open-source materials. This situation indicates a gap between the needs of 21st-century learning and conventional learning practices. Therefore, the integration of digital media, such as video, animation, and interactive multimedia, is increasingly important because it has been proven to significantly increase student learning motivation. Furthermore, to achieve more effective and relevant physics learning, the application of information and communication technology is indispensable. One example of utilizing this technology is the use of interactive modules, which serve as an effective means of creating a learning environment that actively engages students, encourages experimentation, and supports a consistent, learner-centered teaching approach (Hydayat & Ariani, 2022). These modules deliver content through animation, audio, and navigation features, thus helping to maintain learner engagement and reduce boredom during the learning process (Mubarok et al., 2022).

In response to these challenges, this study has developed an innovative learning application named Flip-Mind, which is an interactive module built using HTML5 technology. The Flip-Mind module, based on HTML5, enables students to access web applications through their browsers on a range of devices, including PCs, smartphones, and tablets. This application operates seamlessly without the need for additional software installations or third-party applications. Moreover, HTML5 significantly enhances interactivity by allowing users to drag and drop elements on a webpage, and it provides excellent support for embedding audio and video directly into the web without relying on third-party plugins such as Flash.

Teaching materials presented in HTML5-based interactive modules offer practical and engaging characteristics, making them effective learning resources for students. The HTML5-based Flip-Mind interactive modules are designed to help students grasp challenging physics concepts and serve as a valuable resource for developing critical thinking skills. The content related to critical thinking is structured around critical questions focused on implementation aspects, in accordance with Ennis' indicators of critical thinking skills. The developed interactive module features quizzes, videos, and flip-fun facts that include everyday information related to the chapter on temperature and heat. Additionally, it incorporates interactive navigation at the outset, allowing students to select the material they wish to study without needing to follow a sequential page order. Teaching materials packaged as HTML5-based interactive modules offer practical and engaging features, making them an effective learning tool for students. The HTML5-based Flip-Mind interactive modules are designed to assist students in overcoming challenges in understanding physics concepts and to act as a resource for developing critical thinking skills. The module's critical thinking content is presented through critical questions centered on application, drawing on Ennis' indicators of critical thinking skills. The developed interactive module includes features such as quizzes, videos, and flip-funfact sections that provide everyday facts related to the chapter on temperature and heat. Additionally, it offers interactive navigation at the start, allowing students to select the topics they wish to study without having to go through the pages in order.

The conceptual framework of this study assumes that the HTML5-based Flip-Mind Module serves as an interactive learning tool designed to promote active, independent, and reflective learning. This module integrates interactive visualizations that assist students in analyzing data and phenomena, problem-based exercises that enhance interpretation and evaluation abilities, and automated feedback that motivates students to reflect and improve their thinking. Each component supports the development of critical thinking skills: analysis is fostered through engaging with interactive simulations, evaluation is cultivated through contextual problems that require logical reasoning, inference is reinforced through scenarios grounded in real-world phenomena, and metacognitive reflection is stimulated by systematic feedback. Therefore, the Flip-Mind Module not only delivers digital content on temperature and heat but also acts as a strategic resource for internalizing critical thinking indicators among high school students.

This section summarizes previous research on the creation of interactive e-modules for physics education. Latifah et al. (2020) developed a physics e-module using the Kvisoft Flipbook Maker application and observed a moderate increase in students' critical thinking skills (N-Gain= 0.602). Although the module was deemed feasible and well-received by students, its interactivity was limited to multimedia content, lacking contextual or problem-based activities. Similarly, Mubarok (2022) created an electronic physics module with the Flipbook HTML5 application, which successfully enhanced students' creative thinking regarding Newton's laws. However, the study focused mainly on creativity and exploration, rather than on the analytical and reasoning skills necessary for the development of critical thinking. Additionally, Arman et al. (2022) utilized Articulate Storyline 3 to develop an interactive e-module on sound waves, which significantly enhanced students' critical thinking skills (N-Gain = 0.68). Despite its rich interactivity and multimedia features, the module lacked contextual essential questions that would encourage students to reflect and relate physics concepts to real-life situations. Overall, these studies demonstrate that while digital modules can enhance engagement and promote higher-order thinking, there remains a significant need to incorporate contextual, inquiry-based, and critical thinking elements that foster deeper reasoning and improved concept retention in physics education.

According to this description, the researcher aims to assess whether the HTML5-based Flip-Mind interactive module is practical and effective in enhancing students' critical thinking abilities.

METHOD

Research Design

This research employs the Research and Development (R&D) approach, following the 4D development model, which comprises four phases: Define, Design, Develop, and Disseminate. The specific steps of the 4D model, adapted from Thiagarajan, are shown in Figure 1. Additionally, the study incorporates a quasi-experimental design with pretest and posttest control groups to evaluate the effectiveness of the developed Flip-Mind module. This design enables comparison of outcomes between the experimental and control groups after the intervention. The study was conducted at a public senior high school, involving 11th-grade students.

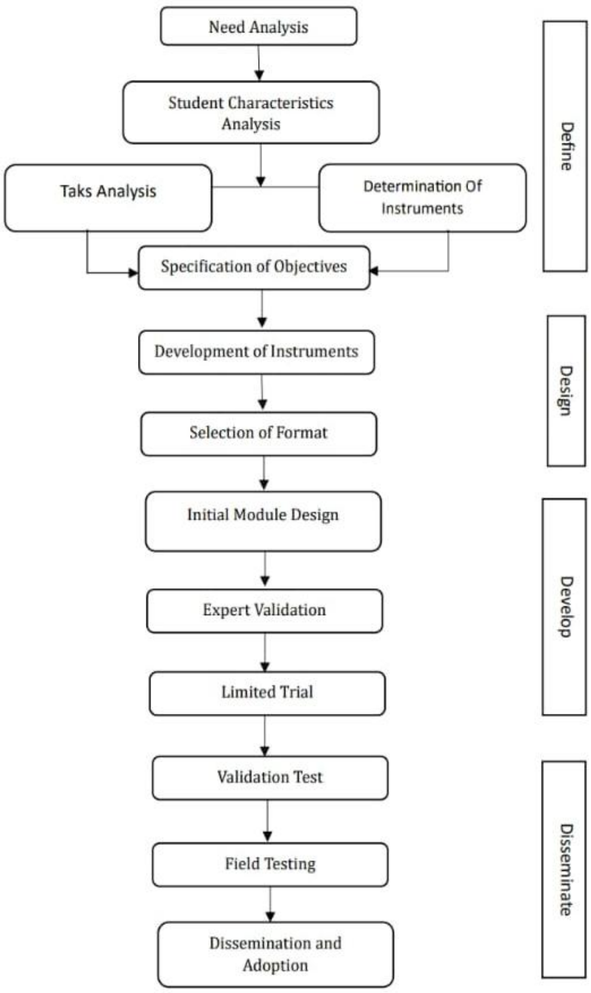

Figure 1. The 4D Development Model Adapted from Thiagarajan (1974)

Participants

The samples in this study were obtained through purposive sampling. The study consisted of 70 students, divided into two classes: class XI-3, the experimental class, and class XI-2, the control class, each with 35 students.

Instruments

The instruments used in this study included: an expert validation questionnaire, used to assess the feasibility of the Flip-Mind module; a critical thinking test instrument, consisting of eight essay questions for pretest and posttest; these questions had undergone a validation and trial process beforehand; and a student response questionnaire, used to assess student responses to the developed module.

Data Analysis

The data collected consisted of the results of critical thinking skills tests administered to students. The analysis began with prerequisite tests, including a normality test using Shapiro-Wilk in SPSS to determine whether the data were normally distributed and a homogeneity test using Levene's test to determine whether the data variance was homogeneous. After meeting the prerequisite tests, the data were analyzed using the Independent Sample t-Test to determine how the Flip-Mind module improved students' critical thinking skills.

RESULTS AND DISCUSSION

Feasibility Flip-Mind Interactive Module

The teaching materials were validated to evaluate the suitability of the content, language, and presentation before implementation in the trial phase (Ihsan et al., 2023). This validation process involved subject matter experts and media experts to ensure that the developed Flip-Mind interactive module was suitable for supporting learning objectives, particularly in improving critical thinking skills. The validation activity in the initial stage was carried out by submitting the research instrument to the supervising lecturer to obtain input and suggestions for improvement (Nisrina et al., 2022). The results of the validation of the Flip-Mind interactive module are presented in Table 1.

Table 1. Result of Module Assessment Recapitulation Based on Expert Validators

Aspect	Validator Percentage (%)		Average Percentage (%)	Criteria
	1	2		
Critical Thinking	90	75	82.5	Excellent
Material	91	87	89	Excellent
Design	90	90	90	Excellent
Linguistic	87.5	93	90.3	Excellent
Average Percentage	89	87	88	Excellent

Aspect	Validator Percentage (%)		Average Percentage (%)	Criteria
	1	2		
Overall Percentage			88	Excellent

According to Jonassen (2000), a well-designed problem-solving module should be activity-based, presented in a digital and interactive format, and specifically structured to facilitate physics problem-solving. The design should provide students with opportunities to explore, simulate real-world situations, interact with information dynamically, and encourage them to find solutions independently. This principle is consistent with Savery (2006), who emphasized that an effective problem-based learning environment should present unstructured problems to learners, encourage independent inquiry, and position the teacher as a facilitator rather than an information provider. In line with this theory, the Flip-Mind module incorporates interactive visualizations, problem-based exercises, and automated feedback, ensuring that students are actively engaged in constructing knowledge rather than passively receiving content.

According to the validation results, the Flip-Mind module received an excellent rating in every category assessed, including design appeal, language clarity, and content relevance. This result indicates that the product design aligns with the theoretical framework for module development, which prioritizes learner engagement, clarity, and interactivity (Wardani et al., 2025). According to Harahap & Abidin (2021), who claim that digital modules with interactive elements can significantly increase cognitive engagement, the high validation ratings also imply that the module has a strong potential to enhance meaningful learning and higher-order thinking.

The validation results of the Flip-Mind interactive module in the temperature and heat chapter, as assessed by the first validator, who evaluated aspects of critical thinking, materials, design, and language, yielded a score of 89%. The second validator achieved a score of 87%, with a final average of 88%. Based on the assessment criteria, this percentage falls into the "very feasible" category, indicating that the developed module is feasible for use. These results suggest that the Flip-Mind module has completed the feasibility stage and can be confidently implemented in the classroom to assess its pedagogical impact.

The linguistic and design aspects, both exceeding 90% suggest that the module employs clear and communicative language as well as an attractive and intuitive interface, enhancing accessibility and engagement during independent learning. These results align with the findings of Rahayu & Suryani (2024), who reported that digital learning media with well-designed layouts and interactive features tend to increase students' motivation and focus during the learning process. Moreover, the critical thinking aspects (82.5%) indicate that the module's structure effectively integrates higher-order questioning and problem-based contexts, encouraging analytical and reflective learning behaviors. This result is consistent with Nisrina et al. (2022), who emphasized that digital modules incorporating reflective prompts can strengthen learners' reasoning abilities.

Overall, the Flip-Mind module is viable for use in classroom settings, as indicated by its average validation score of 88%, which is classified as excellent. The module effectively incorporates interactive, activity-based problem-solving exercises that stimulate real-world scenarios by adhering to Jonassen's design principles. This creates a pedagogically sound platform for students to engage in physics discovery and develop critical thinking skills. These results suggest that the product has effectively met expert requirements in terms of design, pedagogy, and content, indicating that it is prepared to proceed to the next phase of verifying its pedagogical efficacy through experimental deployment.

Analysis of the Improvement of Students' Critical Thinking Skills

The analysis of critical thinking skills aimed to identify the extent of improvement in students' critical thinking before and after implementing the module. The test instrument consisted of eight essay questions that were valid and reliable, covering five Ennis critical thinking indicators. The average pretest and posttest scores for each indicator were obtained based on data processing results. The increase in students' critical thinking skills for each Ennis indicator, as measured by the critical thinking test instrument, is shown in Figure 2 and 3.

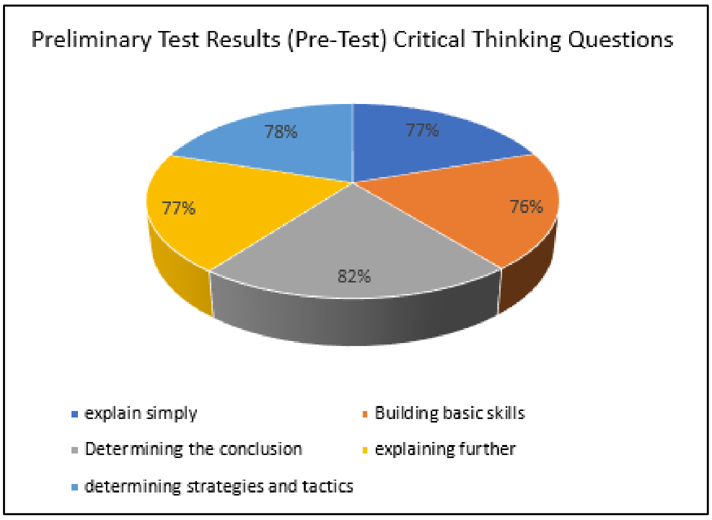

Figure 2. Preliminary Test Result

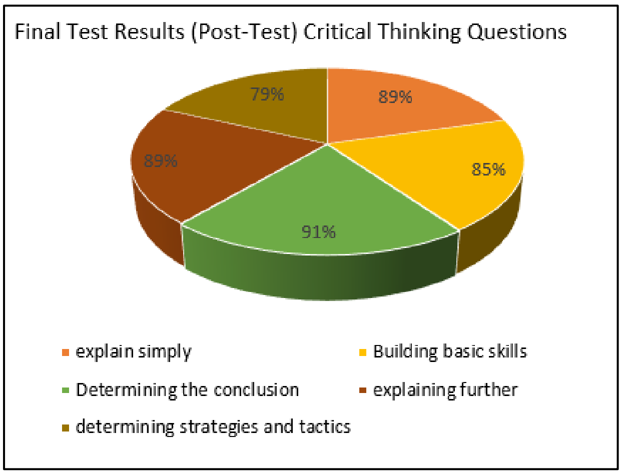

Figure 3. Final Test Result

Visual analysis of the graphs revealed that the highest increase occurred in the concluding indicator, with a sharper post-test spike compared to the other indicators. In contrast, the strategy and tactics indicators showed relatively flat curves. This pattern indicated that while students improved in drawing conclusions, they still faced challenges in developing strategic reasoning and planning skills. Such conditions might be due to the module's emphasis on interpretation and inference through problem-based activities rather than on long-term strategic decision-making tasks. To address this, future module revisions could incorporate learning components such as problem-based stimulations, step-by-step decision-making exercises, or contextual case studies that require more complex reasoning.

The results align with those of Demircioglu et al. (2022), which indicate that digital interactivity, such as activities based on augmented reality, significantly enhances students' engagement in learning compared to traditional instruction. Similarly, the Flip-Mind module employs interactive digital features to motivate students to explore, analyze, and independently solve physics problems. This highlights the significance of digital interactivity in promoting active cognitive engagement and encouraging higher-order thinking. These results suggest that the Flip-Mind module was more effective in stimulating logical reasoning and inference rather than strategic planning. However, such a pattern is natural during early stages of critical thinking development, where learners tend to master concrete reasoning first before advancing to abstract and strategic thinking. This interpretation aligns with Piaget's cognitive development theory, emphasizing that logical reasoning develops before hypothetical-deductive reasoning.

These findings are consistent with those of Febliza et al. (2023), who reported that interactive modules can gradually enhance critical thinking, particularly in interpretation and conclusion. Similarly, Nicholus et al. (2023) emphasized that case-based learning strengthens students' ability to plan and evaluate decisions systematically. Therefore, a more balanced improvement across all indicators could be achieved by integrating contextual problems that train all aspects of critical thinking. Moreover, these findings reinforce the importance of using digital learning environments that engage students in active exploration and decision-making. Compared with conventional instruction, the Flip-Mind module appears to promote autonomy and curiosity, two affective factors that strongly correlate with growth in critical thinking (Redhana,2019). This shows that cognitive improvement is closely related to emotional engagement during interactive learning. Furthermore, the effectiveness of the Flip-Mind module in facilitating higher-order reasoning aligns with international research findings. Putra et al. (2023) demonstrated that technology-based learning environments, particularly those integrating structured digital modules, are highly effective in supporting students' critical thinking skills in physics learning. Their research demonstrated that interactive digital tools enable students to iteratively explore, evaluate, and refine ideas, which aligns with the design principles applied in the Flip-Mind module. Complementing this perspective, Pithers and Soden (2000) argued that modern digital-based learning approaches can overcome common barriers that often hinder students' critical thinking processes, such as high cognitive load and a lack of scaffolding in conventional learning. Thus, both studies reinforce that the integration of structured, interactive digital modules, such as Flip-Mind, creates learning conditions that not only reduce conceptual difficulty but also encourage analytical reasoning, reflective deliberation, and orderly cognitive development.

Inferential statistical analysis is necessary to support the conclusion that the improvement in students' critical thinking skills is a result of using the Flip-Mind interactive module. Prerequisite tests were conducted through normality and homogeneity tests to ensure the data were normal and homogeneous. The normality test was performed using SPSS version 22 with the Shapiro-Wilk method, using the number of samples analyzed, which was 36 students. This method is suitable for small to medium-sized samples, in line with Sugiyono's (2023) opinion. The reference for the normality test is that if the Sig value is >0.05, the data are normally distributed. The hypothesis determination in the normality test is formulated as follows: H_0 = Data is usually distributed; H_1 = Data is not normally distributed.

Sugiyono (2023) states that the homogeneity test must be fulfilled before parametric tests, especially when testing differences between groups. The technique used in testing homogeneity in this study was the Levene Test. Data is homogeneous when the Sig. value is >0.05. Conversely, if the Sig. Value is <0.05; the data is not homogeneous. The results of the normality and homogeneity tests are presented in Table 2.

Table 2. Results of Normality and Homogeneity Tests

Type of Test	Class/Variable	Statistic	Sig.	Description
Normality (Shapiro-Wilk)	Control Group Pretest	-	0.940	Normal
	Control Group Posttest	-	0.629	Normal
	Pretest Experimental Group Pretest	-	0.226	Normal
	Experimental Group Posttest	-	0.070	Normal
Homogeneity (Levene Test)	Based on Mean	1.752	0.159	Homogeneous

Based on Table 2, it can be seen that the Sig. The control class pretest data value is 0.940, the control class posttest is 0.629, the experimental class pretest is 0.226, and the experimental class posttest is 0.070. All values based on the data in Table 3 are by Sig.>0.05. Therefore, all data in this study are normally distributed. The results of the homogeneity test, as shown in Table 3, indicate that the significance value in the "Based on Mean" row is 0.159, which means that the Sig. value is >0.05. This indicates that the data are homogeneous and there are no significant differences in the distribution of the data between the groups being compared.

The hypothesis test uses the Independent Sample T-test because the data come from two independent groups and meet the assumptions of normality and homogeneity of variance. The hypotheses in this study are determined as follows: H_0 = no increase in students' critical thinking skills before and after using the HTML5-based Flip-Mind interactive module; H_1 = There is an increase in students' critical thinking skills before and after using the HTML5-based Flip-Mind interactive module. The results of the hypothesis testing analysis using the Independent Sample T-test method are presented in Table 3.

Table 3. Independent Sample t-Test Hypothesis Test Results

Value	Sig. (2-tailed)	Description
Equal variances assumed	0.00	Significant
Equal variances not assumed	0.00	Significant

Based on Table 3, it can be seen that the Sig. (2-tailed) value is 0.00. The significance value in the output is smaller than the specified significance, which is 0.05 (0.00<0.05). Therefore, H0 was rejected, and H1 was accepted, which means that there was an increase in students' critical thinking skills after using the HTML5-based Flip-Mind interactive module. The improvement in critical thinking skills after using the HTML5-based Flip-Mind interactive module was tested using the N-Gain value. According to Sugiyono (2023), N-Gain is a measuring tool to determine the improvement in learning outcomes after treatment. The results of the N-Gain analysis, using SPSS version 22, are presented in Table 4.

Table 4. Result of N-Gain Analysis using SPSS Version 22

Class		Statistic	Std. Error	N-Gain Category
Experiment	Mean	62.7	4.11	Medium
Control	Mean	34.2	3.13	Medium

The N-Gain analysis further supported the results, showing that the experimental class achieved an average gain of 62.7%, which was higher than the control class's 34.2%, both of which fell within the medium category. In line with Alkhabra et al. (2023), who demonstrated that interactive learning technologies enhance cognitive engagement by prompting students to independently analyze, evaluate, and verify information, the findings of Al Mamun and Lawrie (2023) further support this notion by showing that the quality of students' interactions with digital module content plays a crucial role in monitoring their thinking procedded, correcting misconceptions, and constructing more coherent conceptual representations. Therefore, the effectiveness of the Flip-Mind module in this study is not merely derived from its digital format but from its capacity to stimulate learning engagement and higher-order reasoning, which serve as the foundation for the development of critical thinking skills. Nevertheless, this moderate level of improvement suggests that while the module significantly enhanced learning outcomes, there is still potential for optimization, especially by improving features that promote reflective and strategic thinking. These findings align with those of Harahap et al. (2021), who found that students exposed to interactive digital media exhibited more effective reflective thinking patterns. Thus, the Flip-Mind module not only enhanced understanding but also encouraged metacognitive awareness, which is essential for sustained growth in critical thinking. Furthermore, this improvement in the moderate category suggests that the module effectively served as a scaffolding tool, helping students transition from basic comprehension to more complex reasoning. However, continuous use and iteration of such modules are recommended to maintain learning momentum and gradually reach higher levels of critical thinking proficiency.

The Flip-Mind module operated through three main features: interactive visualization, problem-based exercise, and automated feedback. Interactive visualization enabled students to analyze heat and temperature phenomena concretely; problem-based exercise trained them to evaluate and reason logically; and automated feedback encouraged metacognitive reflection. Each feature directly contributed to the development of analytical, evaluative, and inferential skills, ultimately holistically fostering critical thinking. An important aspect not previously explained is how the e-module contributes to metacognitive regulation and the formation of students' essential representations of thinking. Jamaludin et al. (2022) emphasized that the clarity of physics concept understanding has a strong influence on critical thinking abilities. In this study, the interactive features of the e-module, including visual presentations, reflective exercises, and case-based prompting questions, encouraged students to develop their critical thinking processes and re-evaluate any misconceptions. Activation of metacognitive processes helped students organize concepts more systematically, thereby facilitating their ability to analyze information and make evidence-based decisions. Consequently, the effectiveness of the Flip-Mind module lies not merely in its digital format but in its capacity to facilitate metacognitive regulation and reinforce conceptual structures, which underpin the development of critical thinking. This, in turn, aligns with Anderson and Krathwohl's revised Bloom's taxonomy, which places evaluation and creation as the highest-order cognitive processes. Therefore, the Flip-Mind module not only functioned as a learning medium but also as a pedagogical mechanism for nurturing 21st-century competencies.

Overall, the findings suggest that integrating digital modules, such as Flip-Mind, provides a dual benefit: cognitive advancement and metacognitive awareness. These results have important implications for physics education, suggesting that technology-based learning should be designed not only for concept delivery but also for cultivating reasoning and reflection skills that are transferable beyond the classroom (Bao & Koenig, 2019). Building on these implications, the conceptual design of the Flip-Mind interactive module was developed to align digital learning activities with the stages of critical thinking development. As shown in Figure 4, the learning process begins with interactive visualization, which allows students to explore the phenomena of heat and temperature through simulation. This stage is followed by problem-based exercises that require students to apply physics concepts in solving contextual problems. Subsequently, the automated feedback feature facilitates learners' reflection on their reasoning and learning outcomes. These components constitute an integrated process designed to strengthen students' critical thinking in analysis, evaluation, inference, and reflection. This conceptual framework subsequently served as the foundation for the development and assessment of the Flip-Mind module's feasibility and effectiveness in physics learning.

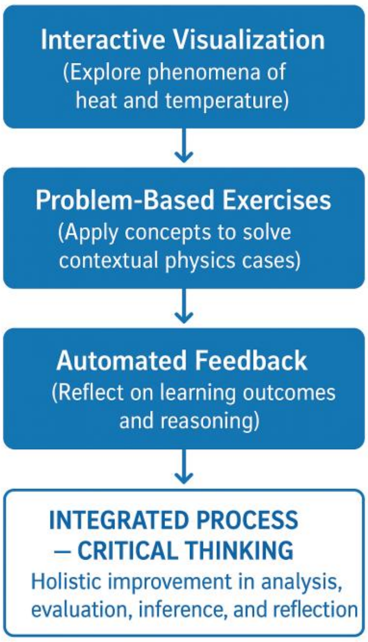

Figure 4. Conceptual design of the Flip-Mind interactive Module to Enhance Students' Critical Thinking

Student Responses to the Flip-Mind Interactive Module

Student responses were analyzed to assess the feasibility of the Flip-Mind interactive module as a teaching material. Student responses to the developed interactive module were one of the aspects analyzed. The response analysis was conducted using a four-point Likert scale questionnaire, comprising 17 statements that covered the aspects of the module's appearance, content, and usefulness. Thirty-six students participated in this study by responding to the questionnaire. The results of the scores for each aspect are presented in Figure 5.

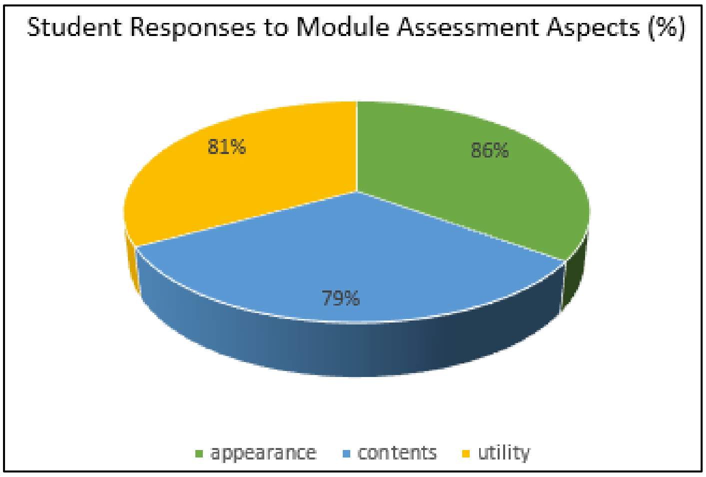

Figure 5. Student Responses to Flip-Mind Module

The analysis results indicate that the Flip-Mind interactive module received positive feedback from students. The analyzed aspects showed high scores, indicating that the interactive module has met the expectations and needs of students in the learning process. The appearance aspect of the module received a score of 86%. This shows that most students are interested in the appearance, color selection, and layout structure that support readability when using this interactive module.

The content aspect received a score of 79%, indicating that the content of the interactive module was considered very appropriate. In general, the content of the interactive module was relevant, in line with learning objectives, systematic, and easy for students to understand. The usefulness aspect scored 81% in the very appropriate category. This shows that the Flip-Mind interactive module helps improve students' critical thinking skills. Content in the interactive module, including practice questions, reflective questions, and problem-based material presentations, contributes to student engagement in the learning process (Aristaria et al., 2024). The overall average percentage score is 82% (very worthy category). Based on these results, the developed product meets the feasibility criteria from the students' perspective and is suitable for implementation in the learning process. These findings align with and are reinforced by international research emphasizing the effectiveness of interactive digital environments in enhancing student engagement. Demircioglu et al. (2022) reported that digital interactivity in science learning increases behavioral engagement and encourages deeper cognitive processing, resulting in more positive responses to learning media. Furthermore, Schunk (2019) stated that learning environments that allow students to interact directly with digital content support autonomy, sustained attention, and self-regulation. This perspective reinforces the conclusion that the high student response scores to the Flip-Mind module demonstrate not only its feasibility but also its alignment with the principles of meaningful and engaging digital learning.

The shortcomings noted by students in the questionnaire comments column were the lack of simple experiments on temperature and heat in the module. The absence of experimental activities was considered to reduce direct and concrete learning experiences (Fischer, 2021). Students suggested that the module be supplemented with relevant simple experiments, such as observing changes in water temperature after heating for different durations or mixing two waters of various temperatures to observe the achievement of temperature equilibrium. Such activities are capable of helping students understand abstract concepts, such as heat and temperature, more concretely through direct, observable, and measurable experiences. Such experiments play a crucial role in developing scientific process skills, such as observation, prediction, and data interpretation (Sugiarti & Ratnaningdyah, 2020). Thus, including simple experiments in the module makes the learning process more meaningful and significantly contributes to the development of critical thinking skills (Syahgiah et al., 2023). Although it does not include experimental activities, the Flip-Mind module is still considered suitable as teaching material in physics education. Interactive modules have proven effective in enhancing students' critical thinking skills through systematic presentation of material and a case study approach.

The results of Susilawati et al. (2024) research reinforce the findings in this study, namely that the use of interactive digital media contributes to the development of critical thinking skills. Student engagement in the process of observation, interpretation, and reflection through interactive media that aligns with the features developed in the Flip-Mind module has similar potential in building students' critical thinking skills (Hidayah et al., 2023).

CONCLUSION

Based on the research findings, it can be concluded that the Flip-Mind interactive module was conceptually designed by integrating case-based learning and critical thinking components into physics learning on the topic of temperature and heat. The module emphasizes the use of interactive HTML5-based features that actively engage students through three main components, namely interactive visualization, problem-based exercises, and automated feedback. Through these features, students are facilitated to explore physical phenomena, respond to critical thinking questions, and connect abstract physics concepts with real-life contexts. The feasibility of the Flip-Mind interactive module was evaluated through validation by media and subject-matter experts, resulting in a feasibility percentage of 88%, which falls into the very good category. This result indicates that, in terms of visual design, content quality, and alignment with learning objectives, the module meets established feasibility criteria and can be utilized as an alternative teaching material in senior high school physics instruction. Furthermore, the implementation of the Flip-Mind interactive module demonstrated a positive impact on students' critical thinking skills. Analysis of pretest and posttest results revealed an increase of 12% in the average score of essential critical thinking indicators, accompanied by a normalized N-Gain value of 62.7%, which is categorized as moderate. These results suggest that the learning activities embedded in the module are effective in facilitating the development of students' critical thinking abilities within the context of temperature and heat concepts. In addition to learning outcomes, student responses toward the Flip-Mind interactive module were also highly positive. The results of the student response analysis showed a feasibility percentage of 82%, which is classified as very good. Students perceived the module as having an attractive appearance and indicated that its interactive features effectively support the training of critical thinking skills. Overall, these findings confirm that the Flip-Mind interactive module is both feasible and effective as a physics teaching material, particularly for temperature and heat topics. The module not only fulfills feasibility standards in terms of content and visual design but also contributes meaningfully to the enhancement of students' critical thinking skills, thereby supporting more meaningful physics learning that is aligned with 21st-century skill demands.

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REFERENCES

Alkhabra, Y. A., Ibrahem, U. M., & Alkhabra, S. A. (2023). Augmented Reality Technology in Enhancing Learning Retention and Critical Thinking According to STEAM Program. *Humanities and Social Sciences Communications, 10*(1), 1–10. https://doi.org/10.1057/s41599-023-01650-w

AlMamun, M.A., & Lawrie, G. (2023). Student-Content Interactions : Exploring Behavioural Engagement with Self-Regulated Inquiry-Based Online Learning Modules. *Smart Learning Environments*, 1–31. https://doi.org/10.1186/s40561-022-00221-x

Anderson, L. W., & Krathwohl, D. R. (2001). A Taxonomy for Learning, Teaching, and Assessing: *A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Pearson.

Aristaria, A., Wilujeng, I., & Herawati, N. I. (2024). Development of Physics Interactive Learning Media based on Problem Based Learning assisted by SAC Application to Improve Student Problem Solving Ability. *Jurnal Penelitian Pendidikan IPA*, *10*(4), 1731–1738. https://doi.org/10.29303/jppipa.v10i4.6082

Arman Cahyanto, Lesmono, A. D., & Handayani, R. D. (2022). Pengembangan E-Modul Interaktif Berbasis Articulate Storyline 3 untuk Melatihkan Kemampuan Berpikir Kritis pada Pokok Bahasan Gelombang Bunyi [Development of an Interactive E-Module Based on Articulate Storyline 3 to Train Critical Thinking Skills on the Topic of Sound Waves]. *Jurnal Literasi Pendidikan Fisika (JLPF)*, *3*(2), 154–164. https://doi.org/10.30872/jlpf.v3i2.1551

Bao, L., & Koenig, K. (2019). Physics education research for 21st century learning. *Disciplinary and Interdisciplinary Science Education Research, 1(1),* 1 12. https://doi.org/10.1186/s43031-019-0007-8

Camilli, C., & Giacomazzi, M. (2022). Contextualization of Critical Thinking in Sub-Saharan Africa : A Systematic Integrative Review. *43*(July 2021). https://doi.org/10.1016/j.tsc.2021.100978

Cris, G., & Dwiqi, S. (2020). Pengembangan Multimedia Pembelajaran Interaktif Mata Pelajaran IPA Untuk Siswa SD Kelas V [Development of Interactive Science Learning Multimedia for Fifth Grade Elementary School Students]. *Jurnal Edutech Undiksha, 8*(2), 33–48. https://doi.org/10.23887/jeu.v8i2.28934

Demircioglu, T., Karakus, M., & Ucar, S. (2022). Developing Students' Critical Thinking Skills and

Argumentation Abilities Through Augmented Reality – Based Argumentation Activities in Science Classes (Issue 0123456789). https://doi.org/10.1007/s11191-022-00369-5

Dwiqi, G. C. S., Sudatha, I. G. W., & Sukmana, A. I. W. I. Y. (2020). Pengembangan Multimedia Pembelajaran Interaktif Mata Pelajaran IPA Untuk Siswa SD Kelas V [Development of Interactive Science Learning Multimedia for Fifth Grade Elementary School Students]. Jurnal Edutech Undiksha, 8(2), 33. https://doi.org/10.23887/jeu.v8i2.28934

Ennis, R. H. (1993). Critical Thinking Assessment. Theory Into Practice, 32(3), 179–186. https://doi.org/10.1080/00405849309543594

Facione, P. A. (2020). Critical Thinking: What It Is and Why it Counts. Insight assessment, 1(1), 1-23.

Febliza, A., Afdal, Z., & Copriady, J. (n.d.). Improving Students' Critical Thinking Skills: Is Interactive Video and Interactive Web Module Beneficial. *International Journal of Interactive Mobile Technologies,17* (3), 70–86. https://doi.org/10.3991/ijim.v17i03.34699

Fischer, H. E. (2021). Challenges in Physics Education. 1–477. https://link.springer.com/bookseries/16575

Fitriyani, F., & Nugroho, A. T. (2022). Literasi Digital Di Era Pembelajaran Abad 21 [Digital Literacy in the 21st Century Learning Era]. *ElMutjama: Jurnal Pengabdian Masyarakat, 2* (2), 201 – 208. https://doi.org/10.47467/elmujtama.v2i2.1088

Harahap, A. N., & Abidin, J. (2021). Pengembangan Bahan Ajar Interaktif Berbasis E-Learning Untuk Meningkatkan Hasil Belajar Mahasiswa [Development of E-Learning-Based Interactive Teaching Materials to Improve Student Learning Outcomes]. *JURNAL MathEdu (Mathematic Education Journal)*, *4*(2), 231–235. https://doi.org/10.37081/mathedu.v4i2.2733

Hidayah, H., Permatasari, N., & Suryana, R. (2023). The Effectiveness of the Predict-Observe-Explain (POE) Model in The Physics Electronic Modules to Improve Critical Thinking Skills. *9*(12), 10679–10688. https://doi.org/10.29303/jppipa.v9i12.4681

Hidayatin, S., Verawati, N. N. S. P., & Susilawati, S. (2022). Pengembangan Perangkat Pembelajaran Berbasis Problem Based Learning untuk Meningkatkan Penguasaan Konsep Fisika Materi Momentum dan Impuls Kelas X [Development of Problem Based Learning Learning Tools to Improve Mastery of Physics Concepts on Momentum and Impulse for Class X]. *Jurnal Ilmiah Profesi Pendidikan*, *7*(2b), 663–671. https://doi.org/10.29303/jipp.v7i2b.623

Hidayatullah, Z., Wilujeng, I., Nurhasanah, N., Gusemanto, T. G., & Makhrus, M. (2021). Synthesis of the 21st Century Skills (4C) Based Physics Education Research In Indonesia. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *6*(1), 88. https://doi.org/10.26737/jipf.v6i1.1889

Husein, S., Herayanti, L., & Gunawan, G. (2017). Pengaruh Penggunaan Multimedia Interaktif Terhadap Penguasaan Konsep dan Keterampilan Berpikir Kritis Siswa pada Materi Suhu dan Kalor [The Influence of the Use of Interactive Multimedia on Students' Mastery of Concepts and Critical Thinking Skills on Temperature and Heat Material]. *Jurnal Pendidikan Fisika Dan Teknologi*, *1*(3), 221–225. https://doi.org/10.29303/jpft.v1i3.262

Hydayat, A., & Ariani, Y. (2022). Pengembangan Bahan Ajar E-Modul Berbasis Flip PDF Professional Materi Jaring-Jaring Bangun Ruang Sederhana di Kelas V SDN 24 Parupuk Tabing [Development of Professional Flip PDF-Based E-Module Teaching Materials for Simple Geometric Nets in Class V of SDN 24 Parupuk Tabing]. *Jurnal Pendidikan Tambusai*, *6*(2), 15683–15688. https://doi.org/10.31004/jptam.v6i2.4868

Ihsan, N., Sejati, A. E. (2023). Pengembangan Bahan Ajar Evaluasi Pembelajaran Berbasis Project pada Fakultas Keguruan dan Ilmu Pendidikan Universitas Sembilanbelas November Kolaka [Development of Project-Based Learning Evaluation Teaching Materials at the Faculty of Teacher Training and Education, Sembilanbelas November University, Kolaka]. *Eduvelop: Journal of Educational Development, 1*(1), 57–70. https://doi.org/10.58738/jkp.v1i2.77

Jamaludin, J., Kakaly, S., & Batlolona, J. R. (2022). Critical Thinking Skills and Concepts Mastery on the Topic of Temperature and Heat. *16*(1). https://doi.org/10.11591/edulearn.v16i1.20344

Jaman, M., & Biswas, T. (2025). The Role of ICT Integration to Support and Enhance the Teaching- Learning Process in the Contemporary Education System. International Journal For Multidisciplinary Research, 7(4). https://doi.org/10.36948/ijfmr.2025.v07i04.50965

Jamil, M., Hafeez, F., & Muhammad, N. (2024). Critical Thinking Development for 21st Century: Analysis of Physics Curriculum. *Journal of Social & Organizational Matters*. https://doi.org/10.56976/jsom.v3i1.45

Jonassen, D. H. (2000). Toward a Design Theory of Problem Solving. *Educational Technology Research and Development, 48(4)*, 63–85. https://doi.org/10.1007/BF02300500

Latifah, N., Ashari, & Kurniawan, E. S. (2020). Pengembangan e-modul fisika untuk meningkatkan kemampuan berpikir kritis peserta didik [Development of physics e-modules to improve students' critical thinking skills]. *Jurnal Inovasi Pendidikan Sains*, *01*(01), 1–7. http://jurnal.umpwr.ac.id/index.php/jips/article/view/570

Makda, F. (2025). Digital education: Mapping the landscape of virtual teaching in higher education – a bibliometric review. *Educ Inf Technol 30*, 2547–2575. https://doi.org/10.1007/s10639-024-12899-2

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

Mubarok, A. Z. Z., Ismet, I., & Kistiono, K. (2022). Pengembangan Modul Elektronik Fisika untuk Meningkatkan Kemampuan Berpikir Kreatif Peserta Didik Pada Materi Hukum Newton [Development of an Electronic Physics Module to Improve Students' Creative Thinking Skills on Newton's Laws]. *Jurnal Ilmiah Pendidikan Fisika, 6(1)*, 87. https://doi.org/10.20527/jipf.v6i1.4743

Nicholus, G., Muwonge, C., & Joseph, N. (2023). The Role of Problem-Based Learning Approach in Teaching and Learning Physics: A Systematic Literature Review. *F1000Research*, 12. https://doi.org/10.12688/f1000research.136339.2

Nisrina, N., Rahmawati, I., & Hikmah, F. N. (2022). Pengembangan Instrumen Validasi Produk Multimedia Pembelajaran Fisika [Development of Validation Instruments for Physics Learning Multimedia Products]. *Jurnal Kependidikan Fisika, 10*(1), 32–38. https://doi.org/10.33394/j-lkf.v10i1.5278

Novitra, F. (2021). Development of Online-based Inquiry Learning Model to Improve 21st-Century Skills of Physics Students in Senior High School. *Eurasia Journal of Mathematics, Science and Technology Education,17*(9), 1-20. https://doi.org/10.29333/ejmste/11152

Paul, R., & Elder, L. (2008). *Miniatur Guide to Critical Thinking Concepts and Tools*. Dillon Beach: Foundation for Critical Thinking Press.

Pithers, R. T., & Soden, R. (2000). Critical Thinking in Education: A Review. *Educational Research, 42*(3), 237–249. https://doi.org/10.1080/001318800440579

Purwaningsih, S., Falah, H. S., & Pujaningsih, F. B. (2025). *The Use of E-Modules to Improve Critical Thinking Skills of Physics Education Students*. *11*(1), 257–264. https://doi.org/10.29303/jppipa.v11i1.9553

Puspitasari, A. D. (2019). Penerapan Media Pembelajaran Fisika Menggunakan Modul Cetak dan Modul Elektronik Pada Siswa SMA [Implementation of Physics Learning Media Using Printed Modules and Electronic Modules for High School Students]. *Jurnal Pendidikan Fisika*, *7*(1), 17–25. http://journal.uin-alauddin.ac.id/indeks.php/PendidikanFisika

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

Rahayu, N., Anggraini, M., Fridiza, V. J., & Susilo, A. (2024). *Analysis of the Use of History Laerning Practices in Secondary Schools :* Challenges and Opportunities. *Journal of Language Teaching Linguistics and Literature,* *2*(2), 84–91. https://ejournal.melekliterasi.com/index.php/JLTLL/article/view/67

Rahmawati, I., Nisrina, N., & Abdani, M. R. (2022). Multi-representation-based interactive physics electronic module as teaching materials in online learning. 11(1), 47–55. https://doi.org/10.24042/jipf

Redhana, I. W. (2019). Mengembangkan Keterampilan Abad Ke-21 dalam Pembelajaran Kimia [Developing 21st Century Skills in Chemistry Learning]. *Jurnal Inovasi Pendidikan Kimia*, *13*(1). https://doi:10.15294/jipk.v13i1.17824

Savery, J. R. (2006). Overview of Problem-based Learning*: Definitions and Distinctions*. *1*(1).

Schunk, D. (2019). Learning Theories: An Educational Perspective (8th edition). New York: Pearson.

Sharma, A. (2025). Transformative Teaching Methods in Higher Education. International Journal For Multidisciplinary Research, 7(1). https://doi.org/10.36948/ijfmr.2025.v07i01.35395

Siahaan, K. W. A., Lumbangaol, S. T. P., Marbun, J., Nainggolan, A. D., Ritonga, J. M., & Barus, D. P. (2020). Pengaruh Model Pembelajaran Inkuiri Terbimbing dengan Multi Representasi terhadap Keterampilan Proses Sains dan Penguasaan Konsep IPA [The Effect of Guided Inquiry Learning Model with Multiple Representations on Science Process Skills and Mastery of Science Concepts]. *Jurnal Basicedu*, *5*(1), 195–205. https://doi.org/10.31004/basicedu.v5i1.614

Silvia, A., & Afrizon, R. (2019). Pengujian Validasi Bahan Ajar Fisika Bermuatan Literasi Saintifik pada Materi Dinamika Rotasi, Kesetimbangan Benda Tegar, Elastisitas dan Hukum Hooke [Validation testing of physics teaching materials containing scientific literacy on rotational dynamics, rigid body equilibrium, elasticity, and Hooke's Law]. *Jurnal Pelangi, 12*(4), 641–648. http://ejournal.unp.ac.id/students/index.php/pfis/article/view/6959

Steenkamp, C. M., Grange, I. R., & Müller-, K. K. (2019). Analysing Assessments in Introductory Physics Using Semantic Gravity : Refocussing on Core Concepts and Context-Dependence. *Teaching in Higher Education*, *0*(0), 1–16. https://doi.org/10.1080/13562517.2019.1692335

Sugiarti, & Ratnaningdyah, D. (2020). Improvement of Science Process Skills Through Discovery. *JPPIPA (Jurnal Penelitian Pendidikan IPA),* *5*(2), 69–74. https://doi.org/10.26740/jppipa.v5n2.p69-74

Sugiyono. (2023). *Metode penelitian kombinasi (mixed methods) dengan 9 desain [Mixed* *methods research method with 9 designs]. Alfabeta.*

Sulistyani, D. C., Krobthong, T., & Mochama, O. E. (2025). Exploring the Utilization of ICT in Physics Learning at Senior High Schools in Demak: Opportunities and Challenges. Schrödinger: *Journal of Physics Education, 6*(1), 19–27. https://doi.org/10.37251/sjpe.v6i1.1065

Susilawati, Kaniawati, I., Ramalis, T. R., Rusdiana, D., & Masturi. (2024). Visual-Digital Literacy in Open-Ended Inquiry Based Astronomy Observati on Labs and Heaven View. *Pegem Journal of Education and Instruction*, *14*(3), 160–169. https://doi.org/10.47750/pegegog.14.03.15

Syahgiah, L., ZAN, A. M., & Asrizal, A. (2023). Effects of Inquiry Learning on Students' Science Process Skills and Critical Thinking: A Meta-Analysis. *Journal of Innovative Physics Teaching*, *1*(1), 16–28. https://doi.org/10.24036/jipt/vol1-iss1/9

Thiagarajan, S., Semmel, D.S., & Semmel, M. I. (1974). *Instructional Development for Training Teachers of Exceptional Children: A sourcebook.* Indiana University.

Tiruneh, D. T., & Cock, M. De. (2018). Designing Learning Environments for Critical Thinking*: Examining Effective Instructional Approaches*. 1065–1089. https://doi.org/10.1007/s10763-017-9829-z

Wahyuni, D., Sari, M., & Hurriyah. (2020). Efektifitas e-Modul Berbasis Problem Solving terhadap Keterampilan Berfikir Kritis Perserta Didik [The Effectiveness of Problem-Solving-Based e-Modules on Students' Critical Thinking Skills]. *Natural Science: Jurnal Penelitian Bidang IPA dan Pendidikan IPA*, *6*(2), 2477–6181. http://www.seminar.uad.ac.id/index.php/quantum/article/view/226

Wardani, H. K., Pramartaningthyas, E. K., Rohman, T., & Alimin, A. (2025). Development of Interactive E-Module to Foster EFL Students' Critical Thinking in Essay Writing. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *11*(1), 190. https://doi.org/10.33394/jk.v11i1.13577