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Analysis Study of Physics Digital Teaching Materials in Improving Critical Thinking Skills Student Participants: Literature Review

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Abstract: In the context of physics learning, critical thinking is a key tool for students to understand complex and abstract natural phenomena. Physics requires students to possess strong analytical skills, logical problem-solving skills, and the ability to connect theory to reality. At present, technological developments demand teaching materials that are able to support physics learning to be more varied, interesting, and effective in honing students critical thinking. However, the use of digital teaching materials for this purpose has not been widely applied in schols, especially at the junior and widely known. This study aims to examine and review various national and international articles that develop or use digital teaching materials in physics learing. This research uses a qualitative method with a literature review approach. Data were collected from relevant articles and journals from 2018 to 2024. A total of 48 articles were identifies and analyzed using coding techniques to understand trens in digital teaching materials in improving critical thingking skills. The results showed that e-modules are the most widely developed and used digital teaching materials in research. This finding contributes that e-modulea can be a solution to improve students critical thinking skills through more innovative physics learning

Keywords: Critical thinking skills; Digital teaching materials; Physics

Introduction

The times always bring progress in every era. The 21st century is an era that is experiencing rapid progress in various fields including education. In facing the challenges of this century, the concept of 21st century learning emerged which aims for education to keep up with the times. This concept believes that knowledge will not be enough so that skills are needed as the basis of learning, one of which is the ability to think critically in students (Rahmawati et al., 2025). The ability of individuals to seek, receive and manage information from various sources includes ways of thinking critically (Kurniawan et al., 2021). This makes the ability to think critically can develop other thinking skills in everyday life (Saputra, 2020). Critical thinking in physics learning needs to prepare students to become strong problem solvers, in making informed decisions.

Although critical thinking is recognized as an important element in 21st century education (Santos-Meneses & Drugova, 2023). Research by states that students' critical thinking skills are still low at the education level. So that students still need to be trained further so that they can be improved. In addition, most students still rely on memorization in learning physics material delivered by educators without conducting in-depth analysis (Khasani et al., 2019). In this condition, it shows the need for teaching materials that can improve critical thinking skills. In this digital era, the use of technology in teaching materials has a major impact on the way students learn and learn (Saiful Rizal, 2023). The use of digital teaching materials can provide flexibility for students to interact with the material in the teaching

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materials (Sinaga et al., 2022). So that digital teaching materials have the potential to facilitate access to learning that can be achieved from anywhere and anytime (Nawwal & Setyasto, 2025; Dhivya et al., 2023). In addition, teaching materials must facilitate students to learn without teachers (Arsita & Astawan, 2022). Furthermore, it can enrich learning materials by presenting information in a variety of different formats and styles (Syafril & Rahmi, 2023).

However, the effectiveness of digital teaching materials still shows mixed results in showing students' critical thinking (Daulay & Asrizal, 2024; Syahfitri & Safitri, 2024). Some studies show the inhibiting factors of digital teaching materials in their use such as the lack of quality content or design and in accordance with the curriculum (Zahmatkeshan et al., 2024; Gkrimpizi et al., 2023). In addition, innovation in digital teaching materials is still said to be lacking, causing student learning outcomes to not be maximized and low student learning motivation as a result students are easily bored in participating in learning, especially in abstract material (Jannah & Atmojo, 2022). So that 4C skills, especially critical thinking skills, have not been achieved properly (Monica et al., 2021).

Based on these problems, this research aims to review various literature related to physics digital teaching materials that have been developed or used, especially those that support the improvement of students' critical thinking. This study will provide an overview and variety of digital physics teaching materials, so that it can be the basis for proposing innovative solutions that are relevant to the needs of 21st century learning.

Method

The method used in this research is a qualitative approach in the form of Study Literature Review (SLR). The research process is carried out by collecting data or literature relevant to the topic and research objectives. The literature used is secondary, in the form of a collection of scientific articles that have high credibility at the national and international levels. The collection of articles and journals selected is limited to the last seven years from 2018 to 2024. The flow of research conducted can be explained in Figure 1 as follows:

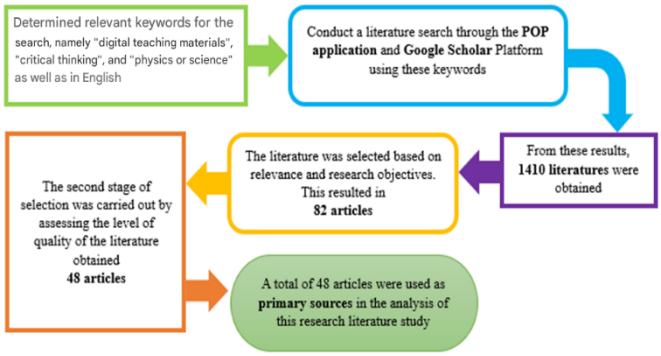

Figure 1. Research flow

Based on the research flow above, 48 articles were obtained as literature data sources. The articles were analyzed and grouped into several aspects that will be researched and discussed further.

Result and Discussion

This research has produced 48 articles as the main source of analysis for the study conducted. The following are the results of the article search. The literature found from 2018 to 2024, obtained a number of relevant articles to be discussed in this study. The articles have journal rankings identified through the highest grouping, namely Scopus Q2 with 11 articles. Furthermore, the article category is Sinta from quality 2 to 6. In the sinta category, the largest number of articles are in quality 3 and 4. The least number of articles is in the sinta 6 category with only 1 article. Each article uses a variety of digital teaching materials. The following percentages are generated on various kinds of digital teaching materials found in Figure 2.

Table 1. Collection of Articles

Article Code	Author (Year)	Article Categories
A1	Chusni, Saputro, Rahardjo, Suranto (2020)	Scopus Q2
A2	Kurniawan, Syafriani (2020)	Scopus Q2
A3	Desnita, Festiyed (2022)	Scopus Q2
A4	Ambarwati, Suyatnva, Ertikanto (2019)	Scopus Q2
A5	Saphira et al.(2022)	Scopus Q2
A6	Damayanti, Kuswanto (2020)	Scopus Q2
A7	Damayanti, Kuswanto (2021)	Scopus Q2
A8	Ramadan, Jumadi, Astuti (2020)	Scopus Q2
A9	Fardani, et al. (2019)	Scopus Q2
A10	Tania, Jumadi, Astuti (2020)	Scopus Q2
A11	Rahmayani, Kuswanto, Rahmat (2024)	Scopus Q2
A12	Adhelacahya, Sukarmin, Sarwanto (2023)	Sinta 2

Article Code	Author (Year)	Article Categories
A13	Rahmawati, Sarwanto, Budiawanti (2021)	Sinta 2
A14	Rachmayani, Jumadi, Supahar (2023)	Sinta 2
A15	Azriyanti, Syafriani (2023)	Sinta 2
A16	Cyinthia, Arafah, Palloan (2023)	Sinta 2
A17	Permatasari, et al. (2023)	Sinta 2
A18	Sari, et al. (2023)	Sinta 3
A19	Pertiwi, suyatna, suyanto (2019)	Sinta 3
A20	Habibulloh, et al. (2024)	Sinta 3
A21	Kurniawan, Syafriani (2021)	Sinta 3
A22	Sari, Wahyuni, Budiarso (2022)	Sinta 3
A23	Naj'iyah, Suyatna, Abdurrahman (2020)	Sinta 3
A24	Haqiqi, Akhdinirwanto, Maftukhin (2020)	Sinta 3
A25	Permatasari, Hermawan, Supriyadi, Masturi dan Linuwih (2023)	Sinta 3
A26	Pabri, Medriati, dan Risdianto (2022)	Sinta 3
A27	Ngurahrai, Farmaryanti, Nurhidayati (2019)	Sinta 3
A28	Pratiwi, Wiyono, Zulherman (2020)	Sinta 3
A29	Boari, et al. (2023)	Sinta 4
A30	Wahyuni, Sari, Hurriyah (2020)	Sinta 4
A31	Paramitha, Sriyanti, Marlina (2021)	Sinta 4
A32	Irma Savitri, Abd. Kholiq (2023)	Sinta 4
A33	Kholisoh, Nulhakim, Berlian (2023)	Sinta 4
A34	Hidayati, Listyowati, Setiaji (2023)	Sinta 4
A35	Nurhalimah, Berlian, Kurniasih (2023)	Sinta 4
A36	Noorruwaida, Suryajaya, Syahmani, Suyidno (2022)	Sinta 4
A37	Rahayu, Hadi (2023)	Sinta 4
A38	Permadi, Anggreini, Wicaksono (2020)	Sinta 4
A39	Burnama, Hariyono (2024)	Sinta 4
A40	Latifah, Ashari, Kurniawan (2020)	Sinta 5
A41	Maulida, Sinaga, Susilawati (2019)	Sinta 5
A42	Sasmita, Medriati, Hamdani (2021)	Sinta 5
A43	Duri, Dewi, Hufri, Hidayati (2024)	Sinta 5
A44	Devi, Budiarso, Wahyuni (2022)	Sinta 5
A45	Laoli, Syahril, Zulirfan (2023)	Sinta 5
A46	Prihandono, Supriyono, Meilina, Ernasari (2023)	Sinta 5
A47	Oktavia, Enjelina Suban, Mole (2024)	Sinta 5
A48	Anjani. J, Ilham Syarif, Susanti, Sulaimon (2023)	Sinta 6

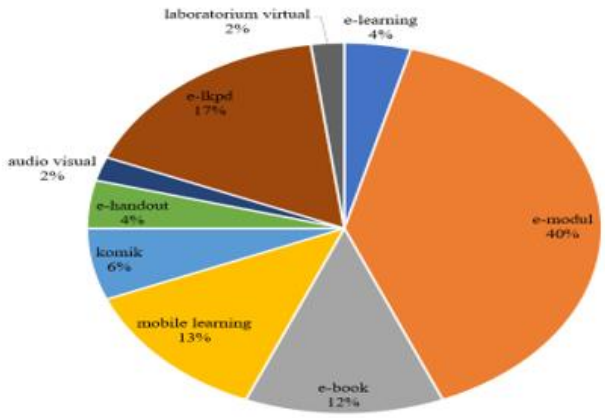

Figure 2. Percentage of digital teaching materials on physics critical thinking ability

In the 21st century, there are various types of digital teaching materials used to support students' critical thinking in physics subjects. Information presented in Figure 2, it was found that there were 9 types of digital teaching materials that had been developed to achieve the objectives of this study. The use of E-Modules dominates as the most frequently used digital teaching material, indicating that this type has a high level of relevance and effectiveness in improving critical thinking skills. After that, it is known that E-LKPD is the second most utilized digital teaching material. This is followed by mobile learning and e-books, which account for more than 10% of learning device usage. These three types of teaching materials occupy the main position due to their flexibility and adaptability in supporting the digital-based learning process. In addition, there are other digital teaching materials that are used below 7%, namely comics, e-learning, e-handouts, virtual laboratories and audio visuals. Although the amount of use is less, these types of teaching materials still contribute as alternatives or variations in supporting the development of critical thinking skills in students at the junior and senior high school levels (Chairatunnisa et al., 2023).

E-Module

Digital teaching materials in the form of E-modules are the most common choice in the use of teaching materials. This is evidenced based on the junior high school level, there are 3 studies that use E-modules. It can be seen that electronic modules are alternative teaching materials for teachers that provide convenience and practicality in students' critical thinking (Liu & Pásztor, 2022). The preparation of e-modules needs to be considered in containing the objectives and indicators achieved, the phase used is adjusted to the material provided, and the practice questions given. Physics modules are said to be valid with assessment aspects such as cover page, table of contents, learning indicators, content design, e-module typography, material accuracy, content presentation, content accuracy, evaluation questions, instruction manual, and glossary (Wienand et al., 2024).

Based on the high school level, e-modules were used as many as 16 articles in research teaching. Making e-modules pays attention to various aspects such as material suitability, learning syntax, presentation, appearance and language (Kurniawan & S. Syafriani, 2021). The application received feedback from students in fostering critical thinking skills who felt easier and more interested in learning compared to opening printed books and presentation media. So it can be said that the e-module produced has very practical criteria for indicators, namely interesting, efficient, and can and easy to use and students do positive activities and respond well (Kurniawan & Syafriani, 2021; Cynthia et al., 2023). Interesting in terms of all the content displayed including the cover of the e-module developed. The cover of the initial part to see whether or not a teaching material is interesting. Making e-modules on the cover has an appropriate point of view, balance of element composition, layout such as titles, authors, logo illustrations, and others (Sari et al., 2023). The elements on the cover must have an appropriate layout. Things that must be considered are seen in the cover design, the color of the title that is synchronized with the material, the shape, size, and object of the illustration and the color of the illustration that matches reality. In addition, e-modules are also supported by relevant learning models. This can support the effectiveness of digital teaching materials on critical thinking skills. The development of e-modules is considered in adaptation to students because they are not used to using them at school to represent their thoughts in detail (Desnita et al., 2022).

The use of interactive modules can train aspects of skills. E-modules can be said to be interactive to support students' critical thinking skills such as being required to be active and reasoning in observing images, illustrations, learning videos, animations, simple practicum or experiment simulations and continued with discussions and sample questions along with practice questions to challenge students in critical thinking (Azukas et al., 2025). Making e-modules can be done using various applications such as Kvisoft Flipbook Maker, Flip Pdf Professional and sigil software. The videos included in the flip pdf application have disadvantages where there are difficulties in opening them, cannot input micro-physical units and power numbers, difficulty in inputting large exe files and cannot type answers directly due to limited application tools (Sasmita et al., 2021). In addition to interactive, there is an android-based multi-presentation module which has the biggest increase in the aspect of building basic skills with a high category. Furthermore, followed by an increase with another high category occurred in the aspect of providing simple explanations. The lowest increase in aspects occurred in the aspects of organizing strategies and techniques, making inferences, and making further explanations (Le et al., 2024). So that these lows can be made a good improvement to support the critical thinking skills of students at school.

Comic

Digital teaching materials have become iconic in classroom learning, such as comics. Comics are not only an entertainment medium, but can be said to be a learning medium that provides knowledge in the field of physics, one of them. Comics are one that can increase students' critical thinking compared to using Power Point (PPT) (Fitria et al., 2023). In its development, this teaching material is expected to facilitate the delivery of material information with a presentation based on everyday phenomena to help students understand the material (Hidayati et al., 2020). Supported by good packaging with narratives and storylines that are conveyed easily understood. The use of teaching materials in the form of comics is a tool in delivering physics learning with the characters integrated in this teaching material, making it interesting and fun (Damayanti & Kuswanto, 2020). However, digital physics teaching materials in the form of comics, it can be said that there are still few applications and have only been used in high schools on critical thinking skills.

E-LKPD

Digital teaching materials that are an important process in the implementation of learning are Electronic Learner Worksheets (E-LKPD). The level of digital teaching materials used in physics learning by measuring critical thinking skills, there are 3 articles in junior high schools that use E-LKPD as digital teaching materials. The evaluation indicator has high criteria because students are able to compare the results obtained based on experiments with other literature

sources. The lowest is in the inference indicator, because students have not been able to express opinions or opinions and causal relationships to a problem (Redjeki et al., 2023). In addition, it can pay attention to content such as the presence of graphics contained in digital teaching materials. This is important because based on the validation of media experts with students' responses after using E-LKPD there are similarities in several aspects assessed (Putri et al., 2025). The similarity of the assessed aspects is in the lowest category of graphics compared to other aspects. In addition, in preparing digital teaching materials in the form of e-lkpd, it can improve the indicators of the suitability of KBBI and PUEBI in critical thinking skills (Sajidi & Parmin, 2025). These two indicators are interrelated because students can easily understand the words and sentences used in writing E-LKPD.

At the high school level, there are 5 articles that develop digital teaching material products in the form of e-lkpd in improving critical thinking skills. In its development, it has aspects of ease of understanding the material, has an attractive color composition, is not boring, and does not make users confused in using electronic teaching materials (Amarin & Al-Saleh, 2020). Four of them made E-LKPD assisted by Liveworksheets. The use of liveworksheets can have advantages that allow teachers to convert worksheets in word, pdf, and jpg into online interactive training materials. In addition, student scores appear so that the teacher does not need to correct anymore, but on essay-shaped questions, it is not possible to automate the assessment because the essays submitted to students have different answers (Figueras et al., 2025). In addition, it can help create a more engaging and dynamic learning experience (Du Plooy et al., 2024). In addition, in critical thinking, students' ability to make simple explanations is in the high category (Zou et al., 2025). On the other hand, the ability to analyze data and evaluate information is in the low and medium categories due to several factors, among others, the difficulty in identifying the equation to be used in solving the problem and many students do not understand to connect physics concepts in the phenomenon of the problem given (Prihandono et al., 2023).

Audio Visual

The use of audio-visual-based digital teaching materials developed with the Kinemaster application has a positive effect on improving the critical thinking skills of high school students. This can be seen in various indicators, such as the ability to analyze, observe, determine appropriate actions, and formulate assumptions that support problem solving. In addition, this teaching material combines material explanations that can be seen and heard, making it effective in strengthening students understanding and critical thinking skills (Mahdian et al., 2024).

E-Book

The development of digital teaching materials in the form of e-books is applied in junior and senior high schools to measure students' critical thinking skills. E-book products are developed by paying attention to variations in typeface, color and size that are clear and attractive, so as to encourage interest in reading and reduce boredom (Rahayu & Al Hadi, 2023). The e-book design developed to improve critical thinking contains instructions for use, markers such as code scanning, learning objectives and materials, sample questions and discussions, images, video illustrations, summary animations and interactive quizzes equipped with exam practice feedback, virtual and non-virtual experiments, as well as a cover containing bibliography, application and developer profiles (Dodevska et al., 2025; Zhang & Liu, 2024; Elmoazen et al., 2023). In addition, the use of e-books is a solution in supporting technology-based learning, especially in schools that do not fully implement face-to-face meetings. Thus, e-books play an important role in both face-to-face and online situations aimed at supporting the learning process, especially on abstract material by combining concepts that students have learned with contextual matters in everyday life (Habibbulloh et al., 2024; Pertiwi et al., 2019).

Mobile Learning

The use of mobile learning as a learning media in critical thinking skills has been reviewed in one article for junior high school level and five articles for high school level. Assessment of the quality of teaching materials focuses on several aspects such as conformity to the curriculum, content integration, currency of content, writing rules, skills trained, and depth and breadth of material (Maulida et al., 2019). This shows that the integrated science teaching materials developed have a significant impact in improving critical thinking skills compared to conventional teaching materials. One of the applications of mobile learning is game applications. Physics learning applied with games feels more fun and provides visualization of concepts in abstract material such as physics so that it is more easily understood by students (Saphira et al., 2022). Especially if added with Augmanted Reality (AR), so that the physics elements in the game become real and easy to understand. In addition, there is an inventor application that makes it easy to learn physics and is categorized as very useful. However, it must pay attention to the design of teaching materials that are expected to provide feedback from students and not just answers.

The results showed that the aspect with the lowest average was in the ability to evaluate arguments.

However, both experimental and control groups still faced defining terms, considering definitions, and identifying assumptions that put critical thinking skills in the moderate category (Yusri et al., 2023). The insignificance of the increase in the average score was inferentially influenced by several factors. One of them is the process of developing critical thinking skills that takes time and cannot be achieved in one lesson on one Basic Competency (KD). Developing physics material into an application called Physics Brain at the Senior High School level (SMA). In measuring the critical thinking skills of students in using this learning application, it can add evaluation materials to cover the number of questions on the quiz so that this skill increases. Then the expected design has language elements that are developed informative and communicative, so that students can understand physics learning well using digital teaching materials in the form of learning applications.

Laboratorium Virtual

Physics learning is not only limited to the classroom, but also requires direct practice in a laboratory equipped with supporting equipment. However, along with technological advances, virtual laboratories are now an effective alternative in supporting learning. Based on the results of research (Sapriati et al., 2023), the use of virtual laboratories shows a more significant effect than conventional laboratories.

E-Learning

Learning using e-learning is an option in using digital teaching materials such as e-learning. E-learning created using schoology application can combine social networking with LMS. The highest assessment aspects of the validators are in the learning design of the material and e-learning aspects. In addition, the resulting media development is feasible in physics learning which has a high level of validity and is included in the very practical category. In other studies, the effectiveness of e-learning is still not fully effective in improving students critical thinking skills due to the lack of interaction and practice in madrasah. This is because students are not yet familiar with the tools provided.

E-Handout

As for digital teaching materials in supporting physics learning, there are e-handouts. Handouts can be said to be devices that usually contain abbreviated material. This teaching material becomes independent learning for students that can be applied inside and outside the classroom in learning new things and adding knowledge that has not been taught by educators.

Conclusion

Physics learning applied in junior and senior high schools in critical thinking can be supported by various digital teaching materials. Among the most developed teaching materials, e-modules occupy a major position because they are able to replace thick printed books, making them more effective and practical to use in digital learning. In addition, there are other effective digital teaching materials such as e-LKPD, e-books, mobile learning, comics, e-handouts, e-learning, audio visual, and virtual laboratories. Developing and using these digital teaching materials, it is important to pay attention to good and correct writing procedures, so that the material and content presented are easy to understand and can optimally improve students' critical thinking skills.

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Author Contributions

Conceptualization, S. P.; methodology, F.; formal analysis, F. M.; investigation, F. S.; resources, S.P.; writing—preparation of original draft, F.; writing—reviewing and editing, F. M.; visualization, F. S.; supervision, S.P.; project administration, F; obtaining funding, F. M. All authors have read and approved the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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