Learning Using Comics and Artificial Intelligence in Physics Subjects : A Review

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Abstract

Technological developments present a variety of forms of interactive media in physics learning. Comics and artificial intelligence (AI) are two innovative media genres that are popularly used to enhance learning. However, a general review of the learning effects of various previous researchers on the effects of comics and AI on physics learning is still limited. This literature review aims to identify the impacts and challenges of implementing comics and AI in physics learning. This literature review goes through five stages, including determining the research question, literature search, article selection, outlining the information from the articles, and literature writing. Articles are sourced from open-access databases, Scorpus, ProQuest, ERIC and Google Scholar. Articles published between 2020 and 2024 are found through searches using keywords in the abstract and title. The search results in as many as 23 articles worth reviewing. Based on the review, comics and AI have proven effectiveness in enhancing physics learning by increasing interest, motivation, and student involvement in learning and understanding concepts in physics. These media have great potential to support interactive and communicative learning. Both media have impacts, advantages, weaknesses, and challenges in their application. AI can give lead to plagiarism in learning, and uncontrolled comics affect students' focus on learning. The implementation of these two learning media has a positive effect on improving learning outcomes. This medium can teach complex subjects in an accessible and fun way. Comics provide interactive and communicative learning that supports independent learning for students. In conclusion, comics and AI positively impact students' physics learning. This literature review provides information about research objects, issues, and conclusions for other researchers regarding the development of comics and AI in physics learning.

Keywords: Comics, artificial intelligence, Physics, teaching aids, teaching and learning

INTRODUCTION

Physics learning is a part of science that discusses natural phenomena and events related to daily life. Physics learning materials can be categorized as abstract or concrete. The presentation of abstract physics material is related to phenomena that are difficult to observe directly, such as atoms and quantum phenomena. Meanwhile, the study of concrete phenomena related to motion. In order to understand physics more thoroughly, analytical skills are needed. The inability to understand physics learning well can result in misconceptions and low understanding. When students have solid physics knowledge, it will be simpler for them to use it in everyday situations.

The actual conditions show that the science ability of students in Malaysia, including in the field of physics, is still low. This is evidenced by the results of the science literacy exam, which is in the low category (PISA, 2023). This situation is due to traditional teaching practices that are still dominant, such as memorization and lectures, which also contribute to students' low interest and understanding of physics (Glickman, 1991). These mistakes and misunderstandings can eventually lead to failure. Consequently, innovative approaches to physics teaching are urgently needed to address these challenges and stimulate students' interest and motivation in science.

Digital technology supports learning by presenting a variety of media types. Technology provides support in explaining physics material. Utilizing technology encourages exciting and effective learning. One of the learning approaches that has become popular in physics learning is the implementation of comics and AI. Comics present learning in the form of stories that support exciting and not dull explanations (Toh et al., 2016). This is because comics are presented as images representing the phenomenon studied (Haloi, 2022). Meanwhile, AI technology provides support for communicative and repetitive material explanations. The presence of comics and AI in learning presents an innovative and creative way of learning to explain physics material.

One of the best Teaching and Learning methods is through storytelling. Comics, as a form of storytelling, can stimulate students' critical and creative thinking (Sagri, Sofos, & Mouzaki, 2018). Beyond their engaging nature, comics facilitate two-way learning. AI, a simulation of human cognitive processes, has changed the educational paradigm (Matthew et al., 2021). Language models such as ChatGPT (Generative Pre-trained Transformer) (Lee et al., 2024) show significant potential in supporting various aspects of learning, from academic writing (Zhai, 2022) to automated assessment (Warschauer & Ware, 2006). In addition, AI can also be used to create a more personalized and interactive learning experience, as explained by Diantama (2024). AI enables interactively personalized learning according to user needs (M., A., Junus, Nurul, Fitriyah, Sulaeman, 2023). In general, comics and AI hold the potential to significantly support physics learning

Previous studies on comics and AI in physics learning have yielded varying results. A comprehensive conclusion regarding the effects of their implementation remains elusive. Furthermore, there is a lack of in-depth research on the specific impacts of comics and AI on physics learning. A thorough review of the challenges and opportunities associated with integrating comics and AI into physics education is necessary. This includes investigating the positive, negative, and challenging aspects of their implementation. The aim of this study is to review existing research to analyze the overall effects of comics and AI on physics learning. Therefore, this study seeks to provide clear guidance for the effective integration of learning through comics, especially in physics.

RESEARCH OBJECTIVE

1. Identify the effectiveness of comics and AI in improving student engagement in physics education
2. Identify students' understanding when taught or learning to use comics and AI in physics education based on previous research.
3. Identifying the strengths, weaknesses, and challenges in implementing comics and AI in Physics Education
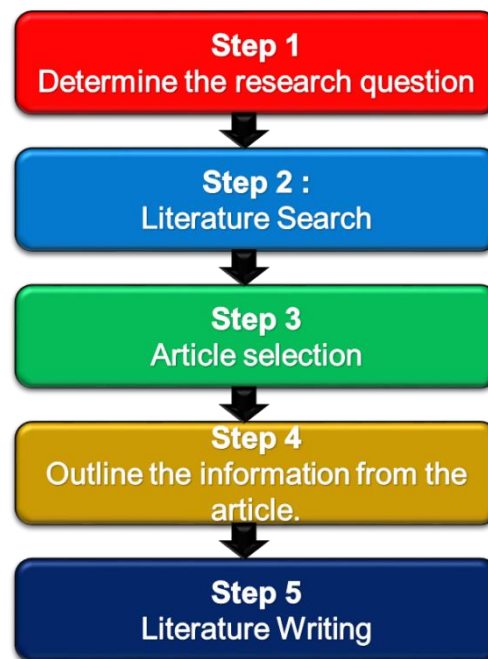
RESEARCH QUESTION

This research aims to answer the following research questions:

1. What is the effectiveness of comics and AI in improving student engagement in physics learning?
2. How do comics and AI help students understand physics material?
3. What are the advantages, disadvantages, and challenges of implementing comics and AI in Physics education?

METHODS

The purpose of writing this literature review is to assess the effectiveness of learning using comics and AI. The data sources in this writing have been selected from various online sources, including books and journal articles. The search used keywords such as comic-based learning, AI, artificial intelligence, and physics for this writing. The steps in the systematic review analysis are adapted from Basu (2017) and Jamal et al. (2019). The steps of the literature review are shown in Figure 1.

Figure 1 Step in Systematic Review Analysis

Figure 1 shows the five steps in a systematic review analysis. The first step is to define the research question using the PICO (Population, Intervention, Comparison, Outcomes) framework. Population refers to elementary and secondary school students. The interventions in this review are related to improving students' understanding of concepts, motivation, and critical thinking skills. Comparisons were made to assess the effectiveness of the intervention compared to other methods. Results refer to the impact obtained from the findings in the literature review. Based on the PICO framework, the research questions aim to determine the impact of learning using comics in improving concept understanding, student motivation, and helping to think critically.

The second step is to search for literature through databases such as Scopus, ProQuest, and ERIC and open-access journals such as Google Scholar, Scribd, and Academia.edu, with a search time span between 2015 and 2024. The third step involves selecting studies based on reading the title and abstract, where the articles are selected according to the theme and research question. In the fourth step, the information is extracted according to the goals set. Finally, the fifth step is to write literature based on research questions to determine the impact of learning using comics in improving concept understanding, student motivation, and helping to think critically. Based on the search and systematic review analysis results, 23 articles have been identified as worthy of review.

RESULT

Based on the literature review process, as many as 23 articles have been found that discuss the use of comics and AI in physics learning. These articles were obtained from databases such as Scopus, ProQuest, ERIC, Google Scholar, and open-access journals, with a period from 2020 to 2024. The information in each article is categorized based on sources, objects of study, issues, and conclusions. This grouping facilitates the

analysis and synthesis of information from various studies. The results of the literature review are presented in Table 1.

Table 1. Results of a Literature Review on Comics and AI in Physics

Source	Research Objective	Issue	Finding
(Khoiri, Lilyani, & Wijayanto, 2024)	Improving students' understanding of Newton's Law	High school's lack of interactive and creative learning media requires more innovative solutions.	Using interactive and creative learning media can increase students' understanding of Newton's Laws concepts.
(Kaat, Uloli, & Odja, 2024)	Improving students' literacy skills	Low literacy skills in heat and heat transfer materials in secondary schools require an effective approach.	Improving students' science literacy skills can be achieved through more interactive and innovative methods.
(Hapsari, Risdianto, & Medriati, 2024)	Developing comic media for motion kinematics materials.	The lack of learning media that can support students' motivation in learning requires more creative solutions.	Comics can increase students' motivation to learn motion kinematics material.
(Purwanto & Widodo, 2022)	Investigating the effects of comics in improving concept understanding	Lack of in-depth conceptual understanding among learners requires a more practical approach	The use of comics can improve students' understanding of concepts in a more interesting and easy-to-understand way
(A E Damayanti & Kuswanto, 2020)	Investigating the effects of comics in improving critical thinking skills	Lack of high critical thinking skills among students requires a more effective approach	The use of comics can improve students' critical thinking skills in a more interesting and interactive way
(Novelita, Yeni, & Hakim, 2024)	Developing Android-based comics to improve understanding of concepts in physics in high school	Students lack a deep understanding of concepts, which requires innovative solutions.	The use of Android-based comics can effectively improve students' conceptual understanding.
(Widyawati, Kuswanto, & Prodjosanto so, 2024)	Investigate the impact of e-comics on improving students' attitudes and critical thinking skills.	Lack of high motivation, attitude, and critical thinking abilities among students requires a more effective approach.	E-comics can increase students' attitudes, interests, and motivation in learning and improve critical thinking skills.
(Badeo & Koc, 2021)	Investigating the impact of using comics as a learning module	Low student interest, motivation, and conceptual understanding require a more effective approach	The use of comics as a learning module can significantly increase students' motivation and understanding of concepts
(Almira Eka Damayanti	Investigate the effects of comics	Students' lack of high critical thinking skills	Comics containing learning games can effectively

Source	Research Objective	Issue	Finding
& Kuswanto, 2021)	containing learning games to support students' critical thinking abilities.	requires a more innovative approach.	improve students' critical thinking skills.
(Jho, 2020)	Investigating the influence of e-comics in increasing students' motivation to learn	Students lack the motivation to study, which requires a more effective approach.	E-comics can significantly increase students' motivation to learn.
(Pathoni, Alrizal, & Febriyanti, 2020)	Investigating the influence of comics with a discovery approach to improve students' science literacy	The lack of high science literacy among students requires a more effective approach.	Comics with a discovery approach can significantly improve students' science literacy in physics learning.
(Wheeler & Scherr, 2023)	Analyze the performance of ChatGPT on the Force Concept Inventory (FCI) to understand its impact on students' understanding of physics concepts.	ChatGPT's popularity among students raises concerns about plagiarism and misinformation.	ChatGPT has the potential to provide accurate information but can also reinforce common misconceptions, making it important for students to understand the limitations of this AI in the learning process.
(Kücheman n et al., 2023)	The use of ChatGPT 3.5 by prospective physics teachers for the development of kinematics assignments in grade 10	A comparison of ChatGPT 3.5's effectiveness with Dalfam's textbook resulted in clear and contextual tasks showing no difference in question accuracy.	Textbooks are superior in terms of clarity and context, while ChatGPT is rated to be easier to use but suffers from problems in output quality.
(Çoban & Çoban, 2023)	The use of ChatGPT in physics education, specifically on the topic of projectile motion, from a student's perspective	ChatGPT offers benefits such as assisting in teaching and providing lesson plans, but there are limitations in mathematical calculations and potential misconceptions.	With proper use, ChatGPT can be very beneficial in physics education, as long as attention is paid to detailed calculations and explanations.
(Lieb & Goel, 2024)	Development of NewtBot, a GPT-3.5-based physics education chatbot that aims to	NewtBot was tested with three configurations—a basic model, a specific tutor, and problem feedback—and the result	ChatGPT boosts confidence in helping physics work.

Source	Research Objective	Issue	Finding
	support the learning of high school students	was that the tutor model provided the best user experience.	
(Aguilar-Mejía, Tejeda, Ramirez-Lopez, & Garay-Rondero, 2022)	Assessing the impact of physics chatbots in active learning sequences for first-year college students	Low concept understanding	Chatbots positively impact learning, with consistent results across all student groups.
(Riabko, Vakaliuk, Zaika, Kukharchuk, & Kontsedailo, 2023)	The use of chatbots to teach physics problem-solving with educational, entertainment, motivational, and reminder functions	Low student problem-solving ability	No significant differences in problem-solving skills were found between students who used chatbots and those who sought direct explanations.
(Kusuma, Maharani, Wibowo, Nasbey, & Costu, 2024)	The effectiveness of self-learning with chatbots	Low learning outcomes	The use of chatbots drives improved student learning outcomes
(Polverini & Gregorcic, 2024)	Introducing how LLMs (Large Language Models) work and prompt-engineering techniques to improve ChatGPT's performance in conceptual physics tasks	Lack of information about how ChatGPT works in a structured way	Understanding LLMs and using prompt-engineering techniques can help leverage ChatGPT in physics teaching and improve learning outcomes.
(López-Simó & Rezende, 2024)	Evaluating how the type of physics questions affects the accuracy and variation of ChatGPT's answers	Mistakes in the use of ChatGPT	Optimize ChatGPT's answer results and maximize the use of AI in physics education with correct commands.
(Ding, Li, Jiang, & Gapud, 2023)	Students' perception of using ChatGPT as a tool in physics classes shows that ChatGPT is often	ChatGPT is often inaccurate, but students generally believe it	Trust in ChatGPT has an impact on student perceptions, and there needs to be improvements in AI literacy teaching to overcome these misconceptions

Source	Research Objective	Issue	Finding
	inaccurate, but students generally believe it.		
(Bruneau, Wang, Cao, & Trương, 2023)	ChatGPT's Potential to Improve Physics Education in Viet Nam High Schools	The use of ChatGPT in the context of physics education in Viet Nam, as well as its integration with information technology and a student-focused pedagogical approach	ChatGPT can improve physics education in Viet Nam by applying technology and a student-centered approach
(Domenichini, Bucchiarone, Chiarello, Schiavo, & Fantoni, 2024)	Design AI education systems to improve physics learning with adaptation, gamification, and personalization	Low motivation and understanding of concepts	AI increases student motivation and engagement and aids in understanding physics concepts through a personalized approach.

Table 1 details the object of study, issues, and conclusions from the literature results. In general, this literature review shows deficiencies in conceptual comprehension, science literacy, and critical thinking skills among students, as well as a lack of motivation and engagement in learning. This indicates that a more innovative approach to teaching is desperately needed. The absence of interactive and creative learning media in secondary schools also exacerbates this situation, requiring solutions that interest students and improve their understanding of concepts in depth. In this context, comics and AI are emerging as potential alternatives to address these challenges. Despite the fact that ChatGPT and similar technologies are widely used by students, its use highlights issues with plagiarism, misinterpretation of data, and the inability to solve complicated mathematical equations.

DISCUSSION

What is the effectiveness of comics and AI in improving student engagement in physics learning?

Comics and AI both proven effective in improving students' understanding of physics. When studying abstract and complicated physics materials, these media helps students understand concepts better. Students nowadays are more interested, driven, and self-assured than they were with traditional learning materials like printed books. This is due to the fact that students actively engage in their learning by presenting through the media's commands and instructions. Previous research corroborates these findings, highlighting the effectiveness of comic-based learning, which combines stories and images presented in various formats tailored to specific content. In physics education, comics can be adapted to different learning materials, such as Newton's Law (Danial & Zulkifli, 2024). Another variation of initial media enriches the learning experience and makes it easier to understand through its colorful graphics, simple themes, and easy-to-understand language (Mamat et al., 2019). The visual elements and storytelling in comics enhance students' motivation to understand the material more deeply (Abdul Murad Abd Hamid, 2013). Comics are considered light reading that is easy to understand and helps students remember and repeat lessons better (Usman et al., 2023; Dewi & Isroah, 2016). Furthemore, by actively engaging students in learning through stroytelling, comics like Pixton also stimulate students' creativity and critical thinking (Danial & Zulkifli, 2024).

AI greatly contributes to better learning outcomes in Pyhsics education. This technology has the potential to increase interest in its application in the education sector (Chen, Xie, & Hwang, 2020). ChatGPT,

Synthesis, Jenni AI, Tome, Murf, and DALL-E-2 are popular technologies that apply physics learning. The flexibility presented supports creative and innovative learning. This technology allows students to learn anytime and anywhere (Azlan Muharram, 2023). With commands according to the user's wishes, the data can be analyzed immediately upon installation and explained in detail. Personalities faced with this technology provide efficiency and effectiveness in physics learning. ChatGPT, as a chatbot technology, helps students develop critical and creative thinking skills that are important in the 21st century (Luckin & Holmes, 2016). The presence of this technology in the world contributes to the formation of a generation that is better prepared to face the challenges of the digital era. However, the use of AI in education requires a good balance, especially in addressing challenges such as potential plagiarism and ethical issues. Consequently, the application of AI is relevant to technological developments and a strategic step to prepare students to compete in an increasingly digital world.

In conclusion, comics and AI offer valuable contributions to education. Comics, with their engaging visuals and storytelling, enhance student engagement and understanding. Meanwhile, AI, with its versatility and personalized approach, empowers students to learn effectively and develop essential skills.Hence, this technology has a positive impact on supporting students' effectiveness in studying physics.

How do comics and AI help students understand physics material?

Students' conceptual understanding of physics is improved when comics and AI are used in the classroom. Through their storylines, comics encourage students to study creatively and effectively by using expressive language. Students are encouraged to explore more questions when studying with AI because of the responsive material explanations. Students can use this technology to respond to a variety of learning questions (Riwanto & Wulandari, 2019). According to Fitri et al. (2021), this situation boosts students' confidence in their ability to study and enhances their comprehension of subjects. When it comes to delivering content for physics education, comics and AI facilitate interactive and communicative learning (Friesen et al., 2018).

Previous research aligns with these findings, highlighting how comics enhance students' interest, motivation, and conceptual mastery. The combined use of comics and AI affects students' cognitive abilities and positive outcomes. AI, in particular, provides real-time answers to students that support their understanding of the concept more quickly, precisely, and accurately. In Newton's law, studies have shown that students taught with comics achieve better learning outcomes than those taught through traditional lectures (Damayanti & Kuswanto, 2021). Moreover, these media can be accessed through various channels including the web, e-modules and applications in physics learning (McDermott et al., 2018). Comics, in particular, can be accessed electronically, which provides efficiency to students in accessing them (Ozdemir, 2017). Meanwhile, AI can be presented in the form of a chatbot. One of the most commonly used forms of chatbots is ChatGPT, which supports the responsive presentation of information.

Comics present learning materials in a strorytelling format, encouraging students to engage in a more casual and unburdened learning experience. By following the stroylines, students can learn and grow their imagination (Megawati Ridwan Fitri et al., 2021; M. A. Junus et al., 2023). This approach positively affects the development of students' cognitive abilities in learning. Studies have shown that integrating comics into physics learning significantly improves student performance on learning tests (Ronsumbre et al., 2023). Both comics and AI support the presentation of easy-to-understand learning materials, ultimately enhancing students' conceptual understanding of physics.

What are the advantages, disadvantages, and challenges of implementing comics and AI in Physics education?

Both comics and AI help to make learning more interesting for students. Comics provide learning presentations through illustrated and processed stories, encouraging students' interest in learning. AI gives students confidence in learning by helping them to answer various questions. These media have advantages in supporting concept understanding, motivation, and student involvement in learning. One challenge of these media is providing explanations that make abstract and complex learning more engaging (Danial & Zulkifli, 2024; Megawati Ridwan Fitri et al., 2021). AI, however, has the advantage of presenting creative learning that adapts to students' abilities. This is possible due to AI's ability to be personalized and governed according to individual needs (Chen, Xie, & Hwang, 2020; Azlan Muharram, 2023). AI can provide

practical and concise learning, and it can streamline students' time spent searching for information (Riwanto & Wulandari, 2019; Usman et al., 2023). Moreover, this technology can analyze, explain, and draw conclusions from the data it has processed. Meanwhile, learning with comics supports students not to get too fixated on concepts but to obtain information through storylines that encourage students' imagination to be active in learning.

Comics and AI have negative effects on learning as well. Previous researchers have reported that using comics in learning encourages students to focus more on stories than learning (Luckin & Holmes, 2016; McDermott et al., 2018). In addition, teaching with these media creates dependence on students to answer various questions. Management controls are an essential part of their use. AI can cause other learning problems such as plagiarism and a tendency to make students lazy when looking for information. A popular form of AI in learning is the responsive use of ChatGPT in answering various questions (Ding, Li, Jiang, & Gapud, 2023).

The reliability of comics and AI in supporting learning has its own challenges for teachers and students when implementing them in physics learning. Effective management controls are important to ensure that learning aligns with established goals. Implementing AI in learning becomes crucial if it is not applied appropriately (López-Simó & Rezende, 2024). This is because this media is able to present convenience that encourages both positive and negative traits for students and teachers in learning. Nevertheless, this media has significant potential to be applied in learning. To support physics learning, comics and AI must be presented in a proper and controlled manner. Therefore, these media are recommended for teachers seeking to facilitate practical, efficient, and effective learning and improve student outcomes.

CONCLUSION

Comics and AI have had a positive impact on physics learning. This implementation of these media has been effectively used to encourage student participation in learning physics. Compared to lecture learning, students have better interest, motivation, and confidence. Comics are presented in the form of storylines along with images to support the explanation of physics material. Meanwhile, AI can can provide immediate and relevant answers to students' questions. Learning by utilizing AI gives users access to personalized learning based on each student's ability level. Interactive, pictorial, and responsive learning presentations encourage the improvement of students' cognitive abilities. Learning using comics and AI is able to support students in understanding abstract physics material to be easier to understand. If this this media is not properly structured, it may negatively affect learning. By using AI, students might participate in plagiarism and media reliance. Additionally, if comics are not arranged according to learning objectives, students may find it difficult to focus when using them to teach lessons. These are challenges with using comics and AI in their application to physics learning. Organized, systematic, and purpose-focused learning is one of the ways teachers deal with the various uncontrollable impacts of the implementation of the media. In general, this media has had a significant positive impact in supporting the improvement of students' cognitive abilities in physics learning. Thus, comics and AI are the recommended media for teachers and students to use in presenting engaging, interactive, and communicative learning.

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