Wahana Pendidikan Fisika (2025) 10 (1): 69-86
https://doi.org/10.17509/wapfi.v10i1.78835
2406-9205 (Print) | 2477-4820 (Online)

ORIGINAL RESEARCH

The role of ChatGPT technology in students conceptual understanding of quantum physics learning

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Received: 31 December 2024 · Accepted: 7 February 2025 · Published Online: 28 February 2025

ABSTRACT

Advancements in technology, particularly in Artificial Intelligence (AI), have significantly impacted human life. ChatGPT is a prime example, demonstrating the power of machine learning and natural language processing. Quantum physics could enhance AI technologies like ChatGPT by improving computational power and efficiency. This study aims to determine the role of ChatGPT technology in learning quantum physics. This type of research is descriptive-quantitative, using a questionnaire survey method. This study's respondents were 46 students of Physics Education UIN Sunan Kalijaga using the simple random sampling technique. The data collection instrument in this study used a survey questionnaire consisting of 20 Likert scale-based statements. The results of the study showed that respondents had a positive perception of the quality of ChatGPT, and its use provided several benefits, ranging from facilitating searches to helping in delivering information, easy-to-understand language, ease of access, speed and accuracy in providing answers to help in saving time. However, ChatGPT's ability to help students learn quantum physics is not optimal. As a result, the influence on the use of ChatGPT is also not strong. ChatGPT has not been able to replace the role of lecturers and teachers in instilling values in students; it only acts as a learning medium.

Keywords: ChatGPT, Education, Learning, Technology, Quantum Physics.

INTRODUCTION

Changes and developments are a constant in human life, and they are especially prominent with the rapid advancement of technology. These technological shifts have transformed industries and reshaped various sectors, including education. In particular, technological innovations have led to developing new tools and systems to enhance education. One of the most significant technological innovations in recent years is Artificial Intelligence (AI). AI, capable of mimicking human thought and action, has increasingly found practical applications across numerous fields. AI is revolutionizing how knowledge is delivered and absorbed in education, opening up new possibilities for educators and students alike (Fitri et al., 2017). Among the AI models that have garnered attention, one of the most notable is the Generative Pre-trained Transformer (GPT), better known as ChatGPT. Released in November 2022, ChatGPT became a popular tool due to its impressive ability to engage in human-like conversations and provide detailed responses to various complex statements. Within just one week of its release, ChatGPT amassed over one million users, highlighting its appeal and effectiveness in addressing diverse needs (Niyu et al., 2024).

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How to Cite: Azizah, H., & Putranta, H. (2025). The role of ChatGPT technology in student's conceptual understanding of quantum physics learning. *Wahana Pendidikan Fisika, 10*(1), 69-86. https://doi.org/10.17509/wapfi.v10i1.78835

ChatGPT's ability to interact conversationally, answering statements and responding to prompts with contextually appropriate and coherent replies, has made it a game-changing tool in various sectors, including education (Dasian & Desriyeni, 2024). The influence of AI technologies like ChatGPT in education is profound and far-reaching. AI has catalyzed significant changes in how educational content is created and consumed, leading to more efficient learning processes, global advancements in educational methodologies, and more effective management of educational systems. The rise of AI in education is not about replacing traditional educators. Instead, it complements their efforts by providing powerful tools to facilitate teaching and enhance learning. With AI tools, educators can access an expanded range of resources to deliver more personalized, diverse, and comprehensive educational experiences (Handoyo et al., 2023; Novrialdy, 2019).

ChatGPT, for instance, can assist educators by providing quick access to vast information, offering explanations, and even generating educational content tailored to specific needs. It serves as a valuable resource for teachers and students, helping to bridge knowledge gaps and expand access to learning materials. AI-driven tools like ChatGPT are particularly beneficial for students when completing assignments and clarifying concepts. With its ability to offer detailed and accurate answers to complex statements, ChatGPT accelerates the learning process and empowers students to explore topics more deeply (Ifani et al., 2024). This technological advancement supports students in their academic journey, enabling them to learn more efficiently and effectively. At its core, ChatGPT is built on Natural Language Processing (NLP) technology, which allows it to process and understand human language. Through NLP, users can engage with the AI in text-based dialogues that mimic human conversation. This interaction feels natural, as ChatGPT provides contextually relevant and articulate responses, much like a human would. This ability to generate human-like, structured sentences is one of the key factors contributing to ChatGPT's widespread success and appeal. Users admire its accuracy, coherence, and ability to produce nuanced, well-formed answers (Nurhuda et al., 2023).

The applications of ChatGPT extend beyond the education sector and into various disciplines, such as history, health, mathematics, and even physics. In physics, for instance, ChatGPT can be a powerful tool for explaining complex scientific concepts in ways accessible to students and researchers alike. As one of the most fundamental sciences, physics underpins many other disciplines, such as chemistry, biology, and geology. It covers various topics, including mechanics, electromagnetism, thermodynamics, and quantum mechanics, all of which contribute to our understanding of the physical universe (Serway & Jewett, 2010; Yuliani, 2017). Quantum physics, in particular, is a core subject for students pursuing a degree in Physics Education, but it is also one of the most challenging. Students often struggle with the abstract nature of quantum physics, which requires understanding complex mathematical equations and the ability to visualize phenomena at atomic and subatomic scales. Traditional teaching methods may not always help students grasp these abstract concepts, and many students turn to supplementary resources or seek additional explanations to improve their understanding (Doyan, 2015; Hidayatulloh et al., 2018).

The difficulty of mastering quantum physics lies in its departure from conventional logic and reliance on theoretical models and advanced mathematics. Given the challenges of studying quantum physics, integrating AI tools like ChatGPT into the learning process could improve student comprehension. ChatGPT has the potential to break down complex concepts into more

https://doi.org/10.17509/wapfi.v10i1.78835

straightforward, more digestible explanations, making it easier for students to grasp complex material (Rahmat et al., 2024). Additionally, ChatGPT can provide interactive dialogues and visual aids, further enhancing students' understanding of quantum phenomena. By offering immediate feedback and tailored explanations, AI technologies like ChatGPT help demystify abstract topics and foster a more profound, engaging learning experience (Hidayatulloh et al., 2018). Furthermore, the use of ChatGPT in quantum physics education is supported by international research, which indicates that AI can significantly improve academic performance and learning efficiency. Studies have shown that ChatGPT can benefit academics and researchers by streamlining tasks, providing real-time assistance, and facilitating more profound insights into complex subjects.

Integrating AI into the study of quantum physics may help students understand abstract concepts and apply their knowledge more effectively in real-world scenarios. As such, researchers and educators alike are increasingly exploring the potential of AI to revolutionize the way quantum physics is taught and learned, especially in contexts where traditional methods may fall short. Finally, the role of ChatGPT in quantum physics education raises important statements about the future of teaching and learning in highly specialized and abstract subjects (Khaeruman et al., 2024). As AI continues to evolve and improve, its potential to support students and educators in understanding complex topics like quantum physics will only grow. ChatGPT, by offering tailored explanations, interactive learning tools, and instant access to vast educational resources, holds promise as an invaluable resource in transforming how students approach and succeed in their studies. As researchers continue to examine the impact of AI on academic performance, integrating tools like ChatGPT could become a key element in reshaping the educational landscape, particularly in fields such as quantum physics, where traditional methods have historically faced challenges in ensuring comprehension.

LITERATURE REVIEW

ChatGPT

ChatGPT is one of the technological innovations that emerged in the Artificial Intelligence (AI) model, namely the Generative Pre-trained Transformer. Chat GPT (Generative Pre-trained Transformer) is an artificial intelligence that uses a dialogue format with humans by asking a statement. It is an AI-like tool that automatically gets an answer quickly (Rizki et al., 2024). ChatGPT significantly contributes to education by facilitating personalized learning, high affordability, and providing innovative learning resources. In addition, this tool also acts as a virtual assistant that helps students in various aspects of learning, from completing assignments to solving problems (Suharmawan, 2023). ChatGPT has the potential to advance the academic world and librarianship. However, it is important to emphasize that ChatGPT is a tool that complements, not replaces, human capabilities. By working effectively with this technology, we can achieve more innovative and efficient results in generating new knowledge.

(Hermila et al., 2024) ChatGPT can be a customizable learning tool with great potential to improve learning outcomes and efficiency. ChatGPT can customize the learning experience by adjusting the material, delivery style, and difficulty level by understanding and responding to input. ChatGPT, or Chat Generative Pre-Trained Transformer, is a natural language model developed by Open AI to produce coherent text. One of the main features used by ChatGPT is

the ability to interact in conversation mode, such as communicating with humans. This feature can receive text input in the form of statements, statements, or instructions and then produce a response that matches its knowledge of the user's language. In addition, ChatGPT is also equipped with other capabilities, namely correcting inaccurate answers with easy-to-understand statements. ChatGPT technology provides a golden opportunity for Indonesian education to develop student competencies relevant to the demands of the 21st century (Salmi et al., 2023).

Previous research conducted by Fauzi et al. concluded that ChatGPT plays a significant role in increasing student productivity by providing various support, from easy access to information to facilitating collaboration and motivation to continue (Fauzi et al., 2023). ChatGPT is capable of processing complex information and providing relevant responses. However, the accuracy of its answers depends on the quality of the data used in its training. Therefore, not all answers provided can be guaranteed correct (Hidayanti & Azmiyanti, 2023). The ChatGPT application is an artificial intelligence of the NLP (Natural Language Processing) type that utilizes that rogue and responds to humans through text or prompts (Nurhuda et al., 2023).

Quantum Physics

Quantum physics emerged as a response to the inability of classical physics theory to explain phenomena that occur at the atomic scale. Experiments with black body radiation and the photoelectric effect became the starting point for the development of quantum theory by Max Planck and Albert Einstein, respectively. In the mid-20th century, quantum mechanics experienced rapid development and became the foundation for our understanding of the universe at the microscopic level. To this day, quantum mechanics remains an active field of study and an integral part of the physics curriculum at many universities (Yuliani, 2017). Quantum physics is also a field that is constantly evolving, with discoveries and theories emerging (Aini et al., 2020). These developments in quantum physics allow for teleportation technology and quantum computers to develop and speed up communication and information (Irvani et al., 2024)

Quantum physics is not just about memorizing but also about critical thinking, finding out, and developing a deep understanding of the universe. This active and discovery-oriented learning process makes quantum physics interesting and challenging (Doyan et al., 2022). Quantum physics is the foundation of several concepts and phenomena of modern physics that cannot be explained by classical physics (Bouchée et al., 2022). Understanding quantum physics is about understanding the universe and training the mind to think critically, stimulate imagination, and form strong analytical abilities. (Irvani et al., 2024). Quantum physics is a branch of physics that studies objects that are small in scale to tiny objects, namely the behavior of matter and energy contained in molecules, atoms, subatomic particles, and objects smaller than subatomic particles. Quantum physics is categorized as a relatively new science compared to other sciences. Although new, this science is considered meritorious because it bridges science and spirituality. The study of discoveries regarding quantum physics continues to develop in this technological era to transform technology in various fields into something bigger (Irvani et al., 2024).

Quantum physics in physics learning is also one of the essential concepts in the school curriculum. Judging from the learning outcomes or CP, it is stated that students must be able to

analyze the relationship between various physical quantities in the special theory of relativity, quantum phenomena, and radioactivity (Sulaeman et al., 2023). Observing events deepening quantum physics learning material requires various learning approaches (Saregar, 2016). Learning quantum physics was initially limited to theory, equations, or complex mathematical calculations. However, with the Virtual Lab, students can directly deepen their understanding of quantum physics concepts through interactive computer simulations (Bauer et al., 2023).

METHODS

General Background

In this study, the researcher used a quantitative research approach (Sidik & Sunarsi, 2019). Quantitative research is a systematic approach that measures and analyzes numerical data to investigate certain phenomena by collecting data with statistical, mathematical, or computational techniques. This method is widely applied in exact sciences such as natural sciences and physics. This contrasts with qualitative research, which aims to obtain a rich and in-depth understanding of a phenomenon, fact, or reality (Kharis & Zii, 2024). According to Kasiman (2008), quantitative research is searching for information using numbers to analyze your desired information. Quantitative research consists of several stages, namely careful planning, selecting appropriate samples, collecting data using questionnaires or other instruments that have been designed, and analyzing data using statistical methods. The goal is to obtain objective results that can be generalized to a broader population (Wajdi et al., 2024).

As for the data collection, this study used a survey data collection method because it aims to collect numerical data from a large number of respondents to determine the role of chatGPT in Quantum Physics learning. Survey research is conducted to obtain facts or data in the research field and aims to obtain accurate and factual information. According to (Dasian and Desriyeni, 2024), the research method is a method or steps systematically arranged to obtain data or information needed in research. The research method used is descriptive based on the problems studied in this study. In descriptive research, researchers present and explain a problem based on the results of quantitative data analysis obtained during the study. The data collected is then processed and analyzed using statistical methods to obtain valid and reliable information. This study can be used to identify the role of ChatGPT in Quantum Physics learning among students of the Physics Education Study Program, Faculty of Tarbiyah, and Teacher Training. The detailed research stages can be seen in the following Figure 1.

Figure 1 shows the flowchart of the research method. The first stage is problem identification; in identifying this problem, the researcher observes the phenomena that attract the researcher's attention and the issues currently being hotly discussed by the public. The next step is a literature review, which will review and analyze several research sources that are relevant to the topic of this research, such as scientific journals, databases, books, and other online sources that are more specific and relevant to this research. The next stage is research design; in this stage, the researcher creates research objectives, chooses the type of research instrument, namely a questionnaire, and compiles instrument items, namely the type of question, language, and order of statements. The next stage is sampling, namely the process of selecting a small part of a larger population to be used as research subjects; in this study, the sampling method used is probability sampling, which is a simple random sampling type.

https://doi.org/10.17509/wapfi.v10i1.78835

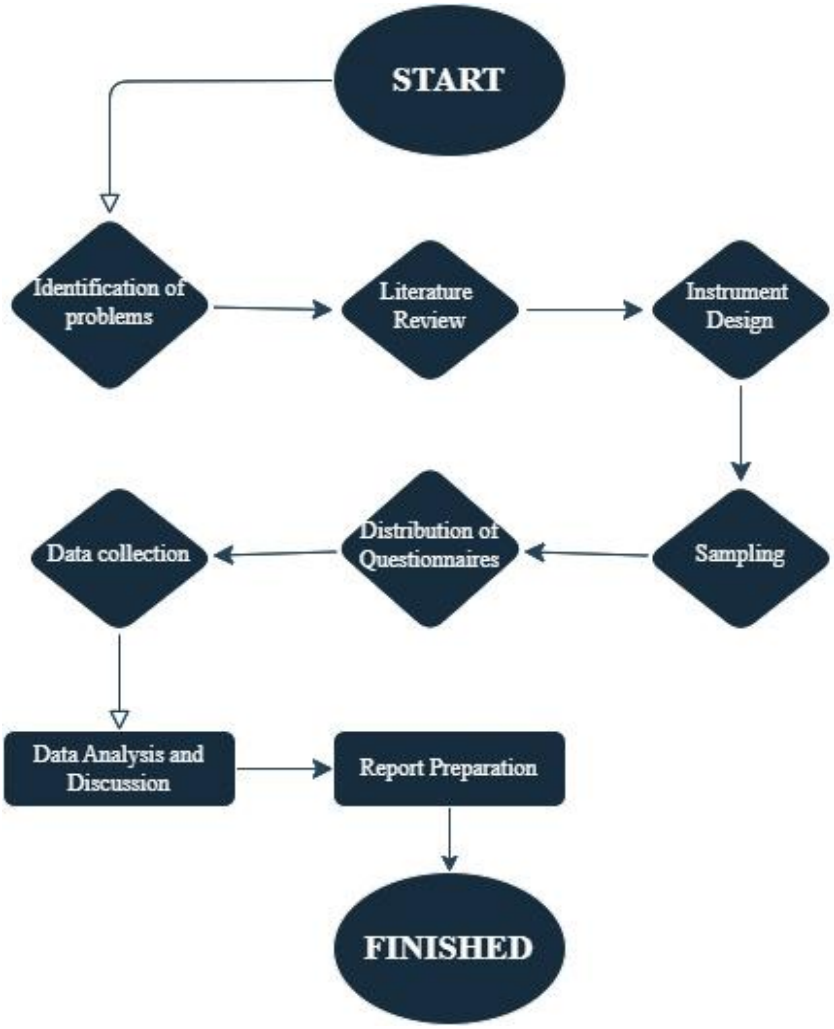

Figure 1. Research Method Flowchart

The next stage is distributing questionnaires to respondents online or via WhatsApp or Google, then collecting respondents' answers. The next stage is data analysis and discussion, followed by the continued writing of the report.

Participants

The sample is defined as part of the population that is the source of data or object in a study. In other words, a sample is part of the population to represent the entire population (Amin et al., 2023). The sample used in this study was 46 students of the Physics Education Study Program, Faculty of Tarbiyah, and Teacher Training who had taken the Quantum Physics course. Sample selection was carried out using simple random sampling. Simple random sampling is said to be simple because sampling sample members from the population is done randomly without considering the strata in the population (Amin et al., 2023). In this study, the sampling was carried out using a questionnaire distribution created through form, which included statements regarding the role of chatGPT in learning quantum physics to students registered in the Physics Education Study Program, class of 2022. The data collection instrument used in this study consists of statements arranged systematically to obtain data from respondents' answers (Luthfiyyah et al., 2024).

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Instruments and Procedures

In this study, data collection was carried out using a Google questionnaire and a Likert scale questionnaire comprising 20 statements systematically arranged to measure the role of ChatGPT Technology in students' conceptual understanding of quantum physics learning. According to Madsen et al. (2020),the Likert scale measures attitudes, opinions, and perceptions of individuals or groups of people toward social phenomena. The Likert scale table is presented below. (Sidik & Sunarsi, 2019)The Likert scale can measure an individual or group's attitudes, opinions, and perceptions regarding a social symptom. Using a Likert scale, the variables to be measured are described into dimensions; dimensions are described into sub-variables, and then sub-variables are described as indicators that can be measured.

Table 1. Likert scale

Assessment Criteria	Rating Scale
Strongly Agree	5
Agree	4
Neutral/Undecided	3
Disagree	2
Strongly Disagree	1

Based on the way the statements are compiled in the questionnaire technique, this research is included in a closed questionnaire (Closed and Items), namely a questionnaire whose written statements have been provided with multiple-choice answers so that respondents can only choose one of the answers provided to find out the role of chatGPT in quantum physics learning. After twenty statements in this survey research questionnaire were developed, the next step was to conduct face validation or face validity. This validity is carried out by testing the suitability between the external appearance of the questionnaire instrument or the appearance of the twenty statements that have been developed with the attributes measured in the form of understanding quantum physics material and the use of ChatGPT (Escorcia & Gimenes, 2020; Tiruneh et al., 2017). The research team carried out this validity test, and qualitative improvements were made from input from the research team members. The basis for improving the twenty statements in this study was based on the results of a cursory assessment of the contents of the statements by the research team and rational analysis or review. If the contents of the statement appear to be by what is to be measured, then the instrument can be declared valid according to face validity (Brundage et al., 2024; Zeng et al., 2011).

Table 2. Questionnaire statements

Number	Statement
1	Chatgpt is one of the AI-based products from OpenAl that is of the best quality.
2	Chatgpt is easy to use and access
3	Chatgpt provides accurate and systematic information
4	Chatgpt contains reliable references to materials.
5	The language used in ChatGPT is easy to understand
6	I am delighted with ChatGPT's speed in answering my statements.
7	The description or answer given by ChatGPT is easy to understand
8	I am delighted with the promptness of the answers given by ChatGPT
9	I get new information and knowledge through ChatGPT
10	Chatgpt helps me use my time as efficiently as possible
11	Chatgpt provides a more precise explanation of quantum physics material than other sources.
12	Chatgpt helps me learn quantum physics in a structured and quality way
13	Chatgpt creates visualizations that make it easier to understand quantum physics.

https://doi.org/10.17509/wapfi.v10i1.78835

Number	Statement
14	Chatgpt can solve complex mathematical material in quantum physics
15	Chatgpt is an effective technology in helping me learn quantum physics
16	I find ChatGPT helpful in understanding quantum physics concepts.
17	Chatgpt can replace the role of teachers in quantum physics learning
18	I feel more motivated to learn quantum physics after using ChatGPT technology
19	Chatgpt increases my creativity in learning
20	Chatgpt makes me more active in learning

The data collection procedure is done by distributing questionnaires through the Google Form platform. Using Google Forms, students can only complete the questionnaire once, making it easier for researchers to process and collect the collected data. This questionnaire is distributed online, namely via WhatsApp. In filling out this questionnaire, students need 10 to 15 minutes to read and choose the correct answer. The statements listed in the questionnaire are as follows:

Data Analysis Techniques

The next stage is the data analysis technique. This stage is carried out after the data is collected from the field using a questionnaire instrument. Then, the collected data is tabulated based on variables. This is done to facilitate the data analysis stages. However, in this study, this data was analyzed using the features in Google Forms as a percentage so that researchers could get a statistical summary that included the percentage of respondents to the statements in the questionnaire. This research data analysis technique is included in the descriptive statistics (Sutisna, 2020). Descriptive statistics are statistics used to analyze data by describing the data collected as it is without intending to make conclusions that apply to the public or generalizations. The data analyzed presents data in tables, graphs, diagrams, pictograms, mode calculations, medians, means, quartiles, deciles, and percentiles. The data analysis results describe chatGPT technology's role in quantum physics learning.

RESULTS

Based on the collected data, the research results below show that Chatgpt plays a role in quantum physics learning.

Respondent satisfaction with ChatGPT

Each respondent's perception of using ChatGPT in the learning process is that they are more satisfied with others. Today's students apply ChatGPT in several learning methods to make it easier. The following are the results of the collected data based on the percentage of Google Forms. The use of ChatGPT is known in the Table 3.

Table 3. Show the percentage result of the questionnaire on respondent satisfaction with ChatGPT

Aspect	Question	Percentage				
		1	2	3	4	5
Respondent satisfaction with ChatGPT	Chatgpt is one of the AI-based products from OpenAI that is of the best quality.	0%	6.50%	30.40%	58.70%	4.30%
	Chatgpt is easy to use and access	2.20%	0%	6.50%	41.30%	50%
	Chatgpt provides accurate and systematic information	0%	17.40%	69.60%	13%	0%
	Chatgpt contains reliable reference materials.	8.70%	15.20%	60.90%	15.20%	0%

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Aspect	Question	Percentage				
		1	2	3	4	5
	The language used in ChatGPT is easy to understand	0%	6.50%	21.70%	50%	21.70%
	I am delighted with ChatGPT's speed in answering my statements.	0%	10.90%	28.30%	43.50%	17.40%
	The description or answer given by ChatGPT is easy to understand	0%	10.90%	34.80%	52.20%	2.20%
	I am delighted with the promptness of the answers given by ChatGPT	2.20%	17.40%	60.90%	19.60%	0%
	I get new information and knowledge with ChatGPT	0%	8.70%	26.10%	47.80%	17.40%
	Chatgpt helps me use my time as efficiently as possible	0%	6.50%	21.70%	58.70%	13%

From Table 3 above, using ChatGPT in this study, most respondents chose an answer with a scale of 4, which means they agree. The study's results on the use of Chatgpt showed that respondents were satisfied with the use of Chatgpt. In the first statement regarding respondents' opinions regarding Chatgpt as one of OpenAI's best quality AI-based products, the results obtained were 0% (strongly disagree), 6.5% (disagree), 30.4% (neutral), 58.7% (agree) and 4.3% (strongly agree), from this data it was obtained that respondents predominantly answered a scale of 4 (agree) with 58.7% of all respondents. So, from this statement, most respondents agree that Chatgpt is one of OpenAI's best-quality AI-based products. In the second statement regarding the ease of use and accessing Chatgpt, the results obtained were 2.2% (strongly disagree), 0% (disagree), 6.5% (neutral), 41.3% (agree), and 50% (strongly agree). From this data, the respondents predominantly answered on a scale of 5 (strongly agree), 50% of all respondents. So, based on this question, most respondents strongly agree that Chatgpt is easy to use and access.

In the third statement regarding whether the information provided by Chatgpt is accurate and systematic, the results obtained were 0% (strongly disagree), 17.4% (disagree), 69.6% (neutral), 13% (agree), and 0% (strongly agree) from this data the respondents predominantly answered a scale of 3 (neutral) which is 69.6% of all respondents. Based on this question, most respondents are neutral or entirely agree that the information provided by Chatgpt is accurate and systematic. In the fourth statement regarding Chatgpt containing references to reliable material, the results obtained were 8.7% (strongly disagree), 15.2% (disagree), 60.9% (neutral), 15% (agree), and 0% (strongly agree). From this data, the respondents predominantly answered on a scale of 3 (neutral), 60.9% of all respondents. Based on this question, most respondents are neutral or entirely agree that the material used as a reference by Chatgpt is reliable.

In the fifth statement regarding the ease of understanding the language used by Chatgpt, the results obtained were 0% (strongly disagree), 6.5% (disagree), 21.7% (neutral), 50% (agree) and 21.7% (strongly agree) from this data the respondents predominantly answered scale 4 (agree) which is with 50% of all respondents. So, based on this question, most respondents agree that the language used in ChatGPT is easy to understand. In the sixth statement regarding the satisfaction of Chatgpt's speed in answering the statements asked, the results obtained were 0% (strongly disagree), 10.9% (disagree), 28.3% (neutral), 43.5% (agree), and 17.4% (strongly agree). From this data, the respondents predominantly answered on a scale of 4 (agree), 43.5%

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of all respondents. So, based on this question, most respondents are satisfied with Chatgpt's speed in answering the statements asked.

In the seventh statement regarding the ease of understanding the description or answer given by Chatgpt, the results obtained were 0% (strongly disagree), 10.9% (disagree), 34.8% (neutral), 52.2% (agree), and 2.2% (strongly agree). From this data, the respondents predominantly answered on a scale of 4 (agree), 52.2% of all respondents. So, based on this question, most respondents agree that Chatgpt's description or answer is easy to understand. In the eighth statement regarding the satisfaction of the accuracy of the answers given by ChatGPT, the results obtained were 2.2% (strongly disagree), 17.4% (disagree), 60.9% (neutral), 19.6% (agree) and 0% (strongly agree) from this data the respondents predominantly answered scale 3 (neutral) which is 60.9% of all respondents. So, from this question, most respondents agree with the satisfaction of the accuracy of the answers given by Chatgpt in answering the statements asked.

Respondents can get new information and knowledge regarding the use of ChatGPT in the ninth statement. The results obtained were 0% (strongly disagree), 8.7% (disagree), 26.1% (neutral), 47.8% (agree), and 17.4% (strongly agree). From this data, respondents predominantly answered on a scale of 4 (agree), 47.8% of all respondents. So, based on this question, most respondents agree that by using ChatGPT, they can get new information and knowledge. In the tenth statement regarding how Chatgpt helps in using time as efficiently as possible, the results obtained were 0% (strongly disagree), 6.5% (disagree), 21.7% (neutral), 58.7% (agree), and 13% (strongly agree). From this data, the respondents predominantly answered on a scale of 4 (agree), 58.7% of all respondents. So, from this question, most respondents agree that Chatgpt helps make time efficient.

Use of Chatgpt in quantum physics learning

Artificial technology, namely ChatGPT, has spread widely in various aspects of life and in learning quantum physics. Quantum physics is a branch of physics that studies the properties and behavior of objects that cannot be seen directly by human senses, so understanding the concept of quantum physics requires a more complex understanding than other physics. Mathematical calculations in quantum physics are also more complex than other mathematical calculations. The results of the data collected through the questionnaire, which obtained answers to statements regarding the use of ChatGPT in quantum physics learning, can help us understand its role.

Table 4. Result of the percentage of the questionnaire on the use of ChatGPT in quantum physics learning

Aspect	Statements	Percentage				
		1	2	3	4	5
Use of Chatgpt in Learning Quantum Physics	Chatgpt provides a more precise explanation of quantum physics material than other sources.	2.2%	23.9%	58.7%	15.2%	0%
	Chatgpt helps me learn quantum physics in a structured and quality way	4.3%	15.2%	52.2%	26.1%	2.2%
	Chatgpt creates visualizations that make it easier to understand quantum physics.	0%	30.4%	43.5%	26.1%	0%

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Aspect	Statements	Percentage				
		1	2	3	4	5
	Chatgpt can solve complex mathematical material in quantum physics	2.2%	26.1%	52.2%	19.6%	0%
	Chatgpt is an effective technology in helping me learn quantum physics	2.2%	4.3%	41.3%	50%	2.2%
	I find ChatGPT helpful in understanding quantum physics concepts.	2.2%	2.2%	47.8%	41.3%	6.5%
	Chatgpt can replace the role of teachers in quantum physics learning	69.6%	13%	13%	2.2%	2.2%

The results of the statements are presented in Table 4. It is known that the average respondent answered a scale of 3 (neutral). This shows that some respondents feel sufficient with the role of Chatgpt in learning quantum physics. In the 11 statements regarding the role of Chatgpt in quantum physics learning, namely, Chatgpt provides a more precise explanation of the material compared to other sources, the results obtained were 2.2% (strongly disagree), 23.9% (disagree), 58.7% (neutral), 15.2% (agree) and 0% (strongly agree) from this data, respondents predominantly answered scale 3 (neutral) with 58.7% of all respondents. So, from this question, most respondents agree that Chatgpt provides a more precise explanation of the material than other sources. In the 12 statements regarding the role of Chatgpt in quantum physics learning, namely, Chatgpt helps respondents in learning quantum physics in a structured and quality manner, the results obtained were 4.3% (strongly disagree), 15.2% (disagree), 52.2% (neutral), 26.1% (agree) and 2.2% (strongly agree), from this data the dominant respondents answered scale 3 (neutral) which was 55.2% of all respondents. So, from this question, most respondents agree that Chatgpt helps them learn physics in a structured and quality manner.

In the 13 statements regarding the role of Chatgpt in learning quantum physics, namely, Chatgpt creates visualizations that facilitate respondents' understanding of quantum physics, the results obtained were 0% (strongly disagree), 30.4% (disagree), 43.5% (neutral), 26.1% (agree) and 0% (strongly agree), from this data the dominant respondents answered scale 3 (neutral) which was 43.5% of all respondents. So, based on this question, most respondents agree that Chatgpt creates visualizations that facilitate their understanding of quantum physics. In the 14 statements regarding the role of Chatgpt in quantum physics learning, namely Chatgpt's ability to complete complex mathematical materials in quantum physics, the results obtained were 2.2% (strongly disagree), 26.1% (disagree), 52.2% (neutral), 19.6% (agree) and 0% (strongly agree), from this data the dominant respondents answered scale 3 (neutral) which was 52.2% of all respondents. So, based on this question, most respondents agree that Chatgpt can complete complex mathematical materials in quantum physics.

In the 15 statements regarding the role of Chatgpt in quantum physics learning, namely the effectiveness of Chatgpt technology in helping in quantum physics learning, the results obtained were 2.2% (strongly disagree), 4.3% (disagree), 41.3% (neutral), 50% (agree) and 2.2% (strongly agree), from this data the dominant respondents answered a scale of 4 (agree) which is 50% of all respondents. So, based on this question, most respondents agree that Chatgpt can help them learn quantum physics. In the 16 statements regarding the role of Chatgpt in quantum

https://doi.org/10.17509/wapfi.v10i1.78835

physics learning, namely, Chatgpt helps to understand the concept of quantum physics, the results obtained were 2.2% (strongly disagree), 2.2% (disagree), 47.8% (neutral), 41.3% (agree) and 6.5% (strongly agree), from this data, the dominant respondents answered scale 3 (neutral) which was 47.5% of all respondents. So, based on this question, most respondents agree that Chatgpt can help them understand the concept of quantum physics. In the 17statementregarding the role of Chatgpt in quantum physics learning, namely, Chatgpt can replace the role of teachers in quantum physics learning, the results obtained were 69.6% (strongly disagree), 13% (disagree), 13% (neutral), 2.2% (agree) and 2.2% (strongly agree), from this data the dominant respondents answered scale 1 (strongly disagree) which is 69.6% of all respondents. So, from this question, most respondents strongly disagree that Chatgpt can replace the role of teachers in quantum physics learning.

The influence of using Chatgpt in learning quantum physics

Many students already accustomed to using ChatGPT have extensive knowledge in several fields. ChatGPT has a positive influence or benefit in various fields, including academics. However, depending on how students forgive this artificial technology in academics, it can have a negative impact. Although ChatGPT can be a learning medium, it must be balanced with the awareness that one should constantly develop personal skills. Several experts are still debating whether students should use ChatGPT because many factors affect their quality of life, such as a high risk of plagiarism, reduced critical thinking, reduced motivation to learn, and inhibition of skills. The influence of the use of ChatGPT in this learning is related to the attitude of perception or satisfaction of respondents towards the use of ChatGPT. After learning the role of ChatGPT in quantum physics learning, the following statement is about the influence or impact of using ChatGPT in quantum physics learning. The data collected through the questionnaire provided answers to statements regarding using ChatGPT in quantum physics learning.

Table 5. percentage result of the questionnaire on the influence of using ChatGPT in learning quantum physics

Aspect	Statements	Percentage				
		1	2	3	4	5
The influence of using Chatgpt in learning quantum physics	I feel more motivated to learn quantum physics after using ChatGPT technology	4.3%	32.6%	43.5%	19.6%	0%
	Chatgpt increases my creativity in learning	6.5%	28.3%	39.1%	26.1%	0%
	Chatgpt makes me more active in learning	2.2%	26.1%	45.7%	26.1%	0%

In the 18 statements regarding the influence of using Chatgpt in learning quantum physics, namely, respondents feel more motivated to learn quantum physics after using Chatgpt technology, the results obtained are 4.3% (strongly disagree), 32.6% (disagree), 43.5% (neutral), 19.6% (agree) and 0% (strongly agree) from this data the dominant respondents answered scale 3 (neutral) which is 43.5% of all respondents. So, based on this question, most respondents agree that they feel more motivated to learn quantum physics after using Chatgpt technology. In the 19 statements regarding the influence of using Chatgpt in quantum physics learning, namely, Chatgpt can increase respondents' creativity in learning, the results obtained were 6.5% (strongly disagree), 28.3% (disagree), 39.1% (neutral), 26.1% (agree) and 0% (strongly agree) from this data, respondents predominantly answered scale 3 (neutral) which

was 39.1% of all respondents. So, based on this question, most respondents agree that Chatgpt can increase their creativity in learning. In the 20 statements regarding the influence of using Chatgpt in quantum physics learning, namely, Chatgpt can make respondents more active in learning, the results obtained are 2.2% (strongly disagree), 26.1% (disagree), 45.7% (neutral), 26.1% (agree) and 0% (strongly agree) from this data the dominant respondents answered scale 3 (neutral) which is 45.7% of all respondents. So, based on this question, most respondents agree that Chatgpt can make them more active in learning.

DISCUSSION

In this study, a survey was conducted to identify the role of ChatGPT technology in student's conceptual understanding of quantum physics learning. The survey results showed that the most significant percentage of respondents (58.7%) agreed that Chatgpt is one of OpenAI's AI products with the best quality. This indicates that most respondents positively perceive the quality of Chatgpt, perhaps from the aspect of the language used by ChatGPT or other features used in the application. Regarding the statement about the ease of use of ChatGPT, as many as 69.6% of respondents agreed that ChatGPT is easy to use and access. This shows that ChatGPT is well designed to be easy for users to understand so that ChatGPT users feel satisfied. Likewise, in terms of the references used, 60.9% of respondents indicated that the references they used were reliable; this is to the research reviewed (Siregar et al., 2024), namely the discovery of hatGPT support in the learning process at school because ChatGPT contains several supports, one of which is an inspiring reference. As for providing information, 69.6% of respondents indicated that the information provided by ChatGPT was accurate and systematic.

Furthermore, 47.8% of respondents indicated they obtained information and new knowledge using ChatGPT. Although ChatGPT is trained with a vast and diverse dataset, ChatGPT does not yet know the latest information (Suryono et al., 2023). When viewed from the aspect of the language used by ChatGPT, 50% of respondents were satisfied with the language used so that it was easy to understand.

Meanwhile, regarding the answers given by ChatGPT, 52.2% of respondents felt that the description of the answers given in the application was easy to understand. This can happen because ChatGPT was formed to communicate with humans and respond to human statements per the context and user's commands. This is the same as Wahid Suharman's research. Namely, ChatGPT uses natural language (human-friendly) to answer statements and provide information for human interaction (Suharmawan, 2023). The results of this study are also relevant to research conducted by (Nathania et al., 2023), and most respondents expressed satisfaction with the features offered by ChatGPT. Ease of access, ability to understand context, and relevance of the answers produced are the main factors that provide a positive experience for users. As for the speed aspect of ChatGPT in answering statements, 43.5% of respondents were satisfied with the speed of ChatGPT.

Furthermore, the survey results of the accuracy of the answers given by ChatGPT showed that 60.9% were quite satisfied with the accuracy of the answers. This is the same as the research (Mairisiska & Qadariah, 2023), namely the use of ChatGPT in the learning process; respondents feel satisfied with the speed and accuracy of the answers or respondents given by ChatGPT.

https://doi.org/10.17509/wapfi.v10i1.78835

However, ChatGPT also does not guarantee the accuracy of the answers given by ChatGPT to the statements asked (Supriyadi, 2022).

From the ChatGPT time usage survey results, 58.7% of respondents indicated that ChatGPT helped respondents use time as efficiently as possible. This may be due to the influence of ChatGPT's speed and accuracy in answering statements, resulting in the time used in learning being more efficient using ChatGPT. ChatGPT's intelligence in answering quickly is a chatbot feature provided by Open AI (Rizki et al., 2024), and the research conducted on using ChatGPT can bring positive and negative impacts. Still, the use of ChatGPT increases the efficiency of respondents' time in completing college assignments. From the aspect of using ChatGPT, it shows that respondents have a good perception of the role of ChatGPT in learning, meaning that respondents agree that ChatGPT can be a companion in learning.

Furthermore, regarding the use of ChatGPT in quantum physics learning, the survey results showed that 58.7% of respondents were neutral that ChatGPT provided a more precise explanation of quantum physics material compared to other sources; this shows that ChatGPT is lacking in providing a more precise explanation of the material compared to other sources. Likewise, the majority of respondents, 52.2%, were neutral that ChatGPT helped in learning quantum physics in a structured and quality manner. Most respondents, 43.5%, were neutral that ChatGPT also did not strongly influence creating visualizations that facilitate understanding quantum physics. The results of this study are based on what was done (Priyambodo & Permatasari, 2024). ChatGPT's ability to visualize only general characters.

In contrast, the results are not accurate for specific and detailed things. The survey showed that 47.8% of respondents were neutral that ChatGPT helped understand quantum physics concepts, 52.2% of respondents were neutral that ChatGPT was able to solve complex meta-mathematical material problems in quantum physics, as well as 50% of respondents were neutral that ChatGPT was an effective technology to help respondents in learning quantum physics. The results of this study are relevant to the study entitled The Implications of Using ChatGPT on Mathematical Literacy of Mathematics Education Students at the Indonesian University of Education, namely that ChatGPT's ability to explain mathematics or mathematical concepts clearly is less helpful so that when respondents use ChatGPT, it has the potential to reduce the quality of mathematical literacy (Salsabila et al., 2024). In using ChatGPT in mathematical material or numerical integration problems, further validation of the results provided by ChatGPT is needed, especially in more complex or complicated mathematical problems, to ensure their accuracy and precision. (Samaray, 2024)

The advantages of using ChatGPT from the survey show that 69.6% of respondents strongly disagree that ChatGPT can replace the role of teachers in quantum physics learning. This is because the role of teachers in learning is vital, and ChatGPT can only be used as an assistant media in learning. Not replace the role of teachers in learning. However, the teacher's main task is to teach and educate students to have character, attitudes, and moral values to become good and valuable individuals and to guide or provide direction and support to students in overcoming learning difficulties, personal problems, or other problems. This is by the research (Ausat et al., 2023; Ramadhan et al., 2023). Namely, the use of ChatGPT in learning can only be an aid or supporting tool and cannot replace the role of the teacher as a whole. However, although ChatGPT can contribute to facilitating the learning process, the teacher's primary role remains irreplaceable.

https://doi.org/10.17509/wapfi.v10i1.78835

From this aspect, it is known that ChatGPT in quantum physics learning does not have a strong influence and cannot replace the role of the teacher. These results are also by the research conducted (Merentek et al., 2023) with the title Implementation of Artificial Intelligence ChatGPT in learning, namely the use of ChatGPT as a learning aid. It is necessary to remember its limits—the role of teachers as the primary learning facilitators cannot be replaced by technology. Therefore, integrating technology into the learning process must be carried out carefully and effectively and requires increased teacher competence in managing technology-based learning. Research conducted by (Sukarno et al., 2024) states that AI can provide information efficiently, but only teachers can provide the human touch needed in the learning process. Teachers act as guides, motivators, and discussion partners for students. By utilizing AI as a tool, teachers can focus more on things that only humans can do, such as building strong relationships with students and encouraging them to think critically and creatively.

Next is the influence of using ChatGPT in learning quantum physics. The survey showed 43.5% of respondents felt neutral about being more motivated to learn quantum physics after using ChatGPT, 58.7% of respondents felt neutral that ChatGPT increased creativity in learning quantum physics as well and 45.7% of respondents felt neutral that ChatGPT was able to make more active to learn quantum physics. This may be due to the fundamental nature of quantum physics and the need for practicums that support more profound understanding. These results are based on previous research conducted by Mairisiska et al., namely, the use of ChatGPT in learning FITK IAIN Kerinci students has not been able to increase motivation in learning due to concerns about plagiarism. This result is also contrary to research conducted by (Yunarzat et al., 2024). Namely, there is an influence between the use of ChatGPT learning media and student learning motivation and the research conducted (Rosiana et al., 2024), namely, ChatGPT is effective in increasing student learning motivation in Morphosyntax learning and research (Putri et al., 2024), the influence of the use of ChatGPT in higher education, skills, collaboration, and creativity.

CONCLUSION

Based on the results of the questionnaires collected and analyzed, respondents have a positive perception of the quality of ChatGPT in terms of satisfaction with the use of ChatGPT. ChatGPT provides several benefits, ranging from facilitating searches to helping provide information, easy-to-understand language, ease of access, speed, and accuracy in providing answers to help save the time needed. However, ChatGPT's capabilities are not very influential in learning quantum physics. As a result, the influence on the use of ChatGPT is also not strong. The fundamental nature of quantum physics itself can cause this. Not only that, but mathematical calculations in quantum physics are also too complex. Hence, the use of ChatGPT in learning quantum physics plays a less important role, and the use of ChatGPT in learning cannot replace the role of teachers, only acting as a learning medium. Although there is no influence on the use of ChatGPT in learning quantum physics, students must still be wise in using ChatGPT as a learning medium. To increase the role of ChatGPT in learning quantum physics, researchers hope there will be additional features that facilitate learning quantum physics, such as better visualization, increased accuracy of answers, and other features that support learning quantum physics.

https://doi.org/10.17509/wapfi.v10i1.78835

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