Investigating the Effectiveness of ChatGPT for Providing Personalized Learning Experience: A Case Study

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Abstract—The demand for personalized learning experiences that cater to the unique needs of individual learners has increased with the emergence of data science. This paper investigates the potential use of ChatGPT, a generative AI tool, in providing personalized learning experiences for data science education, specifically focusing on Deep Learning. The paper presents a case study that applies the 5Es model to test personalized learning for students using ChatGPT. The study aims to answer the question of how educators can leverage ChatGPT in their pedagogy to enhance student learning, and whether ChatGPT can provide a better learning experience than traditional teaching methods. The paper also discusses the limitations faced during the study and the findings. The results suggest that ChatGPT can be a valuable resource for data science education, providing personalized and instant feedback to learners. However, ethical considerations such as the potential for biased or inaccurate responses and the need for transparency in AI-generated content should be carefully addressed by educators. The study highlights ChatGPT's potential as a research tool for data science educators to investigate the effectiveness of AI in personalized learning experiences. Overall, this paper contributes to the ongoing dialogue on the role of AI in data science education and provides insights into how educators can utilize ChatGPT to enhance student learning and engagement.

Keywords—Personalized learning; data science education; ChatGPT; generative AI

I. INTRODUCTION

In recent years, technology has been transforming many aspects of our lives, and education is no exception. The rise of artificial intelligence (AI) and its applications in education, known as Artificial Intelligence in Education (AIED), have opened new possibilities for personalized and effective learning. The area of Artificial Intelligence in Education (AIED) has made significant progress in the last two and a half decades, particularly in the realm of technological advancements [1]. Moreover, the COVID-19 pandemic has accelerated the shift towards online and remote learning, increasing the demand for intelligent and adaptive learning technologies [2]. The potential for AI to revolutionize teaching and learning is immense, as it can automate tasks, process large quantities of data, and provide predictive insights. Intelligent Tutoring Systems (ITS), such as Beetle II, have demonstrated the potential of AI in education by using natural language processing and interactive experimentation to provide context-specific feedback to students and improve their learning outcomes[3].While the term "artificial intelligence" is broad and encompasses a range

of technologies and techniques, the development of educational chatbots (EC) has garnered attention in the field of education. Built using Natural Language Processing (NLP), ECs offer immediate feedback to learners and assist in achieving educational and pedagogical objectives. Chatbots have been recognized for their potential in the realm of personalized learning, with Chen et al. [4] noting their benefits in this area. Additionally, Garcia Brustenga et al. [5] distinguished EC into two types: those with educational intentionality, which are designed to foster teaching and learning directly, and those without, which are incorporated into teaching tasks of an administrative nature. Colace et al. [6] argued that integrating chatbots in education can result in an engaging and interactive learning environment, similar to one-on-one interactions with teachers. The key for EC, in general, is personalized learning, as emphasized by Basham et al. [7], who state that personalized learning focuses on each student's individual skills and knowledge. It empowers learners to set goals, reflect on their progress, and extend their learning beyond the classroom [8].The research at hand centers around a particular chatbot-based AI platform, ChatGPT, which has attracted significant global interest and sparked a great deal of excitement among the public. Highlighting the uniqueness of ChatGPT as an AI platform and the potential impact it can have on personalized learning, it offers an advanced natural language processing system and the ability to provide tailored guidance and support to students. Through interactive conversations, ChatGPT creates a personalized learning experience that enables learners to receive immediate feedback, adapt their learning process, and explore knowledge in a flexible manner. This innovative AI platform holds great promise for enhancing personalized learning experiences and shaping the future of education. Despite the growing interest in the use of AI in education and the potential of chat-based AI tools like ChatGPT, there are still notable gaps and problems in existing studies. First, while some studies have explored the efficacy of personalized learning approaches, few have specifically investigated the integration of AI tools within this context. This leaves a gap in our understanding of how AI can be effectively harnessed to tailor educational experiences to individual learners. Second, limited research has specifically focused on the field of data science education and the potential benefits of AI-powered tools in this domain. This is particularly important given the rapidly evolving nature of data science and the increasing demand for skilled professionals in this field. Furthermore, while there have been studies examining the impact of AI

tools in education, there remains a lack of comprehensive exploration of the pedagogical methodologies and frameworks that can be successfully employed in conjunction with such tools. This gap hinders educators' ability to effectively implement AI tools like ChatGPT in their instruction and maximize their impact on student learning outcomes. To investigate the effectiveness of ChatGPT in providing personalized learning experiences, a case study approach with two groups, namely a control group and an experimental group, was adopted. The study involved a total of 20 students, with the experimental group having access to ChatGPT and learning through the guidance of the 5Es model, while the control group followed traditional learning methods. Data was collected to analyze the interactions and learning outcomes of both groups. This comparative analysis provides insights into the efficacy of ChatGPT as a personalized learning tool and its impact on student learning outcomes. The findings from this case study contribute to our understanding of the potential benefits and limitations of using ChatGPT in educational settings and inform the future development and implementation of AI-based educational technologies. In this study, the primary research objective was to investigate the effectiveness of ChatGPT in providing personalized learning experiences. The research questions that guided this study include: How does the use of ChatGPT impact student engagement and participation? What are the effects of ChatGPT on student learning outcomes? How do students perceive the personalized learning experience facilitated by ChatGPT? By addressing these research questions, this study aims to contribute to our understanding of the potential benefits and limitations of using ChatGPT as a personalized learning tool and inform the future development and implementation of AI-based educational technologies. By addressing the existing research gaps, and providing evidence-based recommendations on the effective usage of AI-enabled tools like ChatGPT, this study has the potential to enhance the student's learning experience, particularly in the field of data science education. The paper structure provides an overview of ChatGPT and its related studies, discusses personalized learning and AI in education, introduces the 5Es model, employs a methodology to test personalized learning using ChatGPT, presents and analyzes the study results, discusses limitations and implications, and draws conclusions emphasizing the importance of ChatGPT as a resource for data science education and ethical considerations. The paper contributes to the discourse on the role of AI in education and highlights how educators can use ChatGPT to enhance student learning and engagement.

II. CHATGPT

ChatGPT is an AI-based natural language processing model developed by OpenAI and launched in November 2022. It utilizes the GPT (Generative Pretrained Transformer) architecture that employs a transformer network to generate human-like text. This model has been extensively trained on a large volume of text data, enabling it to generate responses on a wide range of questions and topics. ChatGPT has been successful in achieving state-of-the-art performance on various language tasks, including language translation, text completion, and question answering. It can be used for various applications such as chatbots, language learning tools, and text-based virtual assistants [9]. ChatGPT has revolutionized

the world of AI and chatbots and has gained popularity with people relying on it in many aspects of their lives, given its ability to mimic human-like conversations and follow up responses. The popularity of ChatGPT has been rapidly increasing over time, especially on social media platforms, where people are becoming more aware of the capabilities of AI. Since its release, ChatGPT has been inspiring people to create various AI tools, indicating the growing interest in the field of AI. As AI technology continues to advance, it is becoming increasingly important to understand ChatGPT's potential use and how to leverage its capabilities in the most effective and efficient ways possible. Biswas [10] has explored the potential use of ChatGPT in climate change research, suggesting that the model could be valuable in generating and analyzing different climate scenarios using diverse data inputs, ultimately enhancing the accuracy of climate projections. Additionally, Biswas [11] also discussed the potential use of ChatGPT in military applications, such as providing instant language translation and aiding in intelligence analysis. The model can also play a significant role in public health by supporting individuals and communities in making informed decisions about their health [12]. Numerous studies have explored the potential use of ChatGPT in education. Tlili et al. [13] conducted research on the subject, analyzing tweets to gain insights into public discussions about ChatGPT's role in education. Additionally, they conducted interviews with individuals who had used ChatGPT in an educational context and found that users considered ChatGPT to be highly valuable for revolutionizing education. However, some concerns were raised regarding its use. According to UNESCO [14], for teaching and learning ChatGPT can be used as collaboration coach, personal tutor, a study buddy and more. Furthermore, Kung et al. [15] discussed the ability of ChatGPT to perform clinical reasoning by testing its performance on questions from the United States Medical Licensing Examination (USMLE) and the potential of ChatGPT to assist in medical education. While Cooper [16] conducted a study that shows ways to use ChatGPT in science education and asked questions related to science to test ChatGPT's responses. In the realm of potential applications, Ray [17] has explored the versatility of ChatGPT across different fields. In the education sector, ChatGPT has shown promise in personalized learning, language acquisition, and test preparation. It has also demonstrated potential in domains such as healthcare, law services, content generation, programming, and marketing. The broad range of areas where ChatGPT can be utilized highlights its adaptability and the wide array of benefits it can offer across various industries. ChatGPT, like any AI technology, brings forth several challenges and ethical considerations when applied in education. One of the primary concerns is data privacy [17]. As ChatGPT interacts with students and collects data, ensuring the privacy and security of sensitive information becomes paramount. Educational institutions and developers must implement robust data protection measures to safeguard student data and comply with relevant privacy regulations. Another significant consideration is algorithmic bias. AI models like ChatGPT are trained on vast amounts of data, which can inadvertently perpetuate biases present in the training data [17] . This bias can manifest in responses or recommendations provided by ChatGPT, potentially reinforcing stereotypes or discriminatory practices. It is essential to address and mitigate algorithmic bias through careful data curation, diverse training datasets,

and ongoing monitoring of model outputs. Furthermore, over-reliance on AI without human guidance can pose challenges. While ChatGPT offers personalized learning experiences, it should not replace human teachers or mentors. The role of educators in guiding and contextualizing knowledge remains crucial. Striking a balance between leveraging AI tools like ChatGPT and maintaining human interaction and guidance is necessary for effective and holistic education.

III. RELATED WORK

In this literature, we are providing precious works, researches that discussed personalized learning and the effect of using chatbots in education. As ChatGPT is still considered to be new to its field there's not yet much case studies or researches about using it in education. However, Tlili et al. [13] conducted a study on the impact of ChatGPT on education by analyzing three stages, including tweets and interviews with teachers and students, as well as investigating user experiences. The overall findings of the study were encouraging, with positive feedback on the effectiveness of ChatGPT in revolutionizing education and providing a comprehensive understanding of complex topics in a simple language. However, the researchers also highlighted some concerns that need to be addressed to ensure ChatGPT's efficiency in education. While Cooper [16] illustrated ways where ChatGPT can be helpful to generate ideas when designing science units, rubrics, and quizzes, in his study he interacted with ChatGPT and asked questions in which he considered the answers are extraordinary however he believes that there's a lack of evidence to the answers and misleading information. And in the context of educational chatbots in general Colace et al. [6] created a EC and tested its behavior for over than 180 students especially testing behavior, keeping track of progress, and assigning tasks, in this case study researchers tested three different situations Chatbot furnishes a correct suggestion, Chatbot furnishes a correct suggestion but it does not fit with the real needs of the student, and Chatbot furnishes a wrong suggestion the result was Correct Suggestion: 133 student, Correct Suggestionn but not suitable for the needs of the student: 30 student, and Wrong Suggestion: 24 student, the students found the EC user friendly and easy to use comparing to other chatbots. Furthermore Schmulian and Coetzee [18] developed two chatbots were developed to support personalized learning by fulfilling the role of a co-teacher in finding answers to commonly asked questions. This approach was aimed at addressing some of the challenges associated with teaching large groups of students. The study revealed that the chatbots were well-received, with 72 of the respondents expressing satisfaction and even affection towards the chatbots. Additionally, the study found that many students reported higher engagement levels when interacting with the chatbots as compared to a traditional face-to-face classroom environment. According to the study by Kumar and Silva [19], they addressed the challenge of student acceptance towards chatbots for personalized learning. They created a chatbot using Telegram and the results showed a positive response. The respondents indicated that chatbots have various advantageous features such as quick responses, accessibility, mobility, user-friendliness, human-like conversation, and private interaction. The study also highlighted that chatbots could be used for personalized feedback, guidance, peer-peer assessment, critique, and communication management. These

automated attributes can lead to more effective interactions while maintaining privacy boundaries between instructors and students. The findings of the study suggest that chatbots can be a useful tool for learning, with potential future applications in education. In a study conducted by J. Pereira [20] involved creating a multiple-choice question (MCQ) chatbot to assist in the training of university students. The students were receptive to the bot and expressed interest in having similar tools integrated into other subjects. The researcher predicts that in the future, there will be a significant increase in the use of learning-oriented chatbots, which will offer personalized user experiences. Each student will have access to personal teacher assistants or learning coaches in the form of chatbots. Both ChatGPT and EC have a common foundation in personalized learning, which forms the fundamental concept of their educational approaches. I believe that personalized learning serves as the fundamental building block for both tools. According to Lee, Huh, Lin, and Reigeluth [21] believed that personalized learning is an effective approach for tailoring instruction to meet the individual needs and previous experiences of learners. This customized approach allows everyone to maximize their potential by receiving instruction that is specifically designed for them.

IV. METHODOLOGY

This research study aimed to investigate the effectiveness of ChatGPT in providing a personalized learning experience in the context of deep learning. The study employed a case study design with a mixed-methods approach, combining quantitative data from quiz results and qualitative observations. A total of 20 participants were involved in the study, comprising 10 students in the experimental group and 10 students in the control group. The participants were selected based on their interest in learning about deep learning and their varying levels of prior experience with ChatGPT. The participants were enrolled in an Internet of things class at Qassim university and had a basic understanding of machine learning concepts. The procedure consisted of the several steps, The first step was Lesson Preparation, I carefully prepared the lesson materials, ensuring that they covered the essential concepts and topics related to deep learning. The content included explanations of forward propagation, activation functions, convolutional neural networks, and network architecture. I also developed a set of multiple-choice quiz questions to assess the participants' understanding and knowledge. After preparing the lesson I instructed ChatGPT to provide tailored instructions and explanations to each student from the experimental group, based on their individual learning needs and prior knowledge. Drawing inspiration from Cooper [16], the researcher developed a teaching unit based on the 5Es Model, which served as the foundation for creating an automated lesson using this approach. The effectiveness of the 5Es Model was further supported by the findings of Sibel et al. [22], who demonstrated its positive impact in a relevant case study. As a result, the lessons were meticulously designed, aligning with the structure and principles of the 5Es Model, which involved engaging the students, exploring the concepts, explaining the principles, elaborating on the ideas, and evaluating their understanding. Throughout this process, ChatGPT assumed a pivotal role as a virtual assistant, actively supporting the students by addressing their queries, presenting pertinent examples, and guiding them throughout their learning

journey. Next stage Control Group, The control group received traditional instruction from a teacher who followed a standardized curriculum for teaching deep learning. The teacher delivered the content through lectures, and practical exercises, following a well-established approach to teaching the subject matter. The control group followed a structured lesson plan that aligned with the curriculum and did not involve the use of ChatGPT. After completing the lessons, both the experimental and control groups were given the same multiple-choice quiz. The quiz assessed the participants' understanding of deep learning concepts and their ability to apply the knowledge they had acquired. The quiz questions covered topics such as forward propagation, activation functions, convolutional neural networks, and network architecture. The quiz was administered in a controlled environment to ensure consistency across both groups. The last stage of the study is Data Collection and Analysis, The quiz results were collected and analyzed to compare the performance between the experimental and control groups. Quantitative analysis involved assessing the scores and identifying any significant differences in the performance of the two groups. The data from the quiz provided insights into the effectiveness of ChatGPT in facilitating personalized learning experiences in comparison to traditional instruction. Additionally, qualitative observations were made during the lessons to gather insights into the participants' engagement, interaction, and overall learning experience.

V. RESULT

A. Analysis of 5ES Model Implementation

Generally speaking, The analysis of the case study highlights both the advantages and limitations of using ChatGPT to guide students through the 5Es model. Despite some limitations, the 5Es model proved to be an effective framework for student engagement and learning. One of the limitations observed was that ChatGPT occasionally provided incorrect evaluations of the students' answers during the evaluation phase. This indicates a need for caution and verification when relying solely on ChatGPT's feedback. However, the 5Es model served as an effective guide for students. It helped structure the learning process and provided a clear framework for students to follow. The sequential progression through the engagement, exploration, explanation, elaboration, and evaluation phases allowed students to have a comprehensive learning experience. The personalized nature of ChatGPT as a tool was particularly beneficial. It served as a virtual co-teacher, offering guidance and support tailored to each student's needs. This individualized approach helped foster a sense of ownership and agency in the learning process. The quiz results played a significant role in reflecting the students' experience. Some students were able to answer all the quiz questions correctly, indicating that they successfully grasped the concepts and information provided by ChatGPT. However, there were instances where students made errors or skipped questions, suggesting the need for further clarification or reinforcement in certain areas. The integration of the 5Es model as a guide alongside ChatGPT was particularly valuable, especially considering that a majority of the students were unfamiliar with ChatGPT initially. The 5Es model provided structure and support, ensuring that students had a consistent and cohesive learning experience. The students who had prior

familiarity with ChatGPT had a more positive experience overall. Nevertheless, it was important to have teacher supervision to ensure smooth progress and address any errors or deviations from the 5Es model that ChatGPT occasionally encountered. In certain instances, ChatGPT would repeat certain steps or omit them, necessitating the intervention of a teacher to correct and realign the learning process. In Fig. 1 of the lesson, it can be observed that ChatGPT progressed to the next step of the 5Es framework after the student joined the conversation and completed the first E. Subsequently, ChatGPT followed the same pattern for the subsequent E, as depicted in Fig. 2.
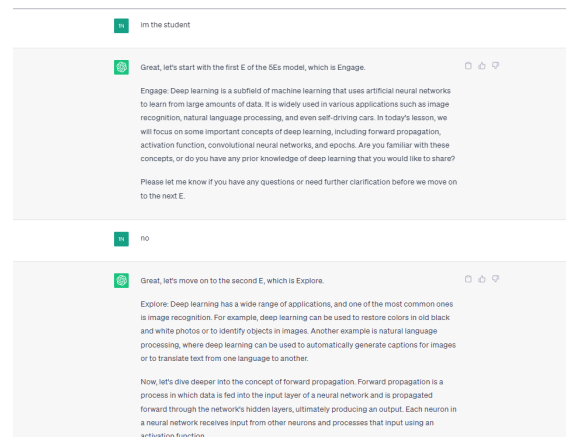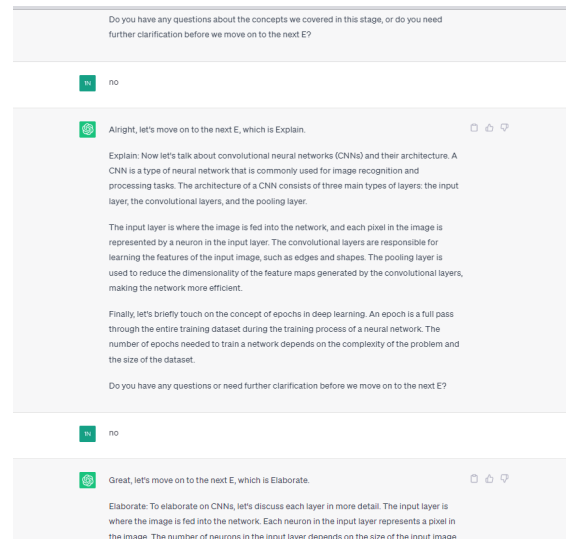

Fig. 1. ChatGPT lesson - Part 1.

Fig. 2. ChatGPT lesson - Part 2.

In the final stage of the lesson, which was the Evaluate phase, ChatGPT effectively implemented it as a multiple-choice question (MCQ), following the instructions provided at the beginning of the lesson as shown in Fig. 3.

B. Analysis of Control Group by Teaching Traditional Way

The analysis of the control group's performance reveals important insights. Initially, the majority of students demonstrated a good understanding of the topic, as indicated by their correct
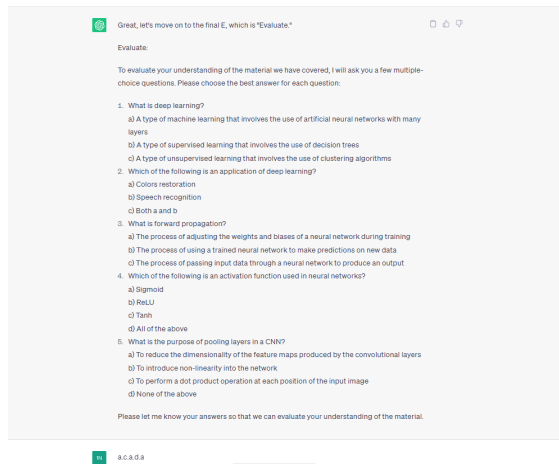
Fig. 3. ChatGPT evaluation quiz.

responses to the first question. However, there was a decline in the number of correct responses in subsequent questions, suggesting a potential decrease in comprehension over time. This raises concerns about the long-term retention of the material taught through traditional teaching methods, indicating that students may struggle to retain and apply the information beyond the immediate context. Furthermore, the varying number of correct responses across questions highlights differences in students' comprehension levels for different topics or concepts, emphasizing the need for further investigation and targeted teaching strategies. The presence of incorrect responses also signifies that the traditional teaching method may not effectively address the learning needs of all students, necessitating the exploration of alternative instructional approaches catering to diverse learning styles and abilities. These findings suggest that the traditional method of teaching has limitations in terms of long-term knowledge retention and ensuring uniform comprehension among students. To overcome these limitations, it is crucial to explore innovative teaching methods, incorporate active learning strategies, and provide personalized support to enhance student engagement and understanding. Further research and analysis are necessary to deepen our understanding of the effectiveness of traditional teaching methods and compare them with alternative approaches, ultimately leading to improved learning outcomes and student success.

VI. DISCUSSION

The discussion in this study involved the qualitative analysis of the results from two groups, namely the experimental group and the control group, to examine the function of ChatGPT as an AI assistant in facilitating personalized learning experiences for students. While there are alternative approaches and methods that can be explored in future studies, our focus was on utilizing the 5Es model to address our research questions.

A. How Does the use of ChatGPT Impact Student Engagement and Participation?

The integration of ChatGPT in the experimental group, guided by the 5Es model, positively impacted student engagement and participation. The personalized nature of ChatGPT as a virtual co-teacher provided individualized guidance and support to students, fostering a sense of ownership and agency in the learning process. This individualized approach helped increase student engagement as they received tailored feedback and support, leading to active participation throughout the learning activities. The structured framework of the 5Es model, combined with ChatGPT's assistance, facilitated a more interactive and engaging learning environment for the students.

B. What are the Effects of ChatGPT on Student Learning Outcomes?

The implementation of ChatGPT alongside the 5Es model resulted in positive effects on student learning outcomes. The quiz results showed that a significant number of students in the experimental group were able to answer the questions correctly, indicating successful comprehension of the concepts and information provided by ChatGPT. The sequential progression through the engagement, exploration, explanation, elaboration, and evaluation phases of the 5Es model allowed students to have a comprehensive learning experience. The personalized guidance and support from ChatGPT contributed to improved learning outcomes by addressing individual learning needs, reinforcing understanding, and providing opportunities for active application of knowledge.

C. How do Students Perceive the Personalized Learning Experience Facilitated by ChatGPT?

The students in the experimental group perceived the personalized learning experience facilitated by ChatGPT positively. ChatGPT served as a virtual co-teacher, offering tailored guidance and support, which helped students feel supported and encouraged throughout the learning process. The individualized approach enhanced their learning experience, allowing them to progress at their own pace and receive immediate feedback. Students appreciated the interactive nature of ChatGPT and the opportunity to engage in dialogue with an AI-powered assistant. The integration of the 5Es model alongside ChatGPT provided a structured and cohesive learning experience, which students found beneficial in terms of clarity and organization.

Overall, the analysis suggests that the use of ChatGPT positively impacts student engagement, learning outcomes, and perception of personalized learning experiences. The integration of ChatGPT alongside the 5Es model provides an effective framework for student engagement, fosters active participation, enhances learning outcomes, and supports students in their individual learning journeys. However, it is important to acknowledge some limitations in this study. Firstly, the sample size of the experimental group may be relatively small, limiting the generalizability of the findings. Additionally, the study primarily focuses on short-term effects, and further research is needed to assess the long-term impact of ChatGPT on student learning and retention. Moreover, the reliance on technology and the potential for technical issues or errors in ChatGPT's feedback pose challenges that need to be considered. Despite these limitations, the findings highlight the promising potential of ChatGPT as a tool for enhancing student engagement and learning outcomes in the educational setting.

VII. Conclusions

This study employed a qualitative approach to investigate the effectiveness of ChatGPT, a chatbot tool, in education, particularly in the context of technology and personalized learning. By conducting a study consisting of two groups, namely the experimental group implementing the 5Es model with ChatGPT and the control group using traditional teaching methods, the analysis sheds light on the efficacy of different approaches in promoting student engagement, learning outcomes, and personalized learning experiences. The integration of ChatGPT with the 5Es model in the experimental group proved to be effective in engaging students and providing a structured learning experience. The sequential progression through the model's phases facilitated comprehensive learning, with ChatGPT serving as a valuable virtual co-teacher that enhanced student engagement and agency. However, the occasional incorrect evaluations by ChatGPT necessitated teacher supervision to ensure a smooth learning process. In contrast, the control group's traditional teaching method exhibited limitations in terms of knowledge retention and uniform comprehension. The declining trend in correct responses across questions indicated potential challenges in long-term retention, emphasizing the need for alternative instructional approaches and personalized support to accommodate diverse learning styles and abilities. These findings underscore the importance of exploring innovative teaching methods, incorporating active learning strategies, and providing personalized support to enhance student engagement and understanding. Further research is necessary to gain deeper insights into the effectiveness of traditional teaching methods compared to alternative approaches and to identify the most effective instructional strategies for improving learning outcomes and student success. In conclusion, the integration of ChatGPT with the 5Es model demonstrated promise in terms of engagement, structure, and individualized support, while the traditional teaching method highlighted the need for improvements in knowledge retention and comprehension. These findings contribute to the ongoing conversation about enhancing teaching and learning practices, ultimately aiming to create meaningful and effective educational experiences for students.

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