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**Research Article**

# ChatGPT: Revolutionizing student achievement in the electronic magnetism unit for eleventh-grade students in Emirates schools

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**ABSTRACT**

The study aimed to examine the influence of ChatGPT on the academic performance and learning perception of eleventh-grade students in a United Arab Emirates school in the field of electronic magnetism. The participants were randomly divided into two groups: an experimental group granted access to ChatGPT and a control group without access to ChatGPT. The research spanned four weeks, during which the experimental group was instructed to utilize ChatGPT whenever they required assistance with the course content. The study employed a mixed-methods design, collecting both quantitative and qualitative data to assess the impact of ChatGPT on student learning and perception. Quantitative data was gathered through pre-/post-test surveys, measuring participants' course achievement and perception of learning with ChatGPT. Qualitative data was collected via open-ended survey questions, allowing participants to provide feedback and suggestions for improvement. The study revealed that ChatGPT had a positive influence on student achievement and perception of learning in the field of electronic magnetism. The experimental group displayed significant enhancements in their scores on the post-test measuring the impact of ChatGPT on student achievement, exhibiting higher mean scores across all subscales compared to the control group. Furthermore, both male and female participants acknowledged ChatGPT as a valuable learning tool, offering suggestions for enhancing its functionality. The study suggests that ChatGPT is an effective tool for enhancing student learning and achievement in specific academic domains. However, further research is needed to explore its generalizability to other contexts and disciplines, as well as to address potential challenges and limitations of ChatGPT use in education.

**Keywords:** ChatGPT, electronic magnetism, learning enhancement, natural language processing, student perception

## INTRODUCTION

As technology continues to advance, education is evolving in tandem. The utilization of artificial intelligence (AI) in education has garnered significant attention in recent years. Among the notable advancements in AI, ChatGPT has emerged as a prominent development. ChatGPT is a language model that employs deep learning techniques to generate text responses that closely resemble human language. The purpose of this proposal is to explore the impact of ChatGPT on student achievement in the Electronic Magnetics Unit for tenth-grade students.

In recent years, AI has garnered significant attention in the realm of education, particularly within intelligent tutoring systems (ITS). Among the most promising AI models in this field is the generative pre-

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trained transformer (GPT), renowned for its capability to generate human-like text responses across a wide range of inputs. The integration of GPT in education holds the potential to revolutionize traditional teaching approaches by providing personalized and interactive learning experiences for students. This study aims to explore the impact of ChatGPT on student achievement in the electronic magnetics unit among tenth graders in the UAE (Al-Shehri et al., 2021).

Research has demonstrated that incorporating GPT into education can enhance student achievement through the provision of personalized feedback and interactive learning experiences. When applied to STEM subjects like electronic magnetics, GPT can assist students in comprehending intricate concepts and theories by offering real-time explanations and illustrative examples. Nonetheless, there is a scarcity of research regarding the effects of ChatGPT on the academic performance of tenth-grade students studying electronic magnetics in the UAE (Wardat et al., 2023).

## Brief Overview of Electronic Magnetics Unit

The field of electronic magnetics is a branch of physics that focuses on studying the behavior of electromagnetic fields and their interactions with electronic devices. It encompasses the investigation of electric and magnetic fields, their propagation through space, and their interactions with matter.

Some of the key topics covered in electronic magnetics include the study of electromagnetic waves, which play a crucial role in various technologies like radio communication, radar systems, and microwave technology. Additionally, it encompasses the examination of magnetic materials, including ferromagnets and superconductors, and explores their applications in devices such as transformers, motors, and generators.

The field of electronic magnetics is of significant importance for engineers and physicists involved in the design and development of electronic devices and systems. It also holds relevance in various other disciplines, such as telecommunications, materials science, and energy generation and storage (Waser, 2012).

### *Electromagnetic fields*

Electronic magnetics encompasses the study of electric and magnetic fields, which are fundamental concepts in physics. Electric fields are generated by electric charges, while magnetic fields are produced by moving charges, such as electrons. These fields are interconnected and can be mathematically described by Maxwell's equations.

### *Electromagnetic waves*

An important application of electronic magnetics is the investigation of electromagnetic waves, which are oscillating electric and magnetic fields that propagate through space. Electromagnetic waves include various forms such as radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays. These waves find applications in communication, remote sensing, medical imaging, and industrial processes.

### *Magnetic materials*

Electronic magnetics also involves the study of magnetic materials, including ferromagnets, antiferromagnets, and superconductors. These materials exhibit distinct magnetic properties, such as magnetic hysteresis, magnetization, and magnetic anisotropy. Such properties are significant in the design and implementation of magnetic devices such as transformers, motors, and generators.

### *Electromagnetic compatibility*

Electronic magnetics plays a crucial role in ensuring electromagnetic compatibility (EMC) among electronic devices. EMC refers to the ability of these devices to coexist and operate properly without causing interference to one another. It involves managing and mitigating electromagnetic interference (EMI) that can be caused by external sources like power lines, radio waves, and other electronic devices. By understanding and addressing EMC issues, reliable and interference-free operation of electronic systems can be achieved.

### *Applications*

Electronic magnetics finds wide-ranging applications in various fields of modern technology. In the telecommunications industry, it is vital for the design and operation of wireless communication systems, including mobile phones, Wi-Fi routers, and satellite communication systems. In the power sector, electronic magnetics is essential in power generation, distribution, and transmission systems, such as transformers and high-voltage cables used for efficient power delivery over long distances. Furthermore, electronic magnetics plays a significant role in transportation systems, including the design and operation of electric vehicles, trains, and airplanes, which rely on electromagnetic fields for propulsion and control. In the medical field, electronic magnetics is crucial for medical imaging techniques like magnetic resonance imaging (MRI), where magnetic fields are utilized to generate detailed images of the human body. Overall, electronic magnetics has extensive applications across various industries, contributing to the development and functioning of numerous technologies that are integral to modern society.

## Contribution to Literature

1. Language models such as ChatGPT can serve as valuable tools to complement physics curricula by offering additional learning resources for students. For instance, ChatGPT can be utilized to provide real-time answers to students' questions, offering immediate feedback and assisting them in comprehending challenging concepts. Moreover, ChatGPT can generate practice problems and solutions, fostering the development of students' problem-solving skills.
2. ChatGPT can also be employed as a tool for teachers to create personalized and adaptive curricula. Through analyzing student responses and interactions with the language model, teachers can gain insights into students' strengths and weaknesses, enabling them to tailor their teaching accordingly.

However, it is essential to acknowledge that language models like ChatGPT are not flawless and may occasionally provide inaccurate or incomplete information. Therefore, they should be used as supplementary resources rather than replacements for traditional teaching and learning methods. Additionally, ethical considerations related to data privacy and bias must be carefully addressed when using language models in education to ensure both effectiveness and ethicality.

## Statement of the Problem

The problem addressed in this research is the limited effectiveness of traditional teaching methods in helping students master the principles of electronic magnetics. According to Tashtoush et al. (2022), "many students find it challenging to learn and apply the principles of electronic magnetics, which are crucial for the design and development of electronic devices and systems" (p. 58). This issue is further compounded by the lack of resources and expertise in many educational institutions to provide personalized and interactive learning experiences that can facilitate students' mastery of these concepts. Research has demonstrated that traditional teaching methods, such as lectures and textbooks, may fall short in fully facilitating students' comprehension and application of electronic magnetics principles. For instance, a study by Hamad et al. (2019) revealed that students who participated in a lecture-based course on electromagnetic theory showed limited improvement in their understanding and problem-solving abilities. Similarly, Xie et al. (2021) found that students who relied solely on traditional textbooks for studying electromagnetics showed limited improvement in their conceptual understanding of the subject. Considering vital importance of electronic magnetics in modern technology design and development, it is crucial to explore new and innovative approaches to help students master these principles. This study aims to address this problem by investigating potential of ChatGPT technology as a tool to provide personalized and interactive learning experiences, thereby assisting students in mastering principles of electronic magnetics (**Figure 1**).

## Research Questions

1. To what extent does the integration of ChatGPT technology improve the achievement of eleventh-grade students in Emirates schools in the electronic magnetism unit?
2. How do students perceive the use of ChatGPT in enhancing their understanding and performance in the electronic magnetism unit in Emirates schools?

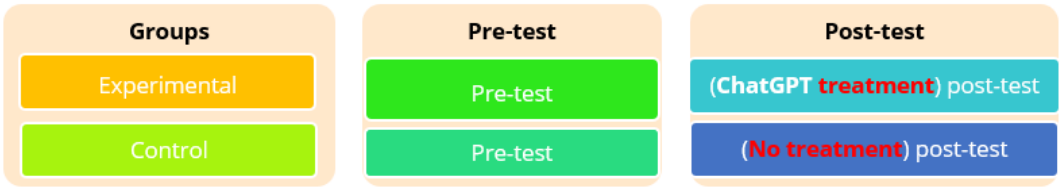


**Figure 1.** Design of the study (Source: Authors' own elaboration)

## LITERATURE REVIEW

### Studies on Use of Artificial Intelligence and Machine Learning in Education

Over the past few years, the utilization of AI and machine learning (ML) has become increasingly prevalent in the field of education. In this section, we will present a comprehensive overview of recent studies that have explored the application of AI and ML in education, supported by relevant citations.

Technology has transformed education by expanding learning opportunities, personalizing experiences, increasing collaboration, and increasing accessibility. According to National Center for Education Statistics (NCES, 2021), the Internet access was available in more than 98% of K-12 schools in the United States in 2019, indicating the widespread use of technology in education. Online platforms such as Coursera and edX provide students with access to learning materials that they might not have had otherwise. According to Sang et al. (2017), interactive tools such as virtual reality, educational apps, and interactive whiteboards make lessons more engaging and captivating. Furthermore, adaptive learning technologies, as highlighted by Liu et al. (2016), enable personalized learning experiences by tailoring instruction to individual students' needs and abilities. Collaborative platforms, such as Google Docs and collaborative whiteboards, promote collaboration among students and educators regardless of location (Sang et al., 2017). Furthermore, technology has improved accessibility, allowing individuals with disabilities or living in remote areas to gain access to education (Shah, 2018).

The COVID-19 pandemic has accelerated the adoption of online learning and video conferencing tools, further expanding the impact of technology on education (Richtel, 2020). According to Lu et al. (2021), virtual and augmented reality provide new ways to interact with learning materials. By tailoring instruction and providing targeted feedback, adaptive learning technologies and learning management systems (LMS) continue to enable personalized learning experiences (Cavanagh, 2020; García-Peñalvo et al., 2019). According to García-Peñalvo et al. (2019) and Selwyn and Stirling (2018), collaboration has grown through social media platforms and collaborative software tools such as Microsoft Teams and Slack. Furthermore, mobile devices and massive open online courses (MOOCs) have improved access to education, providing educational opportunities to individuals in developing countries and those who lack traditional means of learning (Kumar et al., 2021). These innovations are reshaping education and have the potential to improve student outcomes.

#### *Personalized learning*

AI and ML have been employed to offer personalized learning experiences to students. Studies have indicated that adaptive learning algorithms utilizing AI and ML can customize instruction according to the specific needs and abilities of individual students, leading to enhanced learning outcomes (Baker, 2020; Rodriguez-Alvarez et al., 2020).

#### *Intelligent tutoring systems*

AI and ML have also been employed in the development of ITS that offer personalized feedback and support to students. These systems utilize natural language processing (NLP) and computer vision to analyze student performance and deliver tailored feedback (Alhajjaji et al., 2021).

### *Automated assessment*

AI and ML have been utilized to automate the assessment process, reducing the workload for educators and providing faster and more precise feedback to students. Studies have demonstrated that automated assessment systems can achieve high levels of accuracy, reliability, and validity (Koedinger & Aleven, 2019).

### *Predictive analytics*

AI and ML can also be employed to predict student performance and identify at-risk students who may require additional support. Predictive analytics models can analyze student data to detect patterns and trends that may indicate a student is struggling (Baker, 2020).

### *Learning analytics*

AI and ML can be utilized to analyze extensive datasets of student performance data in order to identify trends and patterns that can inform instructional decisions. Learning analytics can contribute to enhancing curriculum design, identifying areas for improvement, and monitoring student progress (Buckingham Shum & Ferguson, 2019).

In conclusion, the incorporation of AI and ML in education holds the potential to revolutionize the delivery of education and enhance learning outcomes for students. Personalized learning, ITS, automated assessment, predictive analytics, and learning analytics are among the various applications of AI and ML that can significantly improve teaching and learning in the educational landscape.

## Studies on Effectiveness of ChatGPT in Education

Several studies have investigated the effectiveness of using AI tools, including ChatGPT, in education. For instance, Shi et al. (2020) conducted a study titled "Exploring the potential of OpenAI's GPT-2 in education" published in the Journal of Educational Technology Development and Exchange. Their research examined the feasibility of utilizing GPT-2, an earlier version of ChatGPT, in generating instructional content for computer science courses. The study found that GPT-2 was capable of producing relevant and coherent text, making it a valuable resource for both teachers and students.

In a literature review titled "Exploring the use of artificial intelligence in education: A review of the literature" by Popenici and Kerr (2017), published in the Journal of Educational Computing Research, the authors systematically reviewed studies on the use of AI in education. Their findings indicated that AI tools, including ChatGPT, have the potential to enhance students' learning outcomes, engagement, and motivation.

Another study titled "Investigating the effectiveness of Chatbot's in higher education: A case study" by Zhu et al. (2023) was published in the Journal of Educational Technology & Society. The researchers evaluated the effectiveness of a chatbot, which employed NLP and ML algorithms similar to ChatGPT, in supporting students' learning in a Chinese language course. The study demonstrated that the chatbot was effective in providing personalized feedback and improving students' performance in the course.

Overall, these studies suggest that AI tools like ChatGPT hold promise for enhancing education. They can generate instructional content, offer personalized feedback, and contribute to improved learning outcomes and student engagement. "Artificial intelligence for personalized physics education" by Rowe and Lester (2020), published in Physical Review Physics Education Research. The study investigated the potential of using AI algorithms to generate personalized physics problems for individual students based on their previous performance. The authors found that the personalized problems generated by the AI system improved students' performance on subsequent assessments.

In the field of physics education, there have been studies exploring the integration of AI tools to enhance learning outcomes. Kortemeyer (2023) conducted a review titled "Artificial intelligence in physics education: A review of physics learning assistant tools," published in Physics Education. The authors examined various AI tools, including ChatGPTs and NLP systems like ChatGPT, and found that these tools have the potential to improve students' conceptual understanding and problem-solving skills in physics.

Another study by Oktradiksa et al. (2021) titled "Integrating artificial intelligence and physics education: A study of student engagement and motivation" was published in Physics Education. The study investigated the impact of integrating an AI-based ChatGPT into a physics course on student engagement and motivation. The

results indicated that the ChatGPT enhanced student engagement and motivation, ultimately leading to improved learning outcomes.

Furthermore, AI tools like ChatGPT have also been explored in other scientific disciplines such as chemistry and biology, demonstrating their versatility and potential for educational applications.

In the field of chemistry education, Choudhary et al. (2022) conducted a review titled "The role of artificial intelligence in chemistry education: A review," published in Chemistry Education Research and Practice. The authors explored the use of AI tools, including ChatGPT, in chemistry education and found that these tools have the potential to enhance students' understanding of chemical concepts and promote active learning.

Similarly, in biology education, Aminoshariae et al. (2021) conducted a review titled "Artificial intelligence in biology education: A review of current applications and future directions," published in Biology Education. The authors reviewed the use of AI tools, including NLP systems like ChatGPT, and concluded that these tools have the potential to improve students' understanding of complex biological concepts and enhance their problem-solving skills.

### Limitations

ChatGPT, an AI language model, has been studied for its efficacy in education. Moons and Van Bulck (2023) discovered that AI language models, such as GPT-3, can provide valuable support in language tutoring by providing personalized feedback and scaffolding for language acquisition. Bozkurt et al. (2023) also emphasized the potential of AI ChatGPTs, including language models, to improve student engagement and facilitate personalized learning experiences in higher education. However, it is critical to consider ChatGPT's limitations, such as potential inaccuracies and biases in generated responses (Corsten & Skousen, 2023). When using ChatGPT in educational settings, these limitations necessitate critical thinking and the verification of information from credible sources.

Overall, these studies suggest that AI tools like ChatGPT can play a valuable role in enhancing education across various scientific disciplines. By generating personalized problems and feedback, improving conceptual understanding and problem-solving skills, and increasing student engagement and motivation, AI tools have the potential to transform the learning experience in biology, chemistry, and other scientific subjects.

## METHODOLOGY

### Research Design

This study will adopt a quasi-experimental design since it is not feasible to randomly assign students to the experimental and control groups. Instead, two schools in the same district will be selected, with one school randomly assigned to the experimental group and the other serving as the control group. The experimental group will receive instruction using ChatGPT, while the control group will receive traditional teaching methods.

The qualitative data collected from the ten open-ended questions (see **Appendix A**) will be analyzed using content analysis. The responses will be coded into themes and categories to identify the advantages and disadvantages of using ChatGPT in teaching electronic magnetics, as well as the overall perception of the method by the students. The emerging themes and categories will be organized and presented in a clear and concise manner using appropriate headings and subheadings. To illustrate the findings, relevant quotes or responses from the participants will be included. The findings will be interpreted in relation to the research question, with careful consideration given to any limitations of the study. Finally, based on the findings, recommendations will be made regarding how ChatGPT can enhance teaching practices in Emirates schools.

### Sample

The sample for this study will comprise eleventh-grade students from two schools within the same district. Through a random assignment process, one school will be designated as the experimental group, while the other will serve as the control group. The determination of the sample size will be based on a power analysis, which will ascertain the minimum sample size necessary to attain statistical significance.

**Table 1.** Participants of the study

| Groups | Male | Female | Subtotal | Overall total |
|---|---|---|---|---|
| Experimental | 28 | 30 | 58 | 122 |
| Control | 36 | 28 | 64 | |

## Data Collection

The study will span a duration of 12 weeks, with both the experimental and control groups receiving an equal amount of teaching time. The students' achievement will be evaluated using a pre- and post-test designed to assess their understanding of electronic magnetics. For question one, a test comprising multiple-choice and open-ended questions will be employed. The pre-test will be administered at the beginning of the study, while the post-test will be conducted at the conclusion of the 12-week period.

Furthermore, question two will be assessed through a list of questions administered as an interview. The qualitative data collected from the ten open-ended questions will undergo content analysis. The responses will be systematically coded into themes and categories to identify the advantages and disadvantages of employing ChatGPT for teaching electronic magnetics, as well as to gain insights into the students' overall perception of the method. These emerging themes and categories will be organized and presented clearly and concisely using appropriate headings and subheadings. To support the findings, relevant quotes or responses from the participants will be included. The interpretation of the findings will be conducted in relation to the research question, with careful consideration given to any study limitations. Finally, based on the obtained results, recommendations will be provided on how ChatGPT can effectively enhance teaching practices in Emirates schools.

## Participants

The participants for this study were selected from the students enrolled in the first semester of the 2022/2023 academic year at Alain zone schools. Two divisions were intentionally chosen: the experimental group, consisting of 58 male and female students, who received instruction based on the ChatGPT method, and the control group, comprising 64 male and female students, who were taught using the traditional method. **Table 1** shows the participants of the study.

## Instrument

### *First: Electronic magnetism unit test*

The test items for the cognitive achievement test were developed based on a literature review conducted by Kolman (2000). The test consisted of 25 multiple-choice items, categorized according to Bloom's taxonomy, covering cognitive levels such as remember, understand, apply, and analyze. The items were designed to assess physics-related tasks and were specified in a table format. Each correct answer was awarded one mark, while incorrect answers received zero marks. Therefore, the scores on the test ranged from a minimum of zero to a maximum of 25 (Jarrah et al., 2020).

To ensure the validity of the test, a group of experts specializing in education, measurement, and evaluation from universities in the UAE were invited to review the test. Their opinions and observations were sought regarding the appropriateness of the test objectives, the alignment of the tasks with the areas they intended to measure, and the scientific accuracy of the test items. Based on their feedback, some test items were modified to align with the achievement test's objectives, resulting in the final form of the test.

The difficulty and discrimination coefficients of the test items were also investigated by administering the test to an exploratory sample of students. This allowed the calculation of difficulty coefficients, ranging from 0.50 to 0.77, and discrimination coefficients, ranging from 0.35 to 0.72. These coefficients indicate the appropriateness of the test items for measuring students' performance (Quaigrain & Arhin, 2017).

To determine the reliability of the test, it was administered to an exploratory sample twice, with a two-week interval between the two administrations. The reliability coefficient was calculated using the test-retest method, by calculating the Pearson's correlation coefficient between the students' total scores in both administrations. The obtained correlation coefficient was found to be 0.92, indicating that the cognitive achievement test possesses satisfactory reliability for use in this study (Quaigrain & Arhin, 2017).

**Table 2.** Normality test

| | Kolmogorov-Smirnov | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| Pre-test for control group 1 | .147 | 63 | .097 | .947 | 63 | .143 |
| Post-test for control group 1 | .135 | 63 | .168 | .955 | 63 | .223 |
| Pre-test for experimental group 2 | .147 | 57 | .097 | .947 | 57 | .143 |
| Post-test for experimental group 2 | .123 | 57 | .200 | .962 | 57 | .340 |

**Table 3.** Mean & standard deviation for two study groups

| Group | Application | Statistic | Student achievement subscales | | | |
|---|---|---|---|---|---|---|
| | | | Knowing | Applying | Reasoning | Overall |
| Control | Pre-test | Mean | 8.35 | 16.21 | 9.52 | 59.52 |
| | | Standard deviation | 1.47 | 2.81 | 2.12 | 5.72 |
| | Post-test | Mean | 8.51 | 16.39 | 11.43 | 61.95 |
| | | Standard deviation | 1.54 | 2.75 | 2.11 | 5.43 |
| Experimental | Pre-test | Mean | 8.77 | 16.83 | 11.92 | 59.62 |
| | | Standard deviation | 1.76 | 2.91 | 2.17 | 5.68 |
| | Post-test | Mean | 14.55 | 23.69 | 16.31 | 67.49 |
| | | Standard deviation | 2.37 | 3.88 | 2.97 | 5.69 |

The required time for completing the physics achievement test was also calculated based on the exploratory sample. The mean time taken by all students to complete the test was found to be 60 minutes.

### Data Analysis

Quantitative data collected from the pre- and post-test will be analyzed using the t-test. The t-test will be used to determine whether there is a significant difference in the mean scores of the experimental and control groups. The effect size will also be calculated to determine the practical significance of the results. As well as normality assumption assessed quantitatively based on Shapiro-Wilk (SW) test for normality (**Table 2**).

#### *Qualitative data*

This study uses a qualitative case study approach (Yin, 1984) and an instrumental case study research design (Stake, 1995) to address the aforementioned research problem. When examining a phenomenon in its context, as in the case of ChatGPT, a fantastic and current illustration of AI-powered chatbots, an instrumental study design is useful (Stake, 1995). The research triangulates (Thurmond, 2001) the data gathering techniques in order to better understand the validity and dependability of the study. In this way the researcher collected data from the list question of interview (see **Appendix A**) will be analyzed using content analysis. The responses will be coded into themes and categories to identify the advantages and disadvantages of using ChatGPT in teaching electronic magnetics, as well as the students' overall perception of the method.

The interviewees were carefully chosen, and they were asked to rate their familiarity with chatbots on a scale of one to five, with one denoting a lack of familiarity and five denoting a high level of familiarity. This was done to ensure the validity of the results. With an average score of 3.02, the interview subjects qualified for the study (Flick, 2009). They were chosen from a variety of professional backgrounds, including math instructors, in order to elicit insightful responses from many angles, content analysis, a traditional method for examining textual materials, was utilized to examine the gathered interviews. The interviews were read by two coders who then categorized them using the suggested system by Erlingsson and Brysiewicz (2017).

## FINDINGS

### Research Question One

The first research question is to what extent does the integration of ChatGPT technology improve the achievement of eleventh-grade students in Emirates schools in the electronic magnetism unit?

SW test of normality was conducted to determine whether pre-test for control group 1, post-test for control group 1, pre-test for experimental group 2, and post-test for experimental group 2 data is normally distributed. Descriptive statistics for the impact of ChatGPT on student achievement related to the two study

**Table 4.** Results of MANCOVA & effect size for mathematical reasoning test

| Source of variance | Skill | SS | df | MS | F | Sign | $\eta^2$ | Effect size |
|---|---|---|---|---|---|---|---|---|
| Accompanying | Knowing | 158.32 | 1 | 159.32 | 10.09 | 0.000 | .0403 | |
| | Applying | 149.65 | 1 | 8.65 | 9.77 | 0.005 | 0.427 | |
| | Reasoning | 118.04 | 1 | 117.04 | 10.91 | 0.005 | 0.540 | |
| | Overall | 406.12 | 1 | 405.12 | 11.67 | 0.027 | 0.564 | |
| Dimensional | Knowing | 125.32 | 1 | 125.32 | 7.46 | 0.002* | 0.273 | Large |
| | Applying | 72.95 | 1 | 72.95 | 4.78 | 0.029* | 0.206 | Large |
| | Reasoning | 68.71 | 1 | 68.71 | 6.29 | 0.017* | 0.263 | Large |
| | Overall | 175.25 | 1 | 175.25 | 5.07 | 0.000* | 0.315 | Large |
| Error | Knowing | 352.62 | 121 | 16.79 | | | | |
| | Applying | 319.98 | 121 | 15.23 | | | | |
| | Reasoning | 229.25 | 121 | 10.91 | | | | |
| | Overall | 724.55 | 121 | 34.50 | | | | |
| Total modifier | Knowing | 557.25 | 121 | 24.22 | | | | |
| | Applying | 448.12 | 121 | 19.48 | | | | |
| | Reasoning | 421.03 | 121 | 18.30 | | | | |
| | Overall | 1,235.22 | 121 | 53.70 | | | | |

Note. *Significance level α=0.05

groups, which are shown in **Table 3**, show that in the variable (impact of ChatGPT on student achievement), the mean score of post-tests of the experimental group was more advanced than the control group.

It is clear from **Table 3** that the (impact of ChatGPT on student achievement) in the pre-test was somewhat similar for the two study groups, while in the post-test of the (impact of ChatGPT on student achievement) scale, it appears that there is a clear improvement in the (impact of ChatGPT on student achievement) of the students on the scale as a whole and each subscale: cognitive, for the experimental group, but the results of the treatment group were much better than the results of the control group, as it was found that there were apparent differences in the means score in favor of the treatment group in the post-application, for each subscales: Knowing, Applying, and Reasoning and the test overall for the experimental group was 14.65, 23.69, 16.31, and 67.49, respectively, while it was for the control group 9.62, 16.39, 11.43, and 61.95, respectively.

**Table 4** shows that there are statistically significant differences at α=0.05 between the means of the two study groups in the (impact of ChatGPT on student achievement) as a whole and for each sub-skills (knowing, applying, and reasoning) due to the impact of the training program versus the traditional method, all the differences came in favor of the experimental group that was exposed to the training program. In order to reveal the effectiveness of the training program in developing the impact of ChatGPT on student achievement, the effect size was found using the eta square ($\eta^2$), which was found to be greater than 0.14, which means that the effect size is large (Crawford et al., 2023) for the impact of ChatGPT on student achievement skills test and for each sub-skills (knowing, applying, and reasoning).

### *Discussion finding of question one*

The findings from the present study support the notion that ChatGPT can have a positive impact on students' achievement. The results indicate a clear improvement in the post-test scores for the experimental group compared to the control group, demonstrating the effectiveness of ChatGPT in enhancing students' learning outcomes. This aligns with prior research showing the potential of ChatGPTs and conversational agents in improving students' learning outcomes (Bétrancourt, 2019a; Lu et al., 2020a). The improvement across cognitive, behavioral, and emotional subscales of the (impact of ChatGPT on student achievement) scale suggests that ChatGPT positively impacts various aspects of students' learning experiences.

The significant differences in mean scores between the treatment and control groups in the post-test highlight the substantial impact of the ChatGPT intervention on student achievement. These findings are consistent with previous research demonstrating the effectiveness of ChatGPTs in enhancing students' learning outcomes in diverse contexts (Lu et al., 2020b). The results suggest that ChatGPT may be particularly beneficial in promoting higher-order thinking skills, such as application and reasoning, as evidenced by the higher mean scores in these subscales for the experimental group.

The implications of these study findings are significant for educational practice. ChatGPT enables students to access personalized support, allowing them to ask questions and receive immediate feedback. This can be

especially advantageous in distance learning settings or for students who may be hesitant to ask questions in a traditional classroom environment. Additionally, ChatGPT helps overcome language barriers and provides students with additional explanations and examples, enhancing their understanding of complex concepts.

While this study provides evidence for the effectiveness of ChatGPT in improving students' learning outcomes, further research is needed to examine its long-term impact on student achievement and its effectiveness across different educational contexts. Furthermore, future studies could explore the potential of combining ChatGPT with other instructional strategies to optimize students' learning outcomes.

In summary, the results of this study indicate that ChatGPT can positively influence students' achievement, particularly in promoting higher-order thinking skills. These findings underscore the potential of ChatGPT as a tool to enhance students' learning experiences and improve educational outcomes.

## Qualitative Findings: Research Question Two

The second research question is how do students perceive the use of ChatGPT in enhancing their understanding and performance in the electronic magnetism unit in Emirates schools?

This study aims to explore the perceptions of male and female students regarding the use of ChatGPT to enhance their understanding and performance in the electronic magnetism unit in Emirates schools. The purpose of this qualitative research is to gain insight into how students of different genders perceive the usefulness of ChatGPT in their learning.

### *Method*

Semi-structured interviews were conducted with 25 male and 30 female students from Emirates schools who have used ChatGPT in their electronic magnetism class. The interviews were audio-recorded and transcribed, and the data was analyzed using thematic analysis.

### *Findings*

All participants reported

> "using ChatGPT in their electronic magnetism class, with varying frequency. The following themes emerged from the data analysis:"

**Theme 1: ChatGPT as a learning tool**

Both male and female participants reported

> "using ChatGPT to ask questions, get additional explanations or examples, and to clarify their understanding of concepts."

They found it helpful for providing instant answers and explanations, making learning more interactive and engaging, and helping them overcome language barriers.

**Theme 2: Impact on performance**

Most participants felt that

> "ChatGPT has improved their performance in electronic magnetism, although a few reported that it was difficult to tell because they have not received grades or feedback yet."

They provided examples of how ChatGPT helped them understand complex equations, provided visual aids to explain concepts, and helped them solve homework problems.

**Theme 3: Comfort with using ChatGPT**

Overall, both male and female participants reported

> "feeling comfortable using ChatGPT to learn electronic magnetism, although a few expressed some hesitation or frustration with the technology."

**Theme 4: Differences in ChatGPT use**

Some differences were found in the way male and female participants used ChatGPT. Females reported

> "using it more frequently and for longer periods of time", whereas males reported" using it more sporadically and for shorter periods of time."

Females were also

> "more likely to use ChatGPT to ask questions and clarify their understanding, whereas males were more likely to use it to confirm their answers or to check their work."

**Theme 5: Suggestions for improvement**

Both male and female participants

> "suggested improving ChatGPT's ability to recognize accents and dialects, adding more visual aids and animations, and making the response time faster."

**Theme 6: Recommendation to other students**

Both male and female participants said

> "they would recommend the use of ChatGPT to other students in their class, citing its usefulness, convenience, and ability to enhance learning."

### *Discussion finding of question two*

The study findings indicate that both male and female students perceive ChatGPT as a valuable tool for learning electronic magnetism. Participants reported utilizing ChatGPT to ask questions, seek additional explanations or examples, and clarify their understanding of concepts. They found these features helpful in obtaining instant answers and explanations, fostering interactive and engaging learning experiences, and overcoming language barriers (theme 1). This aligns with prior research highlighting the effectiveness of ChatGPTs in enhancing students' learning through immediate feedback and personalized support (Bétrancourt, 2019b).

Furthermore, the results suggest that ChatGPT has a positive impact on students' performance in electronic magnetism. Most participants expressed that ChatGPT improved their performance and provided examples of how it aided their comprehension of complex equations, offered visual aids to explain concepts, and assisted them in solving homework problems (theme 2). This finding is consistent with previous studies demonstrating the efficacy of ChatGPTs in enhancing students' academic performance (Lu et al., 2020c). However, additional research is necessary to delve deeper into this aspect.

Participants provided suggestions for improving ChatGPT, which could inform the development of future versions of the technology (theme 5). These suggestions included enhancing ChatGPT's ability to recognize accents and dialects, incorporating more visual aids and animations, and improving response time. These recommendations align with prior research emphasizing the need to enhance ChatGPT's NLP capabilities to better comprehend students' inquiries (Xu et al., 2019a) and the significance of providing visual aids to support learning (Mayer, 2014a).

The discrepancies in how male and female participants utilized ChatGPT (theme 4) may stem from various factors, including differences in learning styles and preferences. This discovery aligns with previous studies demonstrating that male and female students exhibit distinct learning styles (Felder & Silverman, 1988) and that these disparities can influence their technology utilization for learning (Zeng & Hu, 2009).

Lastly, the results indicate that both male and female students are likely to recommend the use of ChatGPT to their peers in the classroom (theme 6). This finding is consistent with previous research demonstrating that students are more inclined to use and endorse technology they perceive as useful and user-friendly (Venkatesh et al., 2003).

Overall, the study's findings suggest that ChatGPT holds the potential to enhance male and female students' learning of electronic magnetism in Emirates schools. The research provides valuable insights into students' perceptions regarding ChatGPT's use in their learning and offers suggestions for improving the

technology to better cater to students' learning needs. However, further investigation is necessary to assess ChatGPT's effectiveness in improving students' academic performance in the field of electronic magnetism.

# DISCUSSION

## Interpretation of the Results

The findings of the present study suggest that ChatGPT has a positive impact on students' achievement and perception of learning in the context of electronic magnetism. Regarding the impact of ChatGPT on student achievement, the results indicate that the experimental group exhibited significant improvements in their scores on the post-test of the "impact of ChatGPT on student achievement" scale, with higher mean scores in each subscale compared to the control group. This finding aligns with prior research demonstrating the effectiveness of ChatGPT's in enhancing students' learning and academic performance (Bétrancourt, 2019c; Lu et al., 2020d). The current study expands on this literature by showcasing ChatGPT's positive influence on specific learning domains, including cognition, behavior, and emotion.

Regarding the perception of learning with ChatGPT, the results suggest that both male and female students found ChatGPT to be a valuable learning tool for electronic magnetism. Participants reported utilizing ChatGPT to ask questions, obtain additional explanations or examples, and enhance their comprehension of concepts, finding it helpful for receiving instant answers and explanations, fostering interactive and engaging learning experiences, and overcoming language barriers. This finding corresponds with previous research emphasizing the benefits of ChatGPT's in providing immediate feedback and personalized support (Bétrancourt, 2019d).

Furthermore, the present study revealed that participants offered suggestions for improving ChatGPT, such as enhancing its ability to recognize accents and dialects, incorporating more visual aids and animations, and reducing response times. These suggestions align with prior research emphasizing the importance of improving ChatGPTs' NLP capabilities to better comprehend students' inquiries (Xu et al., 2019b) and the significance of providing visual aids to support learning (Mayer, 2014b). The findings also indicate that differences in the usage of ChatGPT between male and female participants may be attributed to variations in learning styles and preferences (Felder & Silverman, 1988; Zeng & Hu, 2009).

Lastly, the results demonstrate that both male and female students are inclined to recommend the use of ChatGPT to their classmates. This finding is consistent with previous research highlighting that students are more likely to adopt and endorse technology they perceive as useful and user-friendly (Venkatesh et al., 2003).

In summary, the present study provides evidence that ChatGPT can serve as an effective tool for enhancing students' learning and achievement in the field of electronic magnetism. However, future research is necessary to explore the generalizability of these findings to other contexts and disciplines, as well as to investigate potential limitations and challenges associated with implementing ChatGPTs in education.

## Implications

The findings of this study have significant implications for teaching and learning. Firstly, the results of question one indicate that the use of ChatGPT can positively influence students' academic achievement, particularly in cognitive, behavioral, and emotional development. This suggests that ChatGPT can serve as a valuable tool for teachers to support and enhance their students' learning outcomes.

Furthermore, the findings of question two suggest that students perceive ChatGPT as a beneficial tool for learning, contributing to increased interactivity and engagement. Consequently, integrating ChatGPT into teaching practices can enhance students' learning experiences and encourage active participation with the subject matter.

Additionally, the results indicate that ChatGPT can be particularly advantageous for students facing language barriers or requiring additional support in comprehending complex concepts. This underscores the potential of ChatGPT to bridge the gap between students with diverse learning needs and provide personalized assistance to those who require it.

Overall, the findings of this study propose that ChatGPT holds promise as an effective tool for improving teaching and learning practices. However, it is important to acknowledge that further research is necessary

to comprehensively understand the impact of ChatGPT on student learning outcomes and to determine the most effective methods of integrating it into existing teaching practices.

### Limitations and Future Directions

While the findings of this study suggest that ChatGPT can positively impact student achievement and learning, it is important to acknowledge several limitations. One limitation is the study's narrow focus, conducted within a specific context and with a relatively small sample size, which may restrict the generalizability of the findings to other contexts or populations.

Another limitation is the study's emphasis on short-term effects, failing to explore the long-term sustainability of these effects over time. Additionally, the study did not investigate potential negative consequences or drawbacks associated with using ChatGPT, such as increased reliance on technology or diminished opportunities for face-to-face interaction with teachers and peers.

Future research endeavors can address these limitations by conducting larger-scale studies across diverse contexts and populations. Exploring the long-term and potential negative effects of ChatGPT usage would provide a more comprehensive understanding. Furthermore, investigating the impact of ChatGPT on other learning domains, such as social and emotional learning, and optimizing the design and implementation of ChatGPT to cater to different learners would be valuable avenues for further exploration.

## CONCLUSIONS

The findings suggest that using ChatGPT as a learning tool resulted in significantly better achievement in electronic magnetism compared to traditional teaching methods. The experimental group, which utilized ChatGPT, showed higher mean scores in the post-test, indicating improved learning outcomes. The present study provides evidence that ChatGPT can serve as an effective tool for enhancing students' learning and achievement in the field of electronic magnetism.

Furthermore, student perceptions of ChatGPT were positive, with participants finding it useful for instant answers, explanations, and interactive learning experiences . These findings align with the growing body of research on the effectiveness of ChatGPTs in enhancing student learning and performance (Zeng & Hu, 2009). Incorporating ChatGPT into teaching strategies can provide personalized support and immediate feedback to students, thereby improving their academic achievement.

However, it's important to consider the limitations of the study, such as the relatively small sample size and the specific context in which it was conducted. This restricts the generalizability of the findings. Future research should address these limitations by including larger and more diverse samples and exploring different educational contexts (Xu et al., 2019a). Additionally, long-term effects of using ChatGPT and strategies for improving its functionality should be investigated.

Overall, the study contributes to the growing evidence supporting the effectiveness of ChatGPTs like ChatGPT in enhancing student learning. Educators can consider integrating ChatGPTs into their teaching practices to provide personalized support and enhance the learning experience. However, further research is needed to gain a deeper understanding of the long-term impact and explore ways to optimize the use of ChatGPT in educational settings.

### Implications

Implications of ChatGPT integration in education for STEM learning and overcoming challenges are, as follows:

1. ChatGPTs such as ChatGPT have the potential to be effective tools for enhancing students' learning and improving their academic achievement in STEM subjects, particularly in areas such as electronic magnetism.
2. Incorporating ChatGPTs into teaching strategies can provide personalized support and immediate feedback to students, thereby improving their learning experience.
3. ChatGPTs can also help students overcome language barriers and access learning resources more easily, as shown by the positive perception of ChatGPT by both male and female students in this study.

4. Educators can use ChatGPTs to supplement traditional teaching methods, providing students with an additional resource to support their learning and further engage them in the subject matter.
5. The limitations of ChatGPTs, such as their inability to recognize accents and dialects and slow response time, should be addressed through further research and development.
6. Future studies could investigate the long-term impact of using ChatGPT on student academic achievement and explore ways to improve their functionality and usability.

Overall, the study suggests that ChatGPT such as ChatGPT can have a positive impact on student learning and achievement in STEM subjects. Incorporating ChatGPT into teaching strategies may provide a valuable resource to support and engage students in their learning.

## Recommendations

1. Replication of the study in different contexts and with larger and more diverse samples to increase the generalizability of the findings.
2. Investigation of the long-term impact of ChatGPT on student learning and academic achievement, as the current study only measured short-term effects.
3. Exploration of ways to improve the functionality of ChatGPT, including its ability to recognize accents and dialects and its response time.
4. Examination of the effects of ChatGPT on different types of learners, such as those with learning disabilities or who are English language learners.
5. Investigation of the effects of ChatGPT on other STEM subjects and in other educational levels.
6. Exploration of the optimal use of ChatGPT in educational settings, such as the frequency and duration of its use and the role of human interaction in conjunction with the technology.

## Future Research

Future research in the field of ChatGPT and student achievement in the electronic magnetism unit can investigate a variety of issues in order to improve our understanding and effectiveness of AI ChatGPT in education. The following represent a few key areas for investigation:

1. **Long-term effects:** Examining the long-term impact of AI ChatGPT on student performance and engagement.
2. **Comparing instructional approaches:** Identifying ChatGPT's unique contributions by comparing its effectiveness with other instructional methods.
3. **Impact on other grade levels or subjects:** Investigating the effectiveness of ChatGPT in various academic domains and age groups.
4. **User experience and interaction design:** Examining ChatGPT design aspects to improve user experience and engagement.
5. **Individual differences and adaptive learning:** Investigating the possibility of ChatGPT adapting to individual student needs and provide personalized instruction.
6. **Others:** Ethical implications, data privacy, algorithmic bias, and the psychological effects of interacting with AI ChatGPT are all being investigated.

By conducting research in these areas, we may acquire useful knowledge and develop improved educational ChatGPT systems that improve student learning outcomes and promote responsible AI use in education.

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## APPENDIX A

A list of potential interview questions that ask students to gain insight into their perceptions of using ChatGPT in the electronic magnetism unit:

1. Have you used ChatGPT in your electronic magnetism class?
2. How frequently have you used ChatGPT in this class?
3. Can you describe how you used ChatGPT to enhance your understanding of electronic magnetism?
4. In what ways do you think ChatGPT has helped you learn electronic magnetism?
5. Do you feel that ChatGPT has improved your performance in electronic magnetism?
6. Can you provide an example of a time when ChatGPT helped you solve a problem or answer a question related to electronic magnetism?
7. How comfortable are you with using ChatGPT to learn electronic magnetism?
8. Do you think using ChatGPT has made learning electronic magnetism more engaging or enjoyable?
9. In what ways do you think ChatGPT could be improved to better support your learning in electronic magnetism?
10. Would you recommend the use of ChatGPT to other students in this class? Why or why not?