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Resembling ChatGPT-Generated Science Topics with Human-Written Text-books (A case study)

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ARTICLE INFO	ABSTRACT
	The affordances of Generative Pre-Trainer Transformer (ChatGPT) in learning and teaching have gained increasing traction. Its release and rapid diffusion have caught the attention of educators worldwide. No doubt that ChatGPT and similar generative AI models have attracted hundreds of millions of users and have become part of the public discourse. Rapid developments in generative AI technologies have led to an increased interest in their capabilities and applications. Relevant Literature demonstrates valuable support of this technique(s) for drafting manuscripts, summarizing articles, translating languages, and refining text structures or wording. likewise, these technologies have the ability to mimic human-like conversations with users, such as providing information and assistance, offering emotional support. The most frequently used of these technologies is ChatGPT. This study is evaluating effectiveness and differences between learners' comprehension (concepts acquirement) by generative AI (ChatGPT) and human-generated texts in educational contexts. By determining learner's comprehension level, the study identifies key distinctions between the two types of content. Results showed a statistically significant difference at the significance level ($\alpha \leq 0.05$) between the means of the experimental and control groups in the post-testing in favor of the experimental group. Overall, findings indicated constructive impact of this technology on students' comprehension (acquisition of scientific concepts). **Keywords:** ChatGPT, Concept Acquisition (Comprehension), Generative AI Models, Oman, Scientific Concepts.

PREFACE AND BACKGROUND

Artificial intelligence (AI) has developed rapidly in recent years, leading to various applications in different disciplines, such as education. AI techniques can be trained to simulate the human brain and carry out routine work using large amounts of data and can be utilized in education to enhance academic support. (Lo, 2023).

Generative artificial intelligence (Gen-AI) models, such as ChatGPT, Gemini, and BingAI, have become integral to educational sciences, bringing about significant transformations in the education system and the processes of knowledge production. These advancements have facilitated new methods of teaching, learning, and information dissemination (Durak et al, 2025).

The rapid advancement of artificial intelligence (AI) has transformed how people access knowledge and instruction. Among the most notable developments is ChatGPT, new forms of generative AI are capable of providing guidance on a broad range of topics (Jacob et al, 2024).

The recent interest in generative AI models can be largely attributed to the public release of ChatGPT, a public interface in the form of an interactive chat based on the Instruct GPT model, more commonly referred to as GPT-3.5– an artificial-intelligence (AI) chatbot – has been around since November 2022. (Herbold et al, 2023).

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In the field of teaching and learning, while some educators have expressed concerns about integrating ChatGPT into educational settings, many other educators present strong arguments in favor of incorporating ChatGPT into education (Halaweh, 2023).

Mai and Hanh (2024) listed many systematic studies discussing the significance of ChatGPT in education, ethical issues related to ChatGPT, SWOT analysis of ChatGPT, the impacts of ChatGPT in education, application of ChatGPT in higher education, and ChatGPT's impact on student learning.

INTRODUCTION

Artificial intelligence (AI) has rapidly transformed from a futuristic concept to an integral part of our daily lives, and education is no exception. By integrating AI into classrooms, educators can personalize learning experiences, streamline administrative tasks and provide more effective support to students. The promise of "AI for all", addressed by UNESCO, must be that everyone can take advantage of the technological revolution under way and access its fruits, notably in terms of innovation and knowledge. This positively will contribute to achieving the 2030 Agenda for Sustainable Development. (UNESCO, 2024).

Within this framework, UNESCO developed Artificial intelligence and education: Guidance for policy-makers to foster the readiness of education policy-makers in artificial intelligence (Beijing Consensus, 2019).

Educational institutions must invest in both AI and teacher training, while also ensuring this technology is available to all students. While educational literature has highlighted AI's potential to automate teaching and learning tasks, the more dialogue lies in how teachers can functionalize AI to craft learning practices.

In education field, AI can process and analyze large amounts of information. Unlike human teachers who have finite time and mental bandwidth, AIs can ingest entire libraries worth of data in seconds. This allows AIs to identify patterns and extract insights at a pace exponentially faster than any human.

HUMAN INSTRUCTION STRENGTHS VS CHATGPT INSTRUCTION

Teaching is a rewarding career that requires a lot of effort, passion and skills. Good human teachers are passionate about the subjects they teach and characteristically perform a wide range of activities that we subsume under the general heading of 'teaching'. In human teaching settings, improving leraners' knowledge and ability to solve cognitively demanding problems has always been one of the critical tasks. High-cognitive-demanding tasks usually entail learners to stat the problem, hypothesize, testing, and draw conclusions, and are considered essential for students to develop a deeper understanding of science (Zhai et al., 2025).

According to relevant literature, teaching career involves a wide range of competencies to be mastered. These include planning and designing, demonstrating, guiding, telling, questioning, testing, recording, motivating, criticizing—even learning (Dowling, 2003). Human teachers characteristically have the capacity for emotional understanding, creativity, and ethical reasoning, independent of the algorithmic processes that govern generative artificial intelligence like ChatGPT (Gkonou and Mercer, 2017). Despite the enormous potential of AI techniques, human oversight remains necessary for ChatGPT, as its content may include educationally inappropriate content. (Dwivedi et al, 2023)

Moreover, the conventional teaching settings are excelling in areas where emotional intelligence, adaptability, and deep contextual understanding are required. They can assess a learner's emotional state through tone, facial expressions, or body language, allowing them to adjust their approach in real time (Mukhopadhyay et al, 2020). In that, if a learner seems confused, a human teacher can pause, reframe the explanation, or use examples to clarify the concept. Additionally, they bring cultural and situational sensitivity to their teaching. They can adapt to the learner's unique background and personal experiences, fostering stronger engagement and relevance (Mebert et al, 2020).

Nevertheless, human instruction has its limitations. It is time-consuming and resource-intensive and has biases and inconsistencies. In subjective wise, this mode of teaching can make it dependent on the instructor's mood, experience,

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or teaching style. Unlike AI performances, humans are restricted in the breadth of topics they can cover, as no one person can master every field. (Griffiths, 2020)

The recent interest in generative AI models can be largely attributed to the public release of ChatGPT. ChatGPT is a search engine like Google with a chator dialogue form that uses natural language processing to create humanoid informal dialogue. It is designed to queries and curate various written content, including blogs, social media posts, code and emails. (Neendoor, 2024).

ChatGPT has gained attention worldwide for its impressive performance in generating coherent, systematic, and informative responses. It is a tool for information retrieval and communication tools for scientists as well as supporting learning. (Steiss et al, 2024). In educational contexts, both teachers and learners generally hold a positive perception of the use of ChatGPT in teaching and learning (Limna et al., 2023). Studies (Herbold et al, 2023 and Wilichowski and Cobo, 2023), stated that ChatGPT shines in its ability to deliver fast, scalable, and consistent instruction.

This technique has proven to be a valuable tool in helping teachers to create course materials efficiently (Keiper et al., 2023; van den Berg and du Plessis, 2023). In the field of science education, ChatGPT is smart enough to generate topics, develop scientific tasks and write assignments, case studies, project reports, and work-based problems (Chaudhry et al., 2023) and (Küchemann et al., 2023). Besides creation of scientific topics, ht has demonstrated its ability to generate high-quality assessment rubrics and quizzes (Cooper, 2023).

Overall, the use of ChatGPT is increasing rapidly in the education sector, and has a positive impact in learners' achievement and comprehension. The Figure below highlights the key teachers and students' advantages of using ChatGPT in education (Neendoor, 2024).
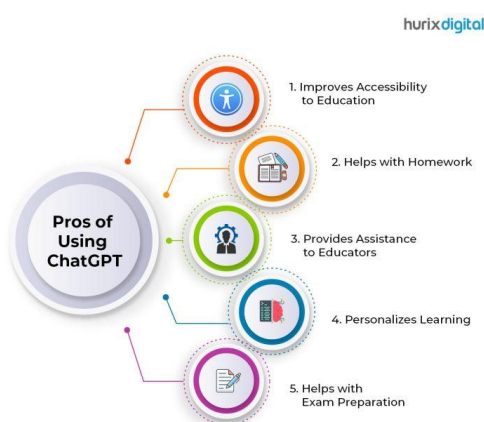
For its major advantages in both academic and administrative tasks; like developing tasks, grading, creating quizzes, analyzing student data and providing, higher education institutions faculty generally have positive attitudes about using ChatGPT in their teaching practice (41.4%) (Kiryakova and Angelova, 2023). Many researchers found that students have a positive attitudes about the integration ChatGPT into the classroom (Bitzenbauer, 2023; Chan and Hu, 2023; Lozano and Blanco Fontao, 2023). They do not consider it as a threat to the educational system as long as the data generated by ChatGPT is verifiable (Lozano and Blanco Fontao, 2023). The benefits of ChatGPT extend beyond the classroom, as students realize its relevance and integration into their daily lives (Bitzenbauer, 2023).

ChatGPT Instruction Limitations

Owing to its capability to generate human-like tasks and topics, ChatGPT is becoming a trusted companion to many educators. However, like any nascent technology, it has its share of challenges.

Stojanov (2023) has exposed that the responses generated by ChatGPT can be superficial and may not always exhibit logical consistency or coherence. Additionally, Stojanov (2023) detailed cases where the answers are contradictory,

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raising concerns about the accuracy of information provided. Furthermore, Allehyani and Algamdi (2023) and Stojanov (2023), showed their concern that novice teachers are lacking the necessary knowledge and skills to interact critically with ChatGPT and may have difficulty using the technology effectively. Besides and in a specific situation, although ChatGPT was capable of generating a scientific unit, the output could be generic and might require further improvement and depends on the clarity and accuracy of the user's input (Cooper, 2023).

In particular, ChatGPT lacks genuine emotional intelligence and the ability to form meaningful relationships with learners. While it can simulate empathy, it does not truly understand emotions. It also struggles with tasks requiring deep contextual awareness or highly specialized expertise. Misleading or ambiguous prompts can result in irrelevant or incorrect responses. Its reliance on pre-existing data means it may not always offer innovative or groundbreaking insights. (Howell, 2024; York, 2024; George, 2023)

The Best of Both Worlds in Science

It is important to realize that despite advances of ChatGPT, it cannot replace the expertise of science teachers (Cooper, 2023). Teachers play a key role in refining and adapting the outputs of ChatGPT's science unit designs to fit their teaching context. By combining the power of AI tools like ChatGPT with the expertise of science teachers, a powerful synergy can be achieved, delivering a richer and more personalized educational experience for students.

Overall, relevant literature emphasizes the importance of developing effective coping strategies to manage ChatGPT integration into education. Rather than viewing human and ChatGPT instruction as competitors, it is more productive to see them as complementary (Hsu et al, 2024). For example, a student can use ChatGPT to quickly grasp scientific concepts and then rely on a human teacher for deeper understanding and discussion. Similarly, in laboratory work, ChatGPT can electronically demonstrate and present experiment (quicker and safer with low cost), while human science teachers focus on building practical skills and connecting facts and concepts from experiment to student's previous knowledge. Likewise, schools and institutions can benefit from integrating both forms of instruction in teachers pre- and post-service programs. This approach can increase accessibility, efficiency, and engagement while ensuring a balance of hands-on and minds-on way of teaching.

Comprehension and Literacy in Science Education

The importance of enhancing science literacy among students of all ages has been emphasized by recent reforms in science education (National Research Council of National Academies, 2011; National Academies of Sciences, Engineering and Medicine, 2016). The Program for International Student Assessment (PISA) defined science literacy as: "The capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity" (Organization, p. 15). Specifically, these educational reforms encourage the reading of scientific texts, calling on students to "learn how to access scientific information from texts and evaluate and interpret the information they have acquired" (National Research Council of National Academies, 2011).

Yet, research has indicated that, when reading scientific texts, students face significant challenges in three major skills for scientific literacy: phenomenon identification, scientific explanation, and evidence utilization (e.g., McNamara, 2017). Namely, many students show substantial difficulties when asked to identify scientific phenomena from such texts (Michalsky, 2013). Moreover, students often struggle when asked to give scientific explanations and to formulate hypotheses based on the texts (Cromley et al., 2010). Finally, when asked to evaluate and interpret experimental evidence described in texts, students tend to reject, misinterpret, or ignore data that do not match their existing naïve theories and misconceptions (McNamara, 2017). In local context, these three skills' centrality is also evident from their appearance in testing of scientific literacy in recent years (Council of Education, 2018).

ChatGPT in Comprehending Science Education

The integration of ChatGPT in teaching and learning opens up many opportunities to enhance the learning journey, customize personalized instruction methods, and revolutionize the role of educators (Firat, 2023). Through its

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adaptive nature, ChatGPT can assist students in grasping complex concepts and exploring topics that align their interests and learning pace.

ChatGPT has demonstrated its potential as a valuable tool in providing foundational knowledge in various educational contexts. By answering common questions and providing immediate responses to students, ChatGPT can reduce the workload of teachers. This allows educators to focus more on higher-level tasks such as discussions, assessments, and personalized learning experiences (Limna et al., 2023).

Building accurate science concepts is one of wide goals for teaching science. ChatGPT can be well utilized to attain this goal quicker and easier. Whether teachers start a new unit or prepping for an exam, ChatGPT can help in putting together detailed concepts lists with clear definitions that fit students' learning level in seconds. Literature stated number of techniques as follows (Ajevski, 2023; Cooper, 2023 and Sallam, 2023):

- Generate Topic-Specific Vocabulary Ask ChatGPT to create a list of essential terms for any science topic, like ecosystems or genetics, ensuring you cover key concepts.

- Provide Clear Definitions ChatGPT can generate student-friendly definitions for each term, making complex scientific concepts easier for students to understand.

- Differentiate for Learning Levels You can customize vocabulary lists for various learning levels by asking ChatGPT for simplified or advanced definitions based on your students' needs.

- Save Time on Prep With just a few prompts, you can quickly create comprehensive vocabulary lists, freeing up time for other lesson planning.

- Expand with Related Terms ChatGPT can also suggest related terms, enriching your vocabulary lists and providing students with a more complete understanding of the unit.

Context of the Study and problem statement:

Oman, officially the Sultanate of Oman, is a country located in western Asia and is the third largest in terms of area in the Arabian Peninsula. It is a very diverse country; geographically and culturally. The population (4.68 million in January 2024) density is diverse too, and this has resulted in diversity in learning profiles, students' interests, readiness levels and backgrounds.

Following Oman Vision 2040 education policy is based on comprehensive education, sustainable learning, and scientific research that leads to a community of knowledge and competing national capacities (Oman Vision-2040, 2020).

There, education in Oman shed its emphasis on developing national talents with dynamic capabilities and practical and scientific competence skills that are competitive locally and internationally. The government, at large, stresses localizing of AI technologies by encouraging public-private partnerships, developing technical infrastructure, and promoting research and development in AI.

Worldwide, although there is extensive research on AI usage intentions (Maheshwari, 2023) and motivation (Lee & Park, 2023), challenges remain in managing the complexities of ChatGPT's role in education. The main issue addresses the benefits, risks, and coping strategies related to ChatGPT in educational contexts. While empirical studies (Fu et al., 2024) have examined these factors, they have not offered solutions for effectively using or avoiding ChatGPT in these settings. As a result, there is still a lack of research that adequately addresses these benefits, even as its relevance grows. This research explores the ability of generative AI (ChatGPT) in science comprehension skills among 10th Omani graders. It is comparing the quality of humans and ChatGPT techniques in acquiring comprehension skills.

Henceforth, the question posed (What is the effectiveness of teaching based on ChatGPT in developing comprehension skills among tenth graders?)

Methodology:

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The researcher has paid a great attention on the ability of new technology impact on number of variables. Evaluation hinges on several criteria: thinking Skills (alshuaili,2025), student engagement, motivation, subject clarity (comprehension), and attitudes towards Science.

The study will shed light on positive utilizing of this technique (ChatGPT) in science education in Oman. By a quasi-experimental approach, it examined whether ChatGPT and humans differed in quality of science teaching for the whole sample, for compositions of science teaching by comparing descriptive statistics and effect sizes. The following table (1) shows the research design adopted by the research

Table 1: The Research Design

Group	Independent variable	Post-testing
experimental	ChatGPT-based teaching	Comprehension test
Control	Human teaching	

Study Aim(S):

This paper will focus on comparison of students' comprehension of science provided in textbook samples from both the Ministry of Education and ChatGPT. The samples will cover similar topics. This methodical approach will ensure a balanced and informed comparison.

Sampling and data collection procedure:

The study was conducted in Oman through a quasi-experimental design, where the sample (N=66) has split up into an experimental group (N=33) taught by AI-based teaching using ChatGPT, and a control group (N=33) taught using the conventional way of teaching. The sampling technique employed was non-probability sampling with a purposive sampling approach selected from a secondary school. A science comprehension test; consisting of (30) multiple choice items; and teacher manual have been prepared. Both were validated by a panel of juries, whereas the test reliability was calculated through alpha Cronbach giving a value of (0.81).

Once study sample was determined, a pre-testing was carried out, to verify equivalency of both groups. The experimental group was taught with a teaching strategy based on ChatGPT, while the control group was taught in the convential way. Then, the post-test was carried out for both groups.

The researcher was keen to ensure that the students in the two groups were statistically equivalent in science achievement which might affect the results validity. Students last term grades was obtained, getting their grades mean and standard deviations. The independent samples t-test was calculated showing no statistically significant differences between the two groups, which demonstrated that both groups are equivalent in their achievement level; as shown below in table (2).

Table 2: Achievement Equivalency of Research Groups

Group	N	Mean	SD	t.value (df=64)	Sig@ (α ≤ 0.05)
experimental	33	25.48	4.59	T. value=2.00	not.sig
Control	33	24.60	3.91	Calc. t. value= 0.953	

This shows that there were no significant differences between the experimental group and the control group, and therefore, they are equal at the beginning of the research.

RESULTS AND DISCUSSION

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Post- testing results, for both experimental and control groups, were manipulated (Table 3) to get means, standard deviations, and independent samples t-test and to calculate the significant differences between means of the experimental and control groups in the post-testing of the science performance took place.

Table 3: Means, Standard Deviations and T-test values of Post-testing.

Group	N	Mean	SD	t.value (df=64)	Sig@ (α ≤ 0.05)
experimental	33	29.69	6.79	T. value=2.00 Calc. t. value= 2.270	sig
Control	33	21.41	2.18		

The results showed that achievement levels for the experimental group were more than the scores recorded in the control group. At the same time, students performed better in the ChatGPT sessions compared to conventional human lessons. The mean score of 29.69 for the experimental group and 21.41 for the control group with a calculated t.test value 2.270 means the experimental group has a different identity in scores compared to the control group, indicating a positive difference in the ratings.

Overall, results indicated that there is a statistically significant difference at the significance level (α ≤ 0.05) between the means of the experimental and control groups in the post-testing of the comprehension test in favor of the experimental group.

Findings from the study suggest that integrating ChatGPT in teaching science correlated with better students' performance. As seen in from the data, the point average of the experimental group was higher than the control group, confirming that using ChatGPT-based instruction method in teaching science increased student achievement. Students appeared motivated and in great attitudes. The practice fosters group cooperation among students, increases their chance of participating in class activity and develops a student's attention, interest, and motivation to participate in the subject and perform better compared to traditional methods of teaching.

CONCLUSION

The results favored the experimental group that was taught through ChatGPT-assisted methods. However, the choice between human and ChatGPT instruction depends largely on the context. Human instructors excel in fostering emotional connections, adapting to complex situations, and providing specialized insights. Meanwhile, ChatGPT offers unparalleled scalability, speed, and breadth of knowledge. By leveraging the strengths of both, individuals and organizations can create a more effective and inclusive learning environment, ensuring that technology enhances rather than replaces human interaction.

Apart from ChatGPT, there are several other education specific AI tools on the market that support teachers in their duties like creating lesson plans, putting together assessments, and grading student work

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