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Comparing the Quality of Humans and Chatgpt Instruction on Students' Generative Thinking

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Abstract

Historically, this has been a question that is asked when comparing humans with other animals. The classical answer (from Aristotle, via the Scholastics) is to view humans as 'rational animals', animals that think. Nowadays, search engines play significant roles in humans technologically enabled lives by shaping how they conceptualize and interact with information and knowledge. The release and rapid diffusion of Generative Pre-Trainer Transformer (ChatGPT) have caught the attention of educators worldwide. Some educators are enthusiastic about its potential to support learning. Others are concerned about how it might circumvent learning opportunities or contribute to misinformation. (Futterer et al., 2023). This study is examining the ability of generative AI (ChatGPT) in developing generative thinking skills among 10th Omani graders. Through a quasi- experimental design, where the sample (N=58) has split up into an experimental group (N=29) taught by AI-based teaching using ChatGPT, and a control group (N=29) taught using the conventional way of teaching, 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 of the generative thinking skills test in favor of the experimental group.

Preface and Background

Researchers and educational events have emphasized the changes that the applications of the Fourth Industrial Revolution will bring about in the present and future in various aspects, which must be kept pace with in various ways and methods (Lee et al., 2018). One of these aspects is the education sector with the different components of the educational and learning system. The world went through successive revolutions, starting from the first industrial revolutions until the world reached the era of the Fourth Industrial Revolution, in which applications of artificial intelligence, the modern Internet, and big data emerged, leading to change in various fields, especially the field of education (Ellahi et al., 2019).

Post Covid-19 years, there has been a gradual shift toward online and asynchronous learning (Beege et al., 2022; Sablić et al., 2021; Tondeur et al., 2023). This trend can be attributed to numerous factors, such as the increased accessibility and convenience of online platforms, potential changes in education systems through the experiences schools (and universities) gained during this pandemic when they had to shift to online teaching and the entry of digital natives into schools and universities (Alon et al., 2023; Anders et al., 2024).

Many universities and schools have already started offering online courses and degree programs, where technology-based instruction playing a pivotal role and has traditionally been produced by human teachers and education technology experts. However, the latest developments in generative AI suggest that AI may be capable of taking over this and other educational tasks in the future (Jeon et al., 2023; Lim et al., 2023).

By leveraging advanced algorithms that analyze and learn from vast amounts of data, generative AI systems can potentially produce highly engaging and effective teaching materials tailored to the needs of learners and teachers (Netland 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).

There are the skeptics, who have tried to ban ChatGPT in schools, and the advocates, who think it is the "silver bullet" solution to a host of education challenges around the world. To the doubters' point that ChatGPT is detrimental to the learning process, and will disrupt the most traditional learning tools teachers have used for decades (e.g., experimenting and hands-on tasks). This raises an important question: how does the quality of instruction from ChatGPT compare to that of human instructors? While both have their strengths and weaknesses, understanding their roles can help maximize their potential in educational and professional contexts.

Wilichowski and Cobo (2023) elevated that how could this mechanism independently complete tasks currently done by teachers? If so, what are the associated risks? How can teachers use ChatGPT to enhance their practice and/or improve the efficiency of certain tasks?

Human Instruction Strengths

What follows is an uncomfortable question: With a shortage of 69 million primary and secondary teachers around the world, could ChatGPT supplement teachers, or even replace them? And handle their vital role in the educational process.

According to relevant literature, human teachers characteristically perform a wide range of activities that we subsume under the general heading of 'teaching'. These include planning and designing, demonstrating, guiding, telling, questioning, testing, recording, motivating, criticizing—even learning (Dowling, 2003).

Human teacher 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) For instance, if a student seems confused, a 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).

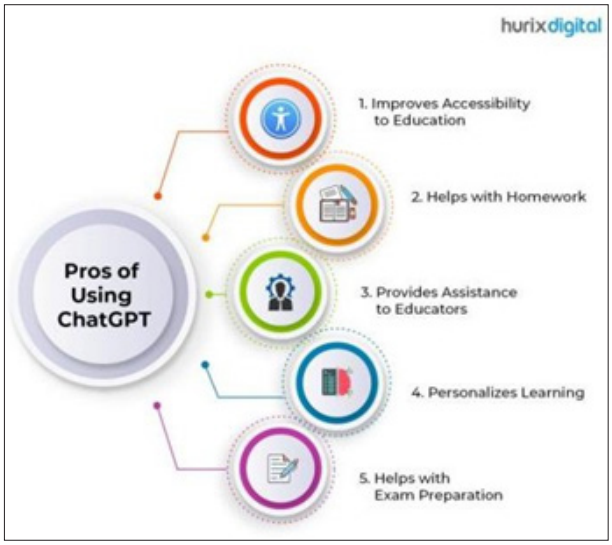
However, human instruction has its limitations. It is time-consuming and resource- intensive. One teacher or expert can only teach a limited number of individuals at a time. Additionally, human biases and inconsistencies can affect the quality of instruction, making it dependent on the instructor's mood, experience, or teaching style. Moreover, humans are restricted in the breadth of topics they can cover, as no one person can master every field (Griffiths, 2020).

ChatGPT Instruction Strengths and Limitations

Generative Pre-Trainer Transformer(ChatGPT) is a language model with artificial intelligence (AI) capabilities that has found utility across various sectors. ChatGPT is a search engine like Google with a chator dialogue form. It is a tool for information retrieval and communication tools for scientists as well as supporting learning (Steiss et al., 2024).

The launch of ChatGPT has demonstrated the potential for the technology to enhance, and in some cases replace, some of the activities and tasks done within jobs by humans. Studies (Netlend et al., 2025; Herbold et al., 2023; Wilichowski and Cobo, 2023), stated that ChatGPT shines in its ability to deliver fast, scalable, and consistent instruction. It operates around the clock, providing guidance to users anytime and anywhere. Its ability to process vast amounts of information enables it to address a wide array of questions, from basic concepts to advanced topics across multiple fields. This makes it an excellent resource for quick problem-solving or as a supplementary tool for learning. Another advantage of ChatGPT is its adaptability to different learning needs. It can simplify complex topics for beginners or provide detailed, technical explanations for advanced learners. Furthermore, ChatGPT eliminates biases linked to personal opinions, offering uniform instruction.

A blog written by (Neendoor, 2024) explored all the nuances of ChatGPT, in the field of education. It highlights the key advantages this tool comes with for teachers and students alike, as shown in Figure (1).



While using ChatGPT for education can be really useful, It is also important to pay attention to its limitations and shortcomings, understand their impact and to know how to overcome them.

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. For example, it might provide general advice about a profession but cannot replicate the nuanced insights of a seasoned practitioner. Moreover, ChatGPT depends on the clarity and accuracy of the user's input. 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).

A Hybrid Approach: The Best of Both Worlds

Academics have been contending with ChatGPT dual effects. Fu et al. (2024) describe this impact as a paradox, characterized by a balance between benefits and threats at both the organizational and individual levels. They emphasize 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 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.

Generative Thinking in Science Education

Traditional forms of science education have tended to concentrate on students who wish to pursue a career in science, thus serving only a particular group of students. It is clearly known that the development of students' learning via higher-order cognitive skills (HOCS)- promoting teaching is a continuous overriding challenge for many educators and researchers in science education. In Bloom's taxonomy of cognitive development (Bloom et al., 1956), analysis, synthesis, and evaluation are considered as HOCS whereas recall of information, comprehension, and application are envisioned as LOCS.

In recent years, a variety of efforts has been developed and implemented through series of research activities that is aimed to make a change the learning model. Based on the result of study has been shown that the use of student-centered learning can be further increased the mastery of physics concepts than teacher-centered (Frankel & Wallen, 2007). One of the learning models has been developed is generative thinking model.

On the activity of generative thinking, the students were demanded to prepare themselves mentally for understanding the material information taught. In the learning process, the active students are taking a part and producing the knowledge with the connections between mental concepts formation (Maknun, 2015 and George, 2011).

The generative thinking model is very suitable and contextual for environmental conservation, affecting the improvement of students' critical thinking ability. By looking at the stages of learning in generative thinking, students can participate more actively and explore the learning process, producing real experiences (Mumtaz et al., 2023; Sjaifuddin and Nestiad. 2023). Students participate actively in the process of observing, focusing on problems, challenging problems, and implementing strategies that have been set to solve problems. For students to succeed in lifelong learning, they must have strong scientific literacy and critical thinking abilities (Riezandi & Nurita, 2022).

ChatGPT In Generative Thinking

According to the Social Cognitive Theory (Bandura, 1986), behavior, cognition, and emotions are influenced by the surrounding environment, including the technology with which individuals interact (Zhuo et al., 2023). Literature has highlighted how the use of technology can impact cognitive processes, and affect a crucial cognitive ability in education, namely the ability to engage in complex thinking. This process allows students to analytically evaluate information, recognize valid arguments, and develop a reflective approach to the world around them (Suriano et al., 2024).

Several potential advantages stated by (Liu et al., 2023, Mhlanga, 2023; Sallam, 2023), describing how ChatGPT can be utilized to release the thinking potential of future teachers:

1. Idea Enrichment: ChatGPT offers new ideas and viewpoints that teacher can integrate into his work. It generates diverse and original responses to questions and challenges, thus aiding both teachers and learners in nurturing their thinking potential.
2. Idea Experimentation: Through ChatGPT, learners can experiment with several ideas and perspectives, test them in practice, and receive response. This allows them to develop their thinking and discover innovative methods to teaching.
3. Interactive Learning: ChatGPT can enable interactive learning and dialogue, promoting the progress of creative thinking. Learners can pose inquiries, receive responses, and stimulate their thinking through interactions with the model.
4. Personalized Learning: ChatGPT can be tailored to meet the individual needs of learners, empowering personalized support and guidance in cultivating their skills.

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). One of the fundamental principles of science education in Oman is supporting scientific thinking. The Ministry is developing a policy for the implementation of comprehensive science education in its broadest sense, where a study has been carried out to identify the challenges facing its implementation (Council of Education, 2018).

Hence, developing curricula in Oman in the current era requires attention to the skills of the Fourth Industrial Revolution, which achieves the objective of Oman Vision 2040, as it aims prepare an Omani citizen with a high degree of practical and scientific competence. He can face the challenges and changes of the world, and keep up with the skills of the future in light of the development of technologies in various fields of life (Oman Vision 2040, 2020). There, education in Oman shed its emphasis on developing national talents with dynamic capabilities and 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 developing generative thinking skills among 10th Omani graders. It is comparing the quality of humans and ChatGPT techniques in acquiring study sample generative thinking skills.

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

Methodology

The study will shed light on positive utilizing of these techniques 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 generative thinking skills by comparing descriptive statistics and effect sizes.

Sampling and Data Collection Procedure

The study was conducted in Oman through a quasi-experimental design, where the sample (N=58) has split up into an experimental group (N=29) taught by AI-based teaching using ChatGPT, and a control group (N=29) 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 generative skills scale (of 30 items), and teacher manual have been prepared. Both were validated by a panel of juries, whereas the scale reliability was calculated through alpha Cronbach giving a value of (0.803).

The following table is describing generative skills covered by scale items:

Item No	Question type	Skill	Item Score
1,2,3,13,21,22	Objective	Imposing assumptions	6
4,5,6,15,16,19	Objective	Data- based Prediction	6
7,8,9,14,17,18,20,23,24	Objective	Fluency and flexibility	9
10,11,12	Objective	Errors identification	3
25,26,27,28,29,30	Essay	criticism	6
30			30

Once study sample was determined, a pre-testing of generative thinking skills 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 conventual way. Then, the post-test of the generative thinking skills was carried out for both groups.

Results and Discussion

Post- testing results, for both experimental and control groups, were manipulated to get means, standard deviations, independent samples t-test and eta-square ($\eta 2$); and to calculate the significant differences between means of the experimental and control groups in the post-testing of the generative thinking skills; as shown below.

Group	N	Mean	SD	t.Value (df=56)	Sig.	$\eta 2$	Effect Size
Experimental	29	19.59	4.15	3.280	0.002	0.161	
Control	29	15.86	4.49				High
High Score = 30							

Results indicated that there is 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 of the generative thinking skills test in favor of the experimental group.

For more details on the performance of the experimental group, the table below shows means (M), standard deviations (SD), paired sample t-test, Cohen test value for each generative skill.

Skill	Score	Pre-test		Post-test		t. value df=28	Sig	Cohen test	Effect size
		M	SD	M	SD				
Imposing assumptions	6	3.24	1.06	2.00	1.20	5.791	0.001<	1.08	High
Data- based Prediction	6	4.45	1.21	3.07	1.69	4.670	0.001<	0.87	High
Fluency and flexibility	9	5.90	1.97	4.28	1.75	4.069	0.001<	0.76	Moderate
Errors identification	3	2.14	0.83	1.31	0.81	5.870	0.001<	1.09	High
criticism	6	3.86	1.62	2.38	1.59	4.376	0.001<	0.81	High
Total	30	19.59	4.15	13.03	5.53	8.099	0.001<	1.50	High

It is clear from the above table that there is a statistically significant difference in all generative thinking skills between the pre- and the post-test means. The table also indicates a large effect of this teaching strategy according to Cohen's test. It was also noted that the effect size in all sub-skills of the test was large, with the exception of the skill of fluency and flexibility, where the size of the effect was medium. This result can be attributed to the nature of this skill, which is characterized by the multiplicity and ease of methods that may help students reach the correct answer and provide them with several ways to answer.

Conclusion

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.

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