Exploring the Impact of ChatGPT on Scientific Research: Assessing Strengths, Weaknesses, Opportunities, and Threats

Yousef F. Alfarraj
https://orcid.org/0000-0001-7750-028X
Department of Curriculum and Instruction, College of Education, the Excellence Center of Science and Mathematics Education (ECSME), King Saud University, Saudi Arabia
yalfarraj@ksu.edu.sa

Yousef Wardat
https://orcid.org/0000-0003-2370-9808
Curriculum and Instruction Department, Yarmouk University, Jordan
yousef.wardat@yu.edu.jo

Abstract

One of the most influential technologies, ChatGPT, has extensive implications for several domains of our life, including scientific research. A SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis was conducted to evaluate the benefits and drawbacks of leveraging ChatGPT in scientific research. The results demonstrate potential advantages in terms of evaluation and assessment, individualised and continuous learning, linguistic competence, comprehensive knowledge, increasing accessibility, and information retrieval. At the same time, there are important shortcomings, such as the absence of contextual knowledge, outcome and information bias, and a limited advanced cognitive ability. The results point to several threats: plagiarism, academic dishonesty, ethical challenges, as well as cybersecurity and privacy concerns. Furthermore, the data point to various prospects, such as creating interactive settings, improving teaching and learning, contributing to literature, collaborative brainstorming, language translation, and knowledge sharing. These complicated considerations necessitate caution when employing artificial intelligence applications since the potential of ChatGPT to improve scientific research is dependent on how researchers utilise its strengths and opportunities while limiting its weaknesses and threats. Thus, great innovation is born out of smart technologies and smarter practices.

Keywords: scientific research; ChatGPT; large language models; SWOT analysis

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Introduction

Artificial intelligence (AI) tools are becoming increasingly popular among academic communities. While different AI technologies are being harnessed for various applications—such as diagnosing diseases, tagging cell images, predicting protein-ligand binding affinities, and conducting literature reviews—the recent introduction of GPT (Generative Pre-trained Transformer) has produced concerns and enthusiasm about the future of scientific research. ChatGPT and other similar GPT-based models represent the most widely used AI tools by researchers. They bring the potential to open new methodological research directions and applications across academia, at the same time giving rise to several threats (Whalen and Mouza 2023).

ChatGPT is an AI language model that can participate in open-domain dialogues and produce human-like responses. It has the potential to influence research trajectories and create new academic prospects (Rospigliosi 2023). It uses deep learning to analyse and assess large sequences of characters, producing cohesive text for both long-form and short-form writing (Sullivan, Kelly, and McLaughlan 2023). ChatGPT is a significant advancement in AI language models, aiding in the extraction of new knowledge from scientific literature (Cox and Tzoc 2023).

The transformer model enables researchers to experiment with larger language representations and text data, enabling research in the development of conversationally persuasive agents. Within the research-driven scope, GPT-style models have been implemented as an academic writing tool (Loos and Radicke 2024) for activities as diverse as literature reviews, full-length articles, abstracts, intensive writing in the human-computer interface, generating linguistic entanglement, scholarly travel applications, and the creation of research ideas. In practice, these models may potentially be utilised to offer research insights sorted into multiple interconnected research disciplines, enabling interdisciplinary and transdisciplinary research practices to navigate towards interdisciplinary objectives. Scientific audit instruments, research methodologies, and results may be devised to encapsulate current knowledge from external and related fields, informing the direction of novel interdisciplinary research (Sullivan, Kelly, and McLaughlan 2023; Tlili et al. 2023).

Recent studies have explored the use of a transformer model in writing-based artificial intelligence, revealing its potential for various applications. However, critics argue that this approach may oversimplify complex issues and may lead to superficial conclusions. This is particularly relevant in social science and humanities disciplines, where the use of SWOT analysis may not align with the preferences of all academics. The study attempts to offer conclusions about the application of AI in scientific research and to address issues regarding its application across different academic settings.

Given the numerous uses and ongoing global research shifts, it is crucial to establish comprehensive rules and frameworks that outline the extent of the anticipated application scenarios (Kasneci et al. 2023). Several recent works have investigated

unconstrained open prompts utilising a transformer model to explore diverse innovative AI-generated writing trajectories. A mind map was created to illustrate the numerous implementation alternatives for the identified open question, along with a narrative survey that further examined current literature on application explorations (Ganguly and Dutta 2024). The model demonstrated extensive applicability for writing-oriented artificial intelligence, ranging from brief summaries to prominent research papers. Nevertheless, Cotton, Cotton, and Shipway (2023) indicate that human writing is typically more contextually oriented and better aligned with the audience's needs, while AI-generated writing frequently appears more broad and less tailored to a specific topic.

Certain researchers, including Jarrah, Wardat, and Fidalgo (2023), urge for the formulation of norms on the utilisation of platforms such as ChatGPT in scientific publishing. They underscore the significance of evaluating the precision and dependability of AI-generated information. A multitude of experts argue that, when utilised correctly, AI can serve as a tremendous instrument for information acquisition while maintaining academic integrity (Mohamed 2024).

To comprehend ChatGPT's importance in the Fourth Industrial Revolution, it is crucial to analyse its historical progression and to assess its influence on modern technical progress. The Fourth Industrial Revolution, defined by the integration of digital, physical, and biological technology, has initiated a period of unparalleled connection and automation. In this context, ChatGPT signifies a significant advancement in the development of artificial intelligence, especially in natural language processing (NLP) (Ganguly and Dutta 2024).

The origins of ChatGPT can be dated to the advancement of deep learning methodologies and neural network science in the late twentieth century. Advancements in machine learning, driven by increased processing power and data accessibility, facilitated the development of advanced language models capable of producing human-like text. The development of the Generative Pre-trained Transformer series by OpenAI, which was launched in November 2022 (Mathew 2023), represents a significant shift in AI research towards large-scale pre-training methodologies (Kalla and Smith 2023).

Within the emergence of the Fourth Industrial Revolution, ChatGPT exemplifies the amalgamation of artificial intelligence, big data, cloud computing technologies, and the Internet of Things (IoT), facilitating advanced and accessible AI-driven solutions (Hwang et al. 2024). Its capacity to recognise and create natural language responses has implications for numerous domains, including medicine, pharmacy, healthcare, finance, education, and research in general. This elucidates how ChatGPT can transform human-machine interaction and information exchange in the digital era (Kasneci et al. 2023) by contextualising it within the broader framework of technological advancement. ChatGPT's widespread use in scientific research is gaining attention due to its potential benefits (Ganguly and Dutta 2024). It enhances productivity and innovation by creating a sustainable ecosystem for academic institutions, technology companies, and

researchers. This improves data analysis, literature reviews, and idea generation while also expanding the market for AI products and services, thereby improving productivity and promoting innovation (Chinonso, Mfon-Ette Theresa, and Aduke 2023).

Researchers could benefit from ChatGPT applications by exploring innovative research avenues, generating original concepts, and fostering collaboration with colleagues—thus enhancing research outcomes and academic influence. However, apprehensions exist regarding the interests promoted by the integration of ChatGPT in scientific research, despite the potential benefits. These issues encompass data privacy, intellectual property rights, job displacement, and equitable access to AI-driven research tools. Consequently, it is imperative to rigorously evaluate the ramifications of ChatGPT usage and to guarantee that its advantages are disseminated across society while also confronting the societal issues associated with its incorporation into scientific research.

Study Purpose

The study attempts to analyse the integration of ChatGPT into scientific research through SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis. The main objective is to assess the advantages and disadvantages of deploying ChatGPT in scientific research, highlighting its strengths, shortcomings, opportunities, and possible threats.

Research Questions

This research aims to answer the following main question:

How can ChatGPT be used to promote the efficiency of scientific research through leveraging its strengths and opportunities, while also addressing its weaknesses and associated threats?

Sub Questions

1. What specific strengths does ChatGPT offer in enhancing the efficiency of scientific research?

2. What specific weaknesses does ChatGPT exhibit in terms of scientific research?

3. What opportunities does ChatGPT provide for enhancing scientific research?

4. What risks are associated with using ChatGPT in scientific research?

Study Significance

This article is significant as it examines the incorporation of ChatGPT in scientific research, focusing on its strengths, shortcomings, opportunities, and threats. As

ChatGPT gains prominence in academic environments, comprehending its diverse ramifications is essential for academics, educators, and policymakers. The research methodically evaluates its strengths, emphasising the model's potential contributions, including personalised learning and continuous learning. It investigates opportunities, including the enhancement of teaching and learning. It also identifies deficiencies such as bias in outcomes and inaccuracy of information. The study concurrently examines potential concerns, including academic dishonesty and plagiarism. The article examines the ethical considerations of AI in scientific research, emphasising the significance of issues related to privacy and prejudice. The study contributes to the discussion surrounding responsible AI use in educational environments by examining its benefits and drawbacks.

Methodology

This study uses the SWOT analysis method of research to assess the implementation of ChatGPT in scientific research. A SWOT analysis is a strategy that investigates the strengths, weaknesses, opportunities, and threats (Teoli, Sanvictores, and An 2019) that surround a project, company, or product. It is well suited for this study since it is comprehensive and helps offer a systematic method of evaluating complicated phenomena. Farrokhnia et al. (2023) and Giray, Jacob, and Gumalin (2024) have already conducted work in this area, which this study aims to expand upon. Using the SWOT analysis framework also makes it possible to systematically introduce and evaluate a number of variables. In this case, these variables show how closely ChatGPT is connected to the complicated processes involved in scientific studies, as shown in Figure 1.

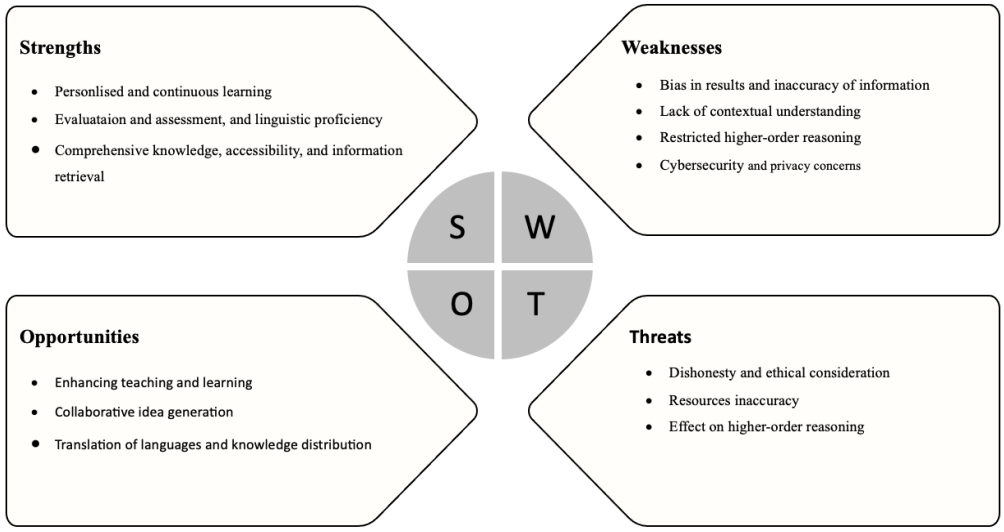

Figure 1: Evaluation of ChatGPT integration into scientific research (SWOT analysis)

Literature Search Strategy and Data Collections

We selected and evaluated several articles published in leading education and artificial intelligence journals between 2018 and 2024, including, for instance, *Education and Information Technologies*, *International Journal of Artificial Intelligence in Education*, *Computers and Education*, and *Artificial Intelligence Review*, as they feature AI in education or dedicate special issues to AI tools and education pedagogy. We also conducted research on specific topics that detail the use of artificial intelligence in teaching. In addition, Google Scholar, Science Direct, and Scopus were the databases of choice for the search, as they incorporate a large number of documents on the topics of interest (Pinzolits 2024). Therefore, we conducted a systematic and structured scoping review of pedagogy and artificial intelligence within the disciplinary area. Figure 2 illustrates the relationship among our research keywords.

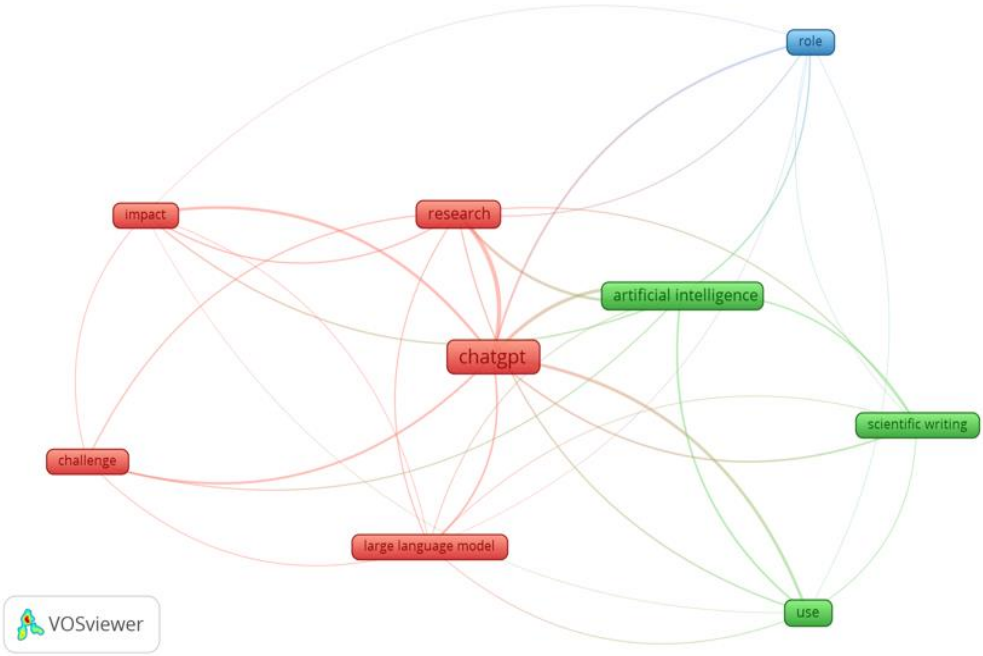

Figure 2: Outcomes of keyword co-occurrence analysis (Source: Authors, utilising VOSviewer software)

Findings and Discussion

This section examines the SWOT analysis—strengths, weaknesses, opportunities, and threats—regarding the application of ChatGPT, an AI language model, in scientific research. The main objective is to provide a detailed analysis of the different aspects of incorporating ChatGPT into research activities, delivering a comprehensive assessment of the potential advantages and challenges that researchers might encounter when utilising this AI tool.

First: Strengths

Personalised Learning and Continuous Learning

Personal and continuous learning has earned significant attention in the fields of learning and research (Else 2023), as it offers ongoing experiences tailored to the learner's educational level. With advancements in knowledge and technology, personalised and continuous learning opportunities have emerged to enhance individual learning. Technologies such as ChatGPT play a crucial role in supporting lifelong learning (Amal, Saiid, and Mansor 2024).

In alignment with the Saudi Human Capability Development Program (Kingdom of Saudi Arabia 2021), the Ministry of Education provides personal and continuous opportunities aimed at enhancing students' literacy and skills. The objectives of these

initiatives are to eliminate illiteracy in all its forms and to instil the principles of quality lifelong learning. Current efforts have shifted towards a broader concept that encompasses continuing and lifelong education, enabling learners to acquire the skills necessary for the twenty-first century and the Fourth Industrial Revolution. Thorat et al. (2024) found that integrating Chatbot GPT into dental education offers promising opportunities for enhancing the learning experience. By creating personalised learning pathways that align with student-centred principles, Chatbot GPT promotes adaptive environments tailored to meet individual needs, thereby encouraging continuous learning. Tony (2023) indicates that ChatGPT, an AI-based chatbot, provides significant advantages for college students' self-directed learning. By engaging in conversations with ChatGPT, students receive personalised study assistance and guidance designed for their actual needs. The chatbot leverages extensive resources to analyse students' learning behaviours and performance, enabling it to create customised study plans and recommend relevant learning materials. This personalised approach allows students to select appropriate content based on their advancement and aptitudes, thereby enhancing their learning outcomes. Additionally, ChatGPT fosters a sense of independent learning, which is essential for students' future success.

Evaluation and Assessment, and Linguistic Proficiency

The evaluation process is basically a measurement system aimed at measuring how well goals have been accomplished, acting as a precursor to decision-making. It serves three main roles: diagnostic, which identifies strengths and weaknesses; formative, which provides ongoing feedback during the learning process to enhance performance; and summative, which assesses overall achievement and outcomes at the end of a learning period or project (Yeung 2023). The use of ChatGPT in assessment and evaluation provides opportunities in various disciplines and domains. Its advanced language processing capabilities allow for innovative assessment methods, which may enhance learning outcomes by providing immediate feedback and handling large volumes of assessments efficiently.

Theelen, Vreuls, and Rutten (2024) examine the potential of large language models (LLMs) such as ChatGPT for qualitative data analysis, specifically concentrating on open coding, selective coding, theme and pattern identification, as well as inter-rater reliability. The findings indicate that ChatGPT offers promising capabilities in open coding, demonstrating a high level of accuracy in the categorisation of qualitative data; however, the study also highlights challenges linked to axial coding, attributed to the model's restricted comprehension. Wang et al. (2023) conducted a meta-evaluation of ChatGPT to evaluate reliability as a metric for natural language generation (NLG) by treating ChatGPT as a human evaluator. Researchers provided task-specific instructions, such as summarisation, along with aspect-specific guidelines, such as relevance, to facilitate ChatGPT's evaluation of outputs generated by NLG models. The results indicate that ChatGPT achieved advanced correlations with human judgements in the majority of cases. Furthermore, the study found that the effectiveness of ChatGPT as an evaluator appears to be influenced by the methodology used in creating the

evaluation datasets. Bin-Hady et al. (2023) emphasise ChatGPT's importance in improving language competence. The model functions as a learning support system, offering feedback on language usage and acting as an interactive companion in language practice by proposing pertinent tasks. Their research advances a comprehensive five-dimensional paradigm for AI-assisted language learning, enhancing teacher flexibility, promoting student autonomy, creating compelling learning experiences, encouraging future innovation, and supporting different applications. Kohnke, Moorhouse, and Zou (2023) emphasise ChatGPT's function in establishing trustworthy relationships in language acquisition. The AI tool can generate quizzes, annotate texts, translate content, and provide sample sentences. It can also recognise word meanings in context, correct and explain linguistic faults, and generate texts in various genres, including emails, stories, and recipes. Because of its many features, ChatGPT is a flexible tool that may be used for various purposes in various industries.

Vast Knowledge, Accessibility, and Information Retrieval

ChatGPT provides extensive knowledge and high accessibility, enabling users to engage easily with a wealth of information and diverse perspectives. It benefits from comprehensive training on a wide range of textual sources and prompts, equipping it to deliver insights across numerous academic disciplines. ChatGPT's broad knowledge base allows it to supply relevant and up-to-date information to researchers by leveraging the vast resources of the World Wide Web (WWW) and integrating this data into its extensive repository. Experts note that utilising ChatGPT can significantly expedite the extraction of essential points and core ideas from complex research topics, thereby enhancing the efficiency of compiling literature reviews for scientific research (Kalla and Smith 2023). This highlights ChatGPT's ability to swiftly provide targeted information tailored to the specific needs of various tasks.

Lund and Wang (2023) conducted a study aimed at exploring the impact of AI and GPT on academia and libraries. The study indicates that ChatGPT can be used to enhance literature review assistance, text generation, data analysis, language translation, automated summarisation, and answering questions. Using ChatGPT can be beneficial for search and discovery, reference and information retrieval, cataloguing and metadata generation, and content creation. Shidaganti et al. (2023) demonstrate recent advancements in a study that shows how ChatGPT can use optical character recognition (OCR) and robotic process automation (RPA) to extract information from images. Their research indicates that ChatGPT can transform text-containing images into text-based prompts, indicating that the AI can recognise and convert text from different sources and formats, allowing users to search for specific information relevant to their academic pursuits. Furthermore, OCR and RPA technologies can streamline the extraction of data from various sources and images, significantly speeding up data collection and processing. However, it is important to note that OCR accuracy can be influenced by factors such as font styles, language variations, text clarity, and image quality (Nandalwar et al. 2023).

Zhang et al. (2023) assess the efficacy of ChatGPT in extracting required information to derive insights for developing more efficient methods or tools for requirement retrieval via generative large language models. The findings indicate that ChatGPT demonstrates a promising ability to recall pertinent requirement information; nevertheless, its capability to recover more detailed details is constrained. ChatGPT, as an AI, is engineered to address user enquiries while perpetually learning and adapting to increasingly intricate systems and upgrades to enhance its understanding of user requirements (Roumeliotis and Tselikas 2023). Nonetheless, it is imperative to recognise specific restrictions. Despite its capacity to produce correct information, ChatGPT's extensive knowledge base may lack comprehensive coverage of precise details in specialised domains. The lack of emotional intelligence, possible prejudice, and reliance on particular cues may limit its capacity to deliver nuanced or highly specialised insights. Mitigating these limitations may necessitate refining the model to better align with user requirements and particular domains (Hidayat and Wardat 2024; Stojanov 2023).

Second: Weaknesses

Biased Results and Inaccurate Information

As a generative AI model, ChatGPT exhibits biases and mistakes in its responses, thus undermining its consistency and reliability in scientific study. These difficulties are seen throughout multiple domains. Elmas, Adiguzel-Ulutas, and Yılmaz (2023) conducted a study to assess the validity of responses generated by ChatGPT in the field of biochemistry. The researchers performed a document analysis to assess the scientific accuracy of ChatGPT's responses for five specific themes. The enquiries, derived from a biochemistry course, were presented to ChatGPT in written form. The generated responses were recorded and assessed for their scientific validity. The study reveals that ChatGPT produced scientifically inaccurate or insufficient responses to all the five enquiries. Furthermore, when interrogated regarding the justification for its responses, the AI maintained its erroneous answers. Following prompts to increase accuracy, the AI's performance was re-evaluated, resulting in scientifically accurate answers for the initial two questions, partially correct responses for the third, and consistently erroneous answers for the subsequent questions. Yuan et al. (2024) conducted a study to investigate psychological traits, cultural values, biases, and prejudices in order to create an inclusive psychological profile of ChatGPT. The research determines that ChatGPT's efficacy in eight decision-making tasks reveals notable cultural prejudices and biases.

Lack of Contextual Understanding

Despite ChatGPT's considerable proficiency in producing human-like responses and aiding in various tasks, it has various limitations. The model proficiently detects grammatical, spelling, and punctuation errors. However, it may encounter difficulties with complex or specialised topics, resulting in inaccurate or inadequate responses. ChatGPT's understanding of context mostly relies on the user's input and the training data it has assimilated (Alneyadi and Wardat 2023). ChatGPT integrates the user's input

with its training data to understand the context and provide relevant responses. It is essential to acknowledge that ChatGPT's understanding of context is limited to the material included in its training. Thus, when a prompt includes information or references outside its training parameters, ChatGPT may find it challenging to accurately understand the context. This limitation may hinder its ability to accurately interpret meanings and understand enquiries, hence reducing its effectiveness. Yang and Ettinger (2023) assessed the situational understanding (SU) of ChatGPT. The research demonstrates that the model's efficacy does not maintain alignment with real environmental variables over time. Despite the availability of the entire conversation history, evaluations indicate that ChatGPT's absence of enduring in-context memory is the principal reason for this performance loss. Furthermore, it is prone to deceptive updates that inflate accuracy metrics. The data indicate that ChatGPT lacks the fundamental mechanisms for effectively monitoring contextual understanding, thus requiring thorough assessment of its conversational effectiveness.

The lack of contextual understanding might be attributed to the fact thar ChatGPT, like other AI language models, depends on training data. The ChatGPT model is designed to anticipate the next word in a sentence by analysing the previous words during pre-training. To accomplish this, the model is trained on a huge dataset using masked language modelling. This dataset often includes several sources, such as books, journals, and websites (Wang et al. 2024). Thus, researchers should use ChatGPT cautiously. Although useful, it should not be relied on exclusively, especially for critical judgements. ChatGPT should be used as a supplement rather than a source of authority because it struggles to understand and analyse complex material (Alneyadi et al. 2023). These limits make AI language models' credibility as information sources uncertain. At this point, it needs to be used with caution. ChatGPT and other AI models can provide significant insights and support, but they must be supervised. If these models are used without human monitoring, faults and biases may spread (Dale 2021).

Restricted Higher-Order Reasoning

ChatGPT lacks comprehension and analytical skills, responding to statistical trends rather than analysing a topic. The model lacks reliable real-world data and direct supervision by human specialists, causing this weakness. ChatGPT can participate in scientific debates, but its conclusions may be superficial. ChatGPT examines a question and responds by detecting patterns from its training data without performing analytical thinking or in-depth research. Higher-order thinking involves questioning, analysing, and evaluating information, establishing logical connections, identifying biases, and considering multiple perspectives. Drawing conclusions requires topic knowledge, critical thinking, and reasoning. However, ChatGPT cannot perform these cognitive tasks.

Ghosh and Bir (2023) conducted a study to find out if ChatGPT may resolve higher-order issues pertaining to medical biochemistry. This research demonstrates that ChatGPT may serve as an effective instrument for addressing enquiries requiring

higher-order thinking in medical biochemistry; however, continuous training and growth utilising new advancements in data are vital for improving performance and ensuring functionality in the expanding domain of academic medicine. Liu et al. (2023) analysed multiple logical reasoning datasets, such as LogiQA, ReClor, and AR-LSAT. They evaluated reading comprehension through multiple-choice questions and natural language inference tasks based on logical reasoning standards. An out-of-distribution dataset for logical reasoning was created to assess the performance of ChatGPT and GPT-4. The findings reveal that handling newly introduced datasets significantly impacts their effectiveness. Both ChatGPT and GPT-4 face ongoing challenges with logical reasoning, particularly in relation to natural language inference and newer datasets. Although ChatGPT has been recognised as a beneficial resource for enhancing research, increasing efficiency, and refining writing in various domains, it struggles to provide deep insights on a wide array of topics. Its responses are constrained as it primarily reiterates previously acquired information without significant analytical capabilities. This constraint may affect users, particularly those reliant on ChatGPT for educational objectives, perhaps obstructing their creative growth if utilised improperly (Azaria, Azoulay, and Reches 2024; Chinonso, Mfon-Ette Theresa, and Aduke 2023).

Cybersecurity and Privacy Concerns

Considering ChatGPT's significant progress in natural language processing, additional examination is necessary regarding the technological and ethical issues associated with cybersecurity and privacy. Derner and Batistič (2023) investigated the security issues associated with large language models, focusing specifically on ChatGPT. They found various types of issues related to the utilisation of AI models, including code generation and personal information disclosure. Sebastian (2023) examined the cybersecurity and privacy matters associated with the use of AI-based chatbots such as ChatGPT. The study found that respondents expressed concerns regarding the potential cyber issues related to chatbot technology. These concerns centre on social engineering attacks, malware threats, phishing attacks, identity theft, and data leaking. Notably, approximately 88% of the participants believe that chatbots have the potential to gather personal information or influence users.

Researchers such as Huang and Ma (2023) and Wu, Duan, and Ni (2024) propose methods to tackle privacy issues and strategies to prevent data leakage and unauthorised access while advocating for collaborative efforts to ensure the establishment of secure and ethically responsible large language models. Liu et al. (2024) highlight the importance of balancing technological advancement with user privacy. We expect privacy protection to become a fundamental aspect of data-driven applications as technology continues to progress. Shafik (2024) emphasises that adherence to data protection regulations, such as the California Consumer Privacy Act (CCPA) and the General Data Protection Regulation (GDPR), is vital for protecting data privacy. Establishing a secure framework that includes encryption, data access controls, and regular security audits enhances overall security. Furthermore, user awareness and

consent are essential, necessitating transparent opt-out options, data collection practices, and informed consent.

Third: Opportunities

Enhancing Teaching and Learning

ChatGPT facilitates tailored responses for students with diverse cognitive styles, talents, and foundational knowledge, hence enhancing the consistency and impact of the learning process. The capacity to produce unique, AI-driven dialogues fosters student engagement, which is essential for active learning. An advanced educational framework that facilitates instant, sequential mastery of precise research related to concepts and reasoning will utilise AI to reduce obstacles to personalised teaching approaches in larger classrooms, recognising individual cognitive variances and learning methodologies. Notably, although smart tutoring systems and cue-based adaptive systems are regarded as standard within the adaptive learning community, AI's capacity to generate full, organically formulated questions and answers offers a level of personalisation (Mohamed 2024).

Moreover, ChatGPT functions as a tool for student interaction and as a source for instructional information (Kooli 2023). Instructors who employ interdisciplinary approaches such as Science, Technology, Engineering, Art, and Mathematics (STEAM) can significantly enhance their resources by incorporating ChatGPT into their lesson plan. Tutors and educators may observe enhanced learning outcomes by integrating various instructional resources (Lo et al. 2024). By incorporating chat, voice, or written question-answering from critiques, historical data logs, or tutoring sessions, instructors will obtain immediate feedback on prior human responses to questions, the dynamics of the chat, and the insights ChatGPT may impart to students when the fundamental aspects of the problem are elucidated. There is a fear that excessive dependence on AI-generated questions and responses may impede the cognitive skills we need to develop in children. Educators must reconcile the tool's functionalities with conventional methodologies (Kooli 2023). Çobanoğulları's (2024) investigation demonstrates that ChatGPT can noticeably improve foreign language writing and conversational skills by providing tailored language assistance, encompassing personalised feedback and instruction that promote more proficient knowledge acquisition.

Collaborative Idea Generation

The AI assistant excels at idea generation among scientists, providing diverse perspectives on questions and topics. As such, it excels as a sounding board to help refine research questions and hypotheses. Additionally, it can provide a fresh set of eyes on a topic and suggest new approaches. Collaborative brainstorming is a precious opportunity for researchers to work together, both professionals and novices, to shape scientific investigation and enquiry. In searches with it as a collaborator, it has been particularly valuable for insight generation and study design (Stojanov 2023).

The capabilities of AI, encompassing meaningful and spontaneous responses to input, psychological detachment from known frameworks, and outputs unrestricted by temporal and conventional limitations, characterise it as a creative thinker and contributor within a brainstorming team. Collaborative talks on subjects have shown that research backgrounds can enhance, elaborate, and elucidate brainstorming. Mentorship encompasses novices in joint research and brainstorming, where significant questions are deliberated (Zhu et al. 2023).

Filippi (2023) evaluated the effect of ChatGPT on idea generation in product design. The findings indicate that the influence of ChatGPT is apparent in the volume of offered ideas. However, its success includes beneficial as well as negative aspects including utility, innovation, and diversity. From a novelty perspective, ChatGPT surpassed expectations, yet its knowledge base is confined to previously recorded events. AI may enhance brainstorming by technologically incorporating other participants in the study problem. However, careful consideration must be exercised to prevent justifying the substitution of AI for the intentional involvement and examination by individual scientists. Furthermore, in light of the AI's suggested creative notions, it is imperative for researchers to engage actively in all stages of the ideation and discourse process. Systematic interrogation and testing of these unique concepts may enable diverse collaborative enquiries (Yilmaz and Yilmaz 2023).

Translation of Languages and Knowledge Distribution

ChatGPT plays a crucial role in bridging linguistic barriers by providing proficient translation services that enhance the accessibility of research and knowledge across diverse languages. By effectively managing these linguistic obstacles, it fosters dialogue and collaboration among international audiences, making valuable scientific literature more accessible. Its ability to accurately translate specialised vocabulary and abstract concepts ensures that the original context is preserved, promoting engagement with the material. Ultimately, ChatGPT's translation capabilities not only facilitate communication but also contribute to a more interconnected and informed global community (Nikolic et al. 2023).

There has been an increasing recognition of the persistent importance of academics presenting their research to a wider audience. AI tools such as ChatGPT can strategically aid in disseminating cutting-edge content to a larger and more global readership, thereby incorporating others into scientific advancement practices. ChatGPT, as a language-facilitating AI system, cannot weigh the risk of translating scientific articles incorrectly (Lim et al. 2023). Human editors possess contextual and regional knowledge that the model may not perceive, thereby highlighting potential limitations in the process. Users may utilise the tool to translate articles, while others may encounter language barriers when searching for research topics using traditional search engines (Sreen and Majid 2024). One of the defining characteristics of scientific research is the heavy emphasis on distribution, which measures the significance of a scientific contribution; a finding's impact increases with its widespread knowledge or sharing. Scientific discoveries often

reach the broader community even before publication through preprint articles, presentations at scientific conferences, or discussions with colleagues. This practice provides an opportunity for feedback and learning about other work in the field, and it can facilitate the dissemination of knowledge within the scientific community (Ouh et al. 2023).

ChatGPT adds value by summarising presentations and articles, enhancing communication for researchers of varying expertise (Zhu et al. 2023). Non-scientists often struggle with technical language, but accessible academic papers can provide clear insights and actionable advice. For instance, a medical student might grasp important concepts from a methods section on cancer therapy. While a broader readership can increase interest and funding, it does not always lead to more citations. Social media can generate immediate attention, though it risks oversimplifying research. Striking a balance between accessibility and rigour is crucial, as non-scientists prioritise core messages over complex details, even if this leads to some distortion of the original research (Popovici 2023). AI can be regarded as a cognitive substitute for translators, facilitating the enhancement of necessary competencies and skills in the discipline, thereby enabling the evolution of translation beyond conventional roles and methodologies (Lee 2023).

Fourth: Threats

Dishonesty and Ethical Considerations

Plagiarism is defined as representing someone else's ideas or work as one's own. Academic dishonesty includes any attempt to receive or provide assistance in completing an academic assignment. This technology could potentially lead to a reduction in the range of innovative ideas among researchers, a possibility that still requires empirical testing. In theory, researchers might use this technology to generate ideas, improve their writing abilities, assist in coding experiments, provide survey questions, suggest hypotheses, generate writing formulas, or generate article summaries without acknowledging their contributions (Ganguly and Dutta 2024). Improper attribution of AI contributions is considered a real threat in academia. Researchers could be disadvantaged if they had invested resources that subsequently become less popular due to an alternative supply of resources. To maintain the integrity of the academic research process, one ethical consideration for researchers is the importance of investing time and making ethical considerations to train more potent AI models with fairer datasets (Zhu et al. 2023).

Rane, Paramesha, and Desai (2024) underscore the necessity for academic institutions to implement a comprehensive strategy that encompasses revising honour codes, enhancing AI literacy among students and faculty, acquiring sophisticated AI-detection tools, and cultivating a culture of academic integrity to effectively tackle the consequences of AI in education.

The increasing use of AI language models in scientific research raises ethical concerns, including the definition of authorship, authenticity of data and results, and the perceived value of research outputs (Nikolic et al. 2023). Critics argue that AI language models are akin to employing uncredited contributors, challenging traditional academic integrity. Some researchers and developers have proactively stated they do not use AI in their work, while institutional authorities have taken varying stances. AI-generated content may contain intrinsically embedded biases, making it less valuable to science. Critical assessment should be made before using AI-generated data, text, and graphics in scientific research, with clear communication to a specialised party about the origin of the datasets. Informed consent is also crucial for AI research projects. Furthermore, academic institutions should establish fair practice guidelines for AI-based research and collaborate with the AI scientific community to navigate these dilemmas (Sahlgren 2024).

Inaccurate Information

A critical issue with any AI that produces information is its vulnerability to misleading information (Żmudka et al. 2014), resulting in the dissemination of inaccurate or invalid content, thus undermining the integrity of scientific enquiry. Instances of AIs producing deceptive information and providing unsuitable recommendations are common. This may represent a valid observation in scientific discourse, either positively—where creative applications occasionally produce new insights—or adversely, as it may provoke uncertainty about the reliability of AI-generated data and its implications for education and the overall knowledge society (Oertner 2024). The inaccuracy of ChatGPT arises from the attribution of inaccurate data. The nature of ChatGPT is dependent upon training data, generating processes, and programming, as well as unreliable resources (Oertner 2024). As a pre-trained model, ChatGPT draws its responses from a diverse and extensive dataset, including books, papers, and webpages, in a universal way, allowing it to generate coherent text in response to prompts (Ray 2023). This pre-training response enables the model to possess a comprehensive understanding of several subjects, while it may not consistently exhibit accuracy (Balhorn et al. 2023).

Jan (2025) evaluated the reliability and accuracy of artificial intelligence technologies, specifically ChatGPT, in providing information for retracted academic literature and used COVID-19 as a case study. The results provide important insights into the difficulties associated with using AI for academic writing tasks, underscoring the need for sophisticated AI models capable of addressing complex, comprehensive factual queries in research contexts. Interestingly, it turns out ChatGPT can only recognise a small number of relevant retracted COVID-19 articles, predominantly with limited predictive reasoning instead of aligned evidence. This underscores the need for more powerful AI to help students with difficult fact-based questions in school settings. The rise of AI-generated innovation necessitates a thorough evaluation of AI outputs to enhance credibility and reliability. Ganguly and Dutta (2024) advocate for enhancing the legitimacy of articles by assessing the quality of AI-generated content, with peer

review being essential. Evaluating the precision of AI-generated scientific research is crucial for cultivating community confidence.

Effect on Higher-Order Reasoning

ChatGPT's ability to generate text equivalent to human natural language in response to prompts may facilitate the generation of innovative ideas or solutions across several areas, as well as the exploration of new research concepts through constructive exchanges with peers on a virtual platform. If researchers predominantly depend on AI to formulate questions derived from their reading and interpretation of search enquiries, and subsequently to analyse the responses, ChatGPT may inhibit cognitive involvement. It is necessary to expand and refine the spectrum of enquiries directed at the provided material. Documents produced by AI currently react to cognitive engagement instead of promoting it. The utilisation of AI chatbot programmes may significantly reduce cognitive enquiry, as the discourse produced by ChatGPT is pre-formulated in alignment with search perspectives, hence facilitating the cognitive process. AI decision sources must possess an inherent ability to juxtapose findings (human, machine, or hybrid) and analyse instances of divergence and their underlying reasons (Sullivan, Kelly, and McLaughlan 2023).

An increased reliance on AI has raised concerns, according to Bai, Liu, and Su (2023), since researchers may get overly dependent on these tools, which could impair their ability to think critically and retain information. ChatGPT's performance on causal reasoning tasks is influenced by the prompts' language; closed-ended prompts produce better results than open-ended ones. Additionally, ChatGPT has difficulties with implicit causality and more complicated contexts, but it does exceptionally well at identifying explicit cause and effect in sentences with lower event intensity (Gao et al. 2023).

The Beneficiaries of ChatGPT's Integration into Global Scientific Research

The utilisation of ChatGPT in scientific research necessitates a thorough examination of the interests that are prioritised through this innovation. This section aims to critically analyse the stakeholders involved and pinpoint potential beneficiaries within the realm of ChatGPT's application in scientific enquiry. The integration of AI can serve various entities, including academic institutions, researchers, and businesses. For academic institutions and their scholars, incorporating ChatGPT into scientific research offers numerous advantages. It aids researchers by enhancing data analysis capabilities, facilitating literature reviews, and fostering idea generation—all contributing to greater productivity and efficiency in research endeavours. Furthermore, providing students access to ChatGPT could enrich their learning experiences as well as their engagement with research (Zhu et al. 2023). Individual researchers also stand to gain from utilising ChatGPT. The tool enhances scholarly capacity by enabling them to formulate new ideas and hypotheses while encouraging collaboration among peers. Additionally, it

helps overcome language barriers and broadens access to diverse information sources—thereby improving both the quality and range of their investigative work (Sahlgren 2024).

Beyond academia, technology firms developing AI solutions benefit significantly from implementing ChatGPT for scientific exploration purposes. OpenAI's distribution strategy for ChatGPT bolsters its market position while generating novel revenue streams; thus, expanding offerings within the AI product line accelerates innovation amidst competitive pressures faced by tech industries (Tlili et al. 2023). Nonetheless, there are substantial concerns regarding whose interests are served through integrating ChatGPT into scientific studies. A primary issue is the risk associated with consolidating power among technology companies responsible for creating these AI systems—a development that prompts serious considerations surrounding data privacy issues alongside intellectual property rights as well as ethical dimensions inherent in AI-driven investigations (Ganguly and Dutta 2024). Moreover, the implementation raises apprehensions about its impact on employment levels within fields specifically related to science. As much as ChatGPT has prospects that enhance overall study output, it conversely threatens job security or diminishes skill requirements traditionally filled by human workers. Consequently, it becomes imperative to address the far-reaching socio-economic consequences stemming from deploying such technologies, ensuring equitable distribution of benefits throughout communities.

Engaging in critical discourse requires the integration of diverse perspectives across various fields, including ethics, technology, policy, and education, to investigate the potential consequences of ChatGPT and similar AI technologies. The dialogue should aim to identify and address the weaknesses and threats related to the utilisation of AI in scientific research. Key concerns include bias in results and inaccuracy of information, and promoting transparency in the development and utilisation of AI. By fostering open communication and collaborative efforts, stakeholders can establish standards and policies that ensure the responsible application of AI technologies such as ChatGPT for the greater good of society. This co-operative approach can lessen potential risks while augmenting the benefits of advancements in AI within scientific research (Sullivan, Kelly, and McLaughlan 2023).

Conclusion and Potential Future Directions

The SWOT analysis of ChatGPT in scientific research highlights its potential strengths, weaknesses, opportunities, and threats. While it is crucial to consider the potential weaknesses and threats associated with intelligent AI, we must also acknowledge the benefits and advancements it can bring. The success of AI systems depends on understanding their impact on science, research, and society. To ensure a comprehensive perspective, it is essential to consider misconceptions and engage in interdisciplinary research on AI's strengths and weaknesses.

The widespread adoption of intelligent AI systems such as ChatGPT requires a thorough exploration of ethical implications and societal consequences, including privacy, data security, and algorithmic bias. Interdisciplinary research can help understand the interconnections between AI advancements and societal impacts. Although the integration of AI in scientific research can revolutionise methodologies and facilitate global collaboration, addressing challenges and risks is crucial to fully harness AI's transformative power.

The integration of AI in scientific research is transforming the way humans interact with computational abilities, enabling new discoveries and advancing knowledge. AI solutions such as ChatGPT can enhance cognitive abilities, analyse data, and generate valuable insights. However, challenges such as interpretability, accountability, and unintended biases need to be addressed to ensure the safety and accuracy of AI in scientific research.

The growing scientific literature necessitates AI-powered solutions to navigate information overload. ChatGPT can help scientists collaborate across disciplines, breaking down language barriers and promoting interdisciplinary research. Nonetheless, responsible AI development and deployment are crucial. Continuous monitoring, AI governance, ethics, and compliance frameworks are essential. Involving diverse stakeholders can shape AI's trajectory and align it with societal values and goals. The synergy between human ingenuity and the computational power of AI systems such as ChatGPT paves the way for groundbreaking advancements, enabling academics and researchers to tackle complex problems, unlock profound insights, and make unparalleled strides towards societal progress. Through a relentless commitment to responsible AI development, we can ensure that these technologies are harnessed for the greater good, empowering scientists with unprecedented tools to push the boundaries of knowledge and foster innovation.

Future research on GPT models is crucial for enhancing the efficacy and functionality of research institutions. Innovative governance mechanisms and thorough discussions on ethical implications are essential. Involving a diverse, multidisciplinary group—including experts in philosophy and ethics—can significantly enrich these discussions. GPT models have the potential to revolutionise scientific disciplines by uncovering patterns in large datasets and identifying relationships that may not be immediately apparent. They can facilitate genomics by forecasting gene interactions (Nath et al. 2024), hence optimising research endeavours. Furthermore, these models can improve experimental design by facilitating virtual simulations (Benfatah et al. 2024), thereby substituting expensive experiments that require significant labour and money. Researchers in pharmacological development can utilise simulations to forecast the efficacy of drugs prior to undertaking costly clinical trials. Furthermore, teachers specialising in STEAM fields can utilise technologies such as AI tools to develop and deliver scientific content (Kotsis 2024) and enhance interdisciplinary approaches (Alfarraj and Althubyani 2023). Investigating the effectiveness of integrating ChatGPT

into educational practices is also highly encouraged. As technology evolves, understanding how AI tools such as ChatGPT can enhance both learning and teaching processes becomes essential. For example, ChatGPT can provide personalised tutoring or assist educators in creating tailored learning materials.

On the other hand, the growing utilisation of these models underlines the imperative for robust governance frameworks to address biases, privacy, and prevent the unsuitable utilisation of AI capabilities. Policymakers, scholars, and stakeholders should collaborate to create governance frameworks that align innovation with ethical responsibility. This entails advocating for the ethical application of AI models while guaranteeing accountability and openness in decision-making processes. Such direction can foster public trust and confidence in AI advancements, encouraging widespread acceptance and responsible integration into various sectors, including education and scientific research.

In summary, the broad adoption of ChatGPT in scientific research offers advantages to various stakeholders, including researchers, research centres, technology companies, and society as a whole. However, it also raises concerns about data privacy and the lack of contextual understanding. Thus, it is essential to include ChatGPT in critical discussions and ethical considerations that align with established standards and societal values. In a nutshell, great discoveries are born from smart technologies and smarter practices.

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