

The Advantages and Disadvantages of ChatGPT in Humanities, Social Sciences and STEM Education: From a Comparative Perspective

Yuman Wang^{1,a,*†}, Shiqi Wang^{2,b,†}

¹*School of Foreign Studies, Hebei Normal University, Shijiazhuang, 050024, China*

²*Suzhou Dulwich International High School, Suzhou, 215021, China*

a. wangyuman@stu.hebtu.edu.cn, b. Kayla.Wang24@stu.dulwich.org

**corresponding author*

†These authors contributed equally.

Abstract: ChatGPT is a powerful language model capable of understanding and generating human language. The increasing number of students utilizing ChatGPT to support their academic endeavors has gained prominence, prompting discussions surrounding technology and its impact on education. With the emerging trend of ChatGPT, students now could enjoy a great deal of conveniences, but there are also a number of problems while using ChatGPT. Despite extensive research investigating the correlation between ChatGPT and education, there remains a notable gap in comprehensively examining the similarities and differences concerning the benefits and drawbacks of humanities, social sciences compared to STEM fields. This research intends to delve into these domains, employing qualitative analysis to acquire pertinent data. This research will be rested on cognitivism theory and the methodological approach will be aligned to the theory. This approach involves a combination of an open-ended survey and semi-structured interviews for high school and undergraduate students to holistically explore these facets. The finding of this research might enlighten some students in using technological tools in their study in the future.

Keywords: ChatGPT, cognitivism theory, advantage, disadvantage, education

1. Introduction

The modern age, frequently referred to as the 21st century, is renowned for its significant strides in technology, which wields substantial influence over numerous aspects of human life. Furthermore, the recent strides in artificial intelligence (AI) have sparked a burgeoning interest in understanding the potential uses and consequences of AI across a wide array of disciplinary fields. This epoch is characterized by a dynamic interplay between human innovation and the digital realm, shaping the way we interact, work, and navigate the world around us. The advent of AI, in particular, has ushered in a new era of possibilities, from revolutionizing industries to challenging ethical and philosophical paradigms. As we continue to navigate this technologically driven landscape, the fusion of human intellect and artificial prowess promises to redefine the boundaries of what we can achieve, offering both unprecedented opportunities and posing complex questions that demand thoughtful consideration. This era stands as a testament to the remarkable capacity of human ingenuity to push

the boundaries of what is conceivable, ultimately reshaping the contours of our shared human experience. This article mainly focuses on the characteristics of ChatGPT, whether merits or drawbacks, in some specific subject domains. After collecting data by survey and interviews, qualitative analysis will be conducted. The significance of this research will affect different groups and methods of application, which will encourage us to rethink and examine the relationship between humans and artificial intelligence. Some restrictions and expectations also will be discussed in the end.

2. Problem Statement

The contemporary era, often denoted as the 21st century, is widely recognized for its profound technological advancements that exert influence over various facets of human existence. Moreover, the latest progressions in artificial intelligence (AI) have ignited a growing curiosity in comprehending the potential applications and ramifications of AI across diverse disciplinary domains. ChatGPT was created by OpenAI and made accessible to the public in November 2022. Since then, it has expanded quickly, reaching one million users in just five days. It took Facebook 300 days, Twitter 720 days, and Instagram 75 days to reach this figure [1,2]. What is ChatGPT? We started by asking ChatGPT to describe itself. This response was created by ChatGPT:

ChatGPT is a large language model developed by OpenAI. Based on the vast dataset of various texts, it processes and generates language using deep learning techniques, enabling it to have natural language conversations and carry out other language-related activities. [3]

The inherent attributes of ChatGPT enable it to pick up on grammar, syntax, context, and semantics. Consequently, the responses generated by ChatGPT exhibit logical coherence and contextual appropriateness, rendering it a potent instrument suitable for endeavors such as translation, summarization, creative textual composition, and various other applications. These powerful functions could help users to raise efficiency in a number of fields, in which education is one of the representatives. In education, artificial intelligence is hailed as a potentially powerful technology capable of supplementing or even replacing teachers' jobs by continuously monitoring students' development, evaluating their academic progress, and giving individualized assistance [4]. David Baidoo-Anu [5] also illustrated the advantages of using ChatGPT for education reform. For instance, ChatGPT could grade essays for students automatically, offering personalized feedback to each student's requirements and learning style [6]. It can also support STEM research by analyzing large datasets and identifying patterns and trends that traditional methods may overlook [7]. The use of ChatGPT in educational activities is important for fostering student involvement and is becoming a trend.

While ChatGPT has the potential to yield commendable outcomes, it is not exempt from generating imprecise or misleading information, thereby introducing unanticipated challenges. In the education field, one drawback of employing ChatGPT is that generative models cannot offer the same level of human contact as actual professors or tutors and they lack full conceptual comprehension [8]. There are also a few moral issues with ChatGPT: which brings up issues with authorship, responsibility, and transparency [9]. Turnitin, a plagiarism detection tool, initially showed low similarity scores for ChatGPT-4 responses, but adding human-written paragraphs increased the AI index to 100% [10].

Although ChatGPT-4 is a safer and more creative language system version, ChatGPT-3.5 is more commonly used among Chinese. Henceforth, within the scope of this thesis, ChatGPT-3.5 constitutes the contextual backdrop. The effectiveness of ChatGPT also differed between subject areas. It showed exceptional outcomes in economics, deeper thinking, and critical thinking. Its accomplishments in areas like medical education, law and mathematics, however, were not totally sufficient [11]. In the previous study, very few studies described what are the similarities and differences of using ChatGPT

experiences among different subjects, which have certain referential value in the student's daily learning.

Students who intentionally use ChatGPT will be exposed to cognitivism principles in particular. Specifically, the rationale behind students' utilization of ChatGPT is closely tied to metacognitive processes. The methods would then be carried out. An open-ended survey would be conducted first to narrow down the candidates for a further semi-structured interview. After collecting the data, the beneficial implications of students utilizing ChatGPT in various courses will be discussed. These consequences would be compared both vertically and horizontally. The next section would then go into any possible issues, challenges, or threats that ChatGPT might present to the realm of education and learning. Conclusively, the limitations and anticipations associated with this research will be presented.

3. Theoretical Framework

The act of students actively choosing to utilize ChatGPT for information retrieval or assistance is connected to metacognition. We'll start by introducing cognitivism. Cognitivism emphasizes knowledge internalization when students accept new information, though this process remains unobservable. Ertmer & Newby said, "Cognitive theories stress the acquisition of knowledge and internal mental structures and, as such, are closer to the rationalist end of the epistemology continuum." Cognitive theories focus on knowledge acquisition and internal mental structures rather than observable outcomes. Additionally, metacognition, which involves thinking about thinking, is intentional, foresighted and employed to achieve goals. The metacognitive theory highlights that thinking goes beyond mere memorization of facts or execution of skills; it involves a progression towards greater sophistication in our cognitive processes [12].

Students' decision to use ChatGPT stems from understanding its functionality and the valuable information it can provide, leading them to opt for its assistance when facing academic challenges, which is called metacognition knowledge. This process occurs within students' minds. There is another example of metacognition knowledge. Students might recognize that studying in a quiet library boosts productivity compared to home due to fewer distractions [13]. They similarly weigh the benefits of using ChatGPT over independent problem-solving. Well typically, using AI is a way to reduce cognitive load, it is possible to think about making the decision to use AI to help them with significant cognitive work. Furthermore, following the receipt of responses from ChatGPT, a predominant number of students might encounter apprehensions concerning the potential ramifications associated with the complete adoption of ChatGPT-generated content. This encompasses concerns of being implicated in instances of academic impropriety or plagiarism, thereby encompassing metacognitive encounters. It rests upon the students' individual accountability to contemplate the potential outcomes associated with incorporating ChatGPT responses.

Nevertheless, given that ChatGPT's offerings frequently hold considerable reference value, a prevailing inclination persists among students to integrate content from ChatGPT. This trend is potentially propelled by the aspiration to achieve favorable academic evaluations or to enhance articulation in their assignments, constituting a form of metacognitive objectives or endeavors. Subsequently, a metacognitive approach may emerge, wherein students may opt to employ ChatGPT-generated material while concurrently engaging in paraphrasing or making selective modifications to circumvent the predicament of potential plagiarism accusations. Collectively, the aforementioned aspects illuminate the inherent integration of metacognitive processes that transpire within students' cognitive faculties during their utilization of ChatGPT. This essay highlights the awareness of students utilizing ChatGPT, which is an aspect previously unexplored in research.

4. Research question

The previous studies mainly investigate the different performances of ChatGPT in some disciplines. This research will investigate this research question:

- According to the ChatGPT's different performance, what are the similarities and differences of advantages and disadvantages of it when using it in humanities, social sciences and STEM learning?

We will conduct a comparative analysis among the different subject domains to find the common points and differentiae. The groups of participants primarily comprise high school and undergraduate students. We would question them from a range of subject areas about their real experiences utilizing ChatGPT in order to gather some key information about the topic. Furthermore, we will have a discussion about the enlightenment from the findings.

5. Methods

5.1. Methodological Approach

Utilizing a qualitative research design, this study aims to comprehensively explore the subjective user experiences and perspectives pertaining to the benefits and drawbacks of ChatGPT's role within the educational learning process. Qualitative approaches enable an in-depth examination of the participants' points of opinion, providing for a more nuanced comprehension of the topic under inquiry. Furthermore, given the non-statistical nature of the data presentation, employing a qualitative approach for its analysis is deemed suitable. We have two procedures, the initial phase is to collect data from a survey, which is presented by a questionnaire. After selecting appropriate participants through the first step, we will have a more detailed interview individually to investigate further.

5.2. Sampling & Participants

A non-representative sampling strategy will be chosen to select participants who are using or used ChatGPT for their course learning. To be suitable for the research, participants will need to be currently enrolled in high school or university, or have recently graduated. This purposeful participant selection will seek to guarantee variety in the categories of grade, major, gender, academic performance, and socioeconomic background. The data from these groups are more accessible for us to collect, and the activities, such as survey or interview is more convenient to conduct. Furthermore, these participants are part of the representative users of ChatGPT, because they are vibrant and more familiar with the high-edged and emerging technology. Besides, they are having their classes and applying ChatGPT in their daily learning. The timely feedback quite fits our research topic which is the comparison of the using ChatGPT experiences between two subject domains. The nonrandom purposive sampling will provide more detailed, accurate and authentic information, excluding some distractions and unnecessary time or energy consumption. However, it also could bring some problems like creating statistically inadequate samples or the data being unrepresentative and erroneous.

A total of 15-20 students will be recruited for the research. We will pursue an even distribution of boys and girls across different stages and subjects. All participants have to use ChatGPT for at least one subject learning in the two main classifications.

Table 1: Sampling quantity and distribution of participants

	Humanities & social sciences	STEM	Total
High-school student	4	4	8
Undergraduate student	4	4	8
Total	8	8	16 (15-20)

5.3. Data Sources

Data will be initially collected through an open-ended survey conducted individually with each participant. The survey is a questionnaire with about 10 open-ended questions from the different stages of using ChatGPT, which mainly concludes three parts: general questions, before and after using ChatGPT. The design of the questions will be aligned with cognitivism theory. Some of them who finished the survey carefully or helpfully will be selected for semi-structured interviews next. The survey could help us narrow down the range and select the appropriate participants. The written answers are also the first data for us to analyze. Semi-structured interviews enable participants to freely share their thoughts and emotions while ensuring that the study topics are discussed consistently across all interviews. The interview has almost 5 questions which are more personalized and in-depth on different subjects. The interviews are going to take place in a private location or by Facetime to maintain privacy and to provide participants with an inviting atmosphere in which to discuss freely. Each interview may take about half an hour.

5.4. Data Analysis

The interview transcripts will be evaluated via thematic analysis. This method entails an organized and repetitive process of identifying, assessing, and presenting themes. Researchers will become acquainted with the data, produce first codes, seek for topics examine and refine them, and eventually describe and label the identified themes. We tend to divide the answers according to the timeline. Before and After using ChatGPT in their learning, what are the changes in their mind? With the data, we could conclude the advantages and disadvantages and make a comparison then. Within this research methodology, a series of comparisons will be conducted with the aim of elucidating the distinguishing attributes among various subjects. Two researchers will undertake the analysis independently to ensure accuracy and prevent bias, with periodic discussions to reach an agreement.

5.5. Limitations

Like any other research, this study has some limitations. Self-report information may be influenced by respondent biases or memory recall problems. Additionally, the sample's distinct cultural and educational environment may restrict the generalizability of results to other groups. Besides, there are also age and region range limitations about the participants, which only include the high-school and undergraduate students in two provinces. Furthermore, the study only focuses on a few subjects, which may affect the accuracy of the final conclusion. The version of ChatGPT is updating fast, so the research might have strong timeliness.

6. Scholarly Significance

These findings contribute to the rapidly expanding landscape of educational advancements, encompassing both humanities, social sciences and STEM fields, particularly within the realm of new

technology represented by ChatGPT. Notably, functionalities that demonstrate similarity across both humanities, social sciences and STEM disciplines possess the potential for broader applicability, extending their utility to domains such as arts and sports. This broader implementation stands to enhance the efficiency and scope of these functionalities. However, it is acknowledged that some of the input offered by ChatGPT may include errors or have potential for improvement. Consequently, users opt to compile ideas and give them to the developer in order to stimulate the creation of a better ChatGPT version. Nonetheless, it is imperative to recognize that the pursuit of heightened intelligence within ChatGPT could potentially engender multifaceted societal challenges, including a pronounced escalation in unemployment rates across diverse nations. Therefore, a comprehensive exploration of the ethical dimensions underpinning these advancements is paramount and warrants diligent examination.

7. Conclusion

These discoveries make a valuable addition to the swiftly developing domain of educational progressions, which encompasses a broad spectrum ranging from the humanities and social sciences to the STEM fields, with a specific focus on the emerging technological landscape epitomized by ChatGPT. It is noteworthy that functionalities exhibiting commonalities across these diverse academic domains have the inherent capacity for more extensive application, thereby expanding their practicality into realms. This investigation, akin to all scholarly inquiries, is not without its inherent constraints. The utilization of self-report data introduces the potential for respondent predispositions and recollection inconsistencies. Moreover, the particular cultural and educational milieu of the sample may circumscribe the extrapolation of findings to broader demographic cohorts. Furthermore, there exist constraints pertaining to participant age and regional diversity within the study cohort. Increasing ChatGPT's intelligence may potentially lead to a variety of societal issues, which means an in-depth investigation of the ethical aspects supporting these achievements is of utmost significance and requires careful study.

Acknowledgement

Yuman Wang and Shiqi Wang contributed equally to this work and should be considered co-first authors.

References

- [1] Biswas, S. (2023, February). *Role of ChatGPT in education*. <https://ssrn.com/abstract=4369981>
- [2] Furat, M. (2023). *How ChatGPT can transform autodidactic experiences and Open education? OSF Preprints*. <https://doi.org/10.31219/osf.io/9ge8m>
- [3] Chat GPT a, (2023, August 10). *We asked ChatGPT to define itself*.
- [4] Wang, X., Li, L., Tan, S. C., Yang, L., & Lei, J. (2023). *Preparing for AI-Enhanced Education: Conceptualizing and empirically examining teachers' ai readiness*. *Computers in Human Behavior*, 146, 107798. <https://doi.org/10.1016/j.chb.2023.107798>
- [5] Baidoo-Anu, David and Owusu Ansah, Leticia (2023). *Education in the Era of Generative Artificial Intelligence (AI): Understanding the Potential Benefits of ChatGPT in Promoting Teaching and Learning*. Available at SSRN: <https://ssrn.com/abstract=4337484> or <http://dx.doi.org/10.2139/ssrn.4337484>
- [6] Kim, S., Park, J., & Lee, H. (2019). *Automated essay scoring using a deep learning model*. *Journal of Educational Technology Development and Exchange*, 2(1), 1-17.
- [7] Verma, M. (2023). *The Digital Circular Economy: ChatGPT and the Future of STEM Education and Research*.
- [8] Wang, W., Chen, Y., & Heffernan, N. (2020). *A generative model-based tutoring system for math word problems*. *arXiv preprint arXiv:2010.04*.
- [9] Temsah, O., Khan, S. A., Chaiah, Y., Senjab, A., Alhasan, K., Jamal, A., ... & Senjab, A. M. (2023). *Overview of early ChatGPT's presence in medical literature: insights from a hybrid literature review by ChatGPT and human experts*. *Cureus*, 15(4). <https://www.researchgate.net/profile/Manish-Verma->

47/publication/370637247_The_Digital_Circular_Economy_ChatGPT_and_the_Future_of_STEM_Education_and_Research/links/645b56222edb8e5f094d9e1b/The-Digital-Circular-Economy-ChatGPT-and-the-Future-of-STEM-Education-and-Research.pdf

- [10] Alafnan, M. A., & MohdZuki, S. F. (2023). Do artificial intelligence chatbots have a writing style? an investigation into the stylistic features of CHATGPT *Journal of Artificial Intelligence and Technology*. <https://doi.org/10.37965/jait.2023.0267>
- [11] Lo CK. (2023). What Is the Impact of ChatGPT on Education? A Rapid Review of the Literature. *Education Sciences*. 13(4):410. <https://doi.org/10.3390/educsci13040410>
- [12] Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American Psychologist*, 34(10), 906–911. <https://doi.org/10.1037/0003-066X.34.10.906>
- [13] Livingston, J. A. (2003). *Metacognition: An Overview*. <https://files.eric.ed.gov/fulltext/ED474273.pdf>

Appendix 1

Survey (questionnaire)

Part 1: General questions

1. Are you a high school student/undergraduate student?
2. When using ChatGPT, what subject do you search for? (literature/math/economics/science...)
3. What do you use ChatGPT for? (essay/translation/program...)
4. When do you usually use ChatGPT? (For daily learning/completing the homework/review/preview/preparing for a competition or exam/debate)
5. What is the most evident difference between the answer you might think of and the answer given by ChatGPT? (First draft/edition of your project/assignment)

Part 2: Advantages:

6. What ChatGPT benefits you the most?
7. Is there any time you find the answer given by ChatGPT pretty satisfactory? Please describe the experience in detail, combined with the characteristics of one major (accurate/creational/comprehensive...)

Part 3: Disadvantages:

8. What is the most serious problem using ChatGPT?
9. Is there any time you find the answer given by ChatGPT unsatisfied? Please describe the experience in detail, combined with the characteristics of one major (wrong answer/inaccurate information/too general)
10. Which part of the answer do you usually correct given by ChatGPT?

Appendix 2

Interview Questions

1. How do you make decisions about when to use ChatGPT?
2. What are you thinking about when you look at the answer that ChatGPT spits out for you? /What do you ask yourself as you read it?
3. When and how do you turn a ChatGPT answer into your own answer?
4. What do you think of the plagiarism and equity problem and how would you deal with it?