

Tool, teammate, superintelligence: Identification of ChatGPT-enabled collaboration patterns and their benefits and risks in mutual learning

Xusen Cheng
Renmin University of China
xusen.cheng@ruc.edu.cn

Shuang Zhang
Renmin University of China
zshuang2000@126.com

Abstract

The emergence of ChatGPT has brought new opportunities for AI-enabled collaboration. Due to the amazing performance of ChatGPT, the collaboration between AI and humans is no longer limited to a single pattern. However, previous studies focused on AI working together as a teammate, with little analysis of different collaboration patterns and their impacts. We conducted interviews, encoded data building on grounded theory, developed a ChatGPT-enabled collaboration process, and identified three collaboration patterns: ChatGPT serves as a tool, teammate, and superintelligence for collaboration. Additionally, this study also ascertained the benefits (i.e., improve search efficiency, improve team motivation, enrich and refine ideas, and improve thinking ability) and risks (i.e., increase search time, reduce willingness for face-to-face communication, make the collaborative atmosphere negative, ChatGPT addiction, and cognitive rigidity) in mutual learning between ChatGPT and humans. Finally, theoretical and practical implications are provided.

Keywords: ChatGPT, collaboration patterns, benefits, risks, mutual learning

1. Introduction

Until recently, the promising application of new technologies in the digital era has promoted the development of artificial intelligence (AI) and penetrated into customer service (Schanke et al., 2021), investment (Ge et al., 2021), medical diagnosis (Jussupow et al., 2021), drug discovery (Lou & Wu, 2021), and other fields. While the craze for the metaverse has not subsided, the emergence of conversational chatbots, especially ChatGPT (Chat Generative Pre-trained Transformer), has transformed technology, industry, and society, such as the widely discussed application of ChatGPT in scientific research (Chris & Richard, 2023). ChatGPT is a large language model (LLM) published by OpenAI with powerful language understanding and text generation capabilities

(Open AI, 2022). As clear from recent research on generative AI, ChatGPT's adoption in education is becoming increasingly apparent (Else, 2023; Hutson, 2022; Stokel-Walker, 2022). However, whereas it has greatly improved people's productivity, more concerns and potential threats remain and deserve further attention. For example, as people marvel at the magical experience that ChatGPT brings, "fluent but not factual" (Chris & Richard, 2023) and moral bias (Hutson, 2021) make them harbor doubts about it. Accordingly, investigating how ChatGPT can facilitate transformative changes in education is important.

AI-enabled collaboration has been the focus of interest (Seeber et al., 2018). Imagine that when you collaborate with ChatGPT in a team, it could be a great teammate for you (e.g., a teammate who is good at coordination, optimization, evaluation, creative promotion, etc.), but in fact, it could also be just a tool (e.g., providing a lot of information but not guaranteeing accuracy), or an existence that transcends team members (e.g., superintelligence). Previous studies have examined collaborative learning between humans and AI in teams. For example, experts and algorithms' mutual learning can better manage knowledge (Van Den Broek et al., 2021). Organizations work effectively with AI as a whole by aligning human-machine coordination (Sturm et al., 2021). AI-enabled learning applications improve the digital transformation of education (Cheng et al., 2020). Additionally, there has been research aimed at addressing AI-enabled collaboration issues from a technical perspective, such as multimodal learning analytics (Järvelä et al., 2023). Notably, the assumption that AI operates as a member of a team is often taken for granted. There is evidence to suggest that AI-enabled collaboration can be helpful for team and individuals alike (Cheng et al., 2022). Nevertheless, research is increasingly acknowledging the significance of different role of AI in collaboration and its relationship with humans (Haesevoets et al., 2021). The rationale behind this is that AI's contribution can sometimes be detrimental, making individuals into Borgs (Fügener et al., 2021). Consequently, there is an urgent requirement to uncover different ways of

collaborating between humans and AI, particularly ChatGPT (Fügener et al., 2022). Understanding the collaborative patterns between ChatGPT and humans in the education field will accelerate the development of education. Aside from collaborative patterns, mutual learning becomes paramount in AI governance and collective intelligence (Van Den Broek et al., 2021). Researchers have taken an interest in the benefits of human learning from AI, such as enhanced creativity (Jia et al., 2023). AI learning from people is also being underscored (Lou & Wu, 2021). Despite such compelling studies of mutual learning application, the impact of ChatGPT-enabled collaboration patterns on mutual learning is still nascent.

Collectively, to address this need, this study aims to address the research question: *What are the ChatGPT-enabled collaboration patterns and their benefits and risks in mutual learning?*

2. Literature review

2.1. ChatGPT-enabled collaboration patterns

The launch of ChatGPT has driven the development of conversational chatbots. It is trained with 175 billion parameters built on the GPT-3.5 model and supports tasks such as translation, code writing, and copywriting. The abilities of ChatGPT introduced by OpenAI include get instant answers, find creative

inspiration, and learn something new. Some scholars have dived deep into the opportunities and challenges of generative conversational AI (Dwivedi et al., 2023). In particular, humans and AI are contributing to collaborative intelligence together (Wilson and Daugherty, 2018). Against this backdrop, ChatGPT-enabled collaboration, which means infusing AI knowledge into collaboration, is a foreseeable future with pros and cons (see Table 1). This has generated calls for a more nuanced understanding of AI-enabled collaboration patterns (Fügener et al., 2021; Seeber et al., 2018, 2020). In general, the collaboration patterns are mainly manifested in the task assignment, role adjustment and interaction mode when individuals collaborate with AI, including feedback giving and seeking, social interaction, sharing knowledge, explaining, and so on (Serçe et al., 2011). Moreover, collaboration patterns will be shaped by the task context (e.g., high- and low-risk decision-making) and complexity (e.g., necessity of human participation). Previous research has elaborated the role of AI as a teammate in collaboration (Cheng et al., 2022), ignoring the comprehensive collaboration patterns between AI and humans. Currently, although some studies have demonstrated the relationship between AI and humans in collaboration (Haesevoets et al., 2021), a holistic framework of collaboration patterns, especially in the field of education, is still limited.

Table 1. Possible pros and cons of ChatGPT-enabled collaboration.

Unexpected benefits	Example		Inevitable risks	Example
Process automation and efficiency improvement	ChatGPT automates many tedious, low-value, and repetitive tasks to improve efficiency.	VS	Rework	Incorrect or meaningless processing results may lead individuals to spend more time adjusting them.
Decision optimization and innovation generation	ChatGPT optimizes individuals' decisions based on a large amount of information and provide innovative perspectives.		Guide incorrectly	Automatically generated information that is fabricated, false, and has no authoritative source may mislead individuals.
Contextual and interactive dialogue	ChatGPT can quickly answer questions, give understanding, and even expand the content.		Produce ambiguity and misunderstanding	ChatGPT may sometimes fail to understand the questioner's intention for complex problems, requiring repeated questioning.
Competence in the field of expertise	ChatGPT can answer professional knowledge from different fields.		Information leakage	ChatGPT may use the professional knowledge asked by the questioner as corpus, which may later be leaked.

2.2. Mutual learning between ChatGPT and humans

Unlike co-learning, mutual learning refers to the exchange of knowledge and mutual influence among different entities, which can be humans or intelligent systems such as robots and computers (Van Den Broek et al., 2021). Mutual learning has been widely applied in the field of computer science, including sentiment classification (Xue et al., 2020), cross-dataset human parsing (He et al., 2020), and audio-visual speech recognition (Yang et al., 2022). One of the core technologies of ChatGPT is Illustrating Reinforcement Learning from Human Feedback (RLHF) (Nathan & von Werra, 2022), which demonstrates the concept of mutual learning. Additionally, empirical studies seeking to understand the mutual learning process between individuals, such as innovation generation (Aggarwal et al., 2021). Nevertheless, the mechanism of mutual learning between ChatGPT and humans has not yet been

fully understood. As pictured in Figure 1, the combination of machine learning and domain-specific expertise is commonly explained as a mutual learning process. For ChatGPT-enabled collaboration, individuals can learn various types of knowledge from ChatGPT, such as ideas, expertise, communication skills, and so on. Meanwhile, ChatGPT learns from individuals through their questions and feedback, i.e., prompt engineering which is about how to communicate with AI to better obtain the answers you want (*Learn Prompting*, 2023). In this regard, a prompt is a set of instructions/requirements provided to ChatGPT to help it better understand the tasks (Liu et al., 2023). Figure 2 shows a sample of mutual learning between ChatGPT and humans. Applied to our context, the knowledge obtained by the users after asking ChatGPT questions is the human's learning from ChatGPT, while the human's priori knowledge informed to ChatGPT and the feedback on the answers is ChatGPT's learning from the human.

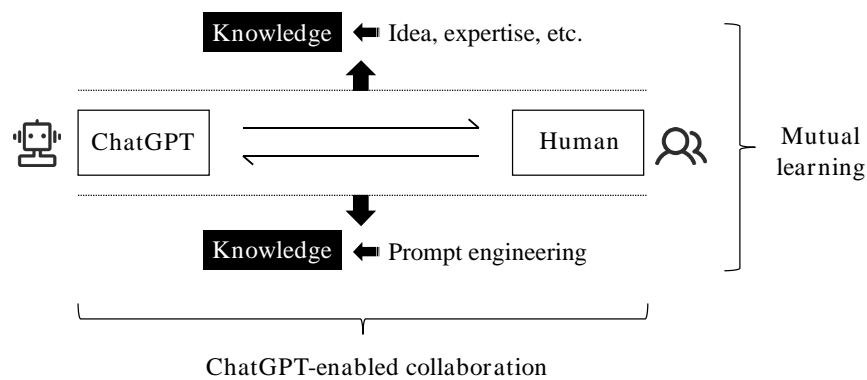


Figure 1. Mutual learning in ChatGPT-enabled collaboration.



Figure 2(a). Human's learning (Ask ChatGPT question).

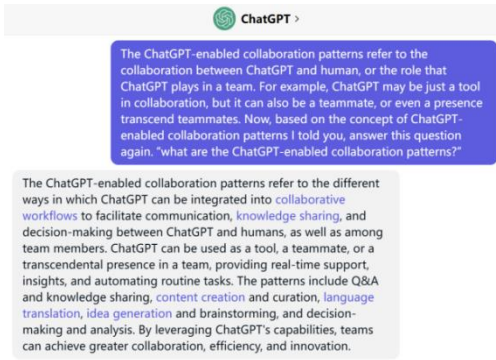


Figure 2(b). ChatGPT's learning (Tell ChatGPT prior knowledge).



Figure 2(c). Human's learning (Deny ChatGPT's answer and re-ask the question).

3. Research methodology

3.1. Development of ChatGPT-enabled collaboration system

The development of collaboration system follows the basic process of collaboration engineering (CE): generate, reduce, clarify, organize, evaluate, and build consensus to enable teams to collaborate without a professional facilitator (Azadegan et al., 2013; Briggs et al., 2003; Cheng et al., 2016; de Vreede & Briggs, 2019). We embedded ChatGPT in the system, allowing individuals to interact and converse with ChatGPT through the chat box, and also enabling ChatGPT to automatically generate its own ideas on the discussion topic in the output column when

individuals express their opinions. This reflects two different interactions between individuals and ChatGPT: conversational (Q&A) and auto-generated functions. Specifically, Figure 3(a) visually demonstrates the dynamics of a team discussion, where users interact with ChatGPT by posing questions. With its remarkable capability to handle multiple user inquiries simultaneously, ChatGPT promptly responds and systematically addresses the questions in a sequential manner. Moreover, as Figure 3 (b) depicts, beyond simply answering user questions, ChatGPT actively contributes its own insights in the output box. This has the potential to ignite inspiration among users, fueling creativity and fostering a more effective collaborative discussion environment.



Conversational (Q&A) between individuals and ChatGPT

Figure 3(a). Conversational (Q&A) function



Auto-generated idea by ChatGPT

Figure 3(b). Auto-generated function

3.2. Analysis and results

3.2.1. Data collection procedure. Our sample comes from two classes at a public university in China, where

71 students were allowed to use our ChatGPT-enabled collaboration system for group discussions. We did not introduce the purpose of using the system, but instead encouraged them to use this interesting system to help complete their group discussions to avoid potential biases. All groups used the system for their discussions,

which was considered to provide a more realistic experience for the participants without prior knowledge of the system. We asked students if they would like to participate in after-class interviews and informed them that they would receive additional rewards. Finally, a total of 63 students participated in the semi-structured interview, including 30 males and 33 females, with an average age of 19 years.

3.2.2. Data analysis. We used NVivo11 to encode and analyze qualitative data building on grounded theory. In the open coding phase, we identified phrases or

sentences that are relevant to the topic. To improve coding accuracy, we formed two teams with three students in each team to code together, and conducted intra- and inter-group cross-check. The coding consistency for each node exceeds 90%, ensuring high reliability and validity of the coding. In the axial coding phase, we screened, merged and classified the primary codes based on the existing literature. In the selective coding phase, we merged the codes again, identified the relevant constructs, and built a complete storyline. The coding process was shown in Figure 4.

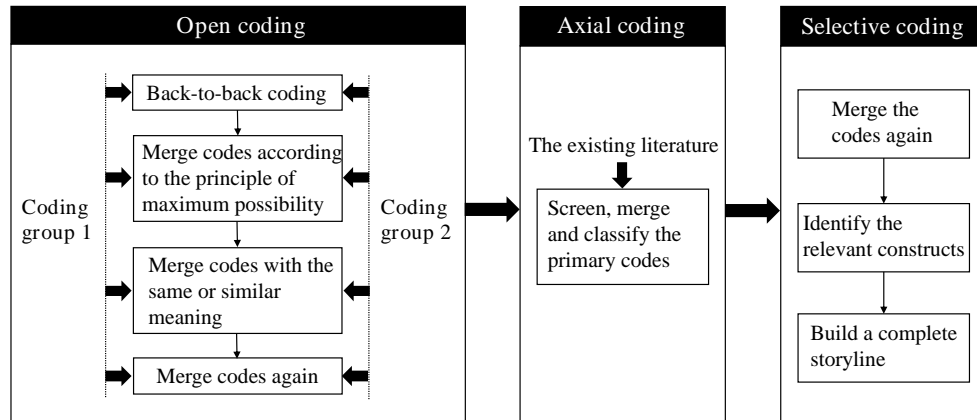


Figure 4. The coding process building on grounded theory.

3.2.3. Identification of the collaboration patterns between ChatGPT and humans. As shown in Figure 5, we identified three collaboration patterns in the ChatGPT-enabled collaboration process: ChatGPT as a tool, teammate, and superintelligence in collaboration,

which are influenced by specific antecedents. Importantly, our findings indicate that diverse collaboration patterns have the potential to influence the trust in ChatGPT, consequently impacting the mutual learning between ChatGPT and humans.

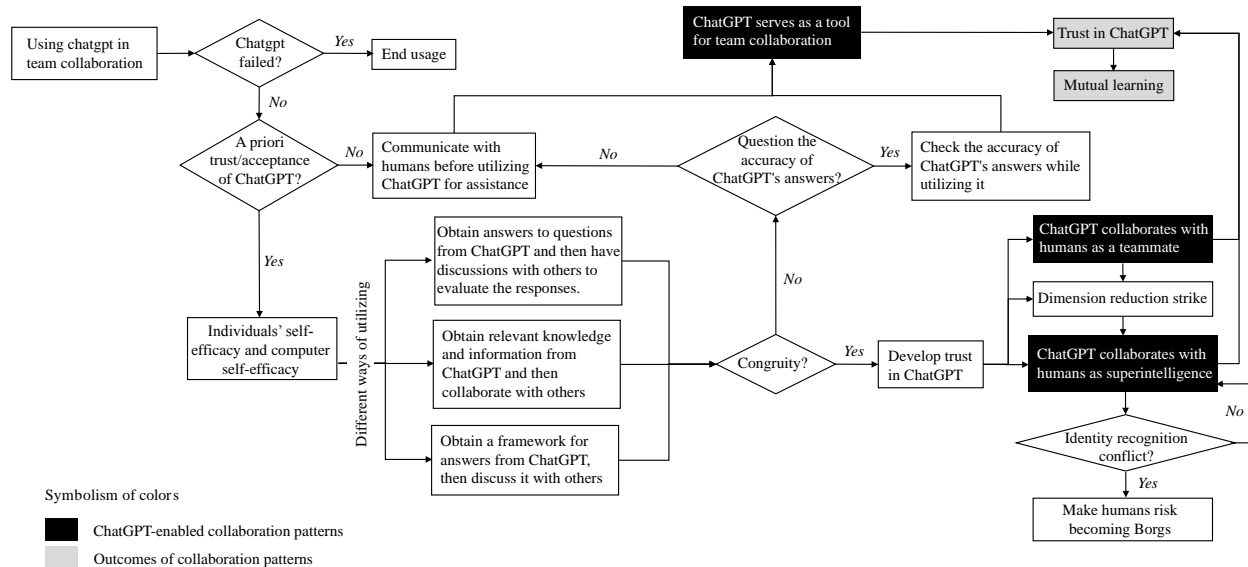


Figure 5. The process of ChatGPT-enabled collaboration.

(1) ChatGPT serves as a tool for collaboration

In the case of a successful ChatGPT service, individuals without prior knowledge or acceptance of ChatGPT will utilize it as an assistant. Furthermore, in cases where individuals possess prior knowledge or acceptance of ChatGPT but perceive congruity between themselves and ChatGPT, they will evaluate the accuracy of ChatGPT's answers. In this case, if the responses are deemed accurate, individuals will utilize ChatGPT as an assistant. If the responses are deemed inaccurate, individuals will check the accuracy during usage. Both scenarios highlight ChatGPT's role as a tool in collaboration.

(2) ChatGPT collaborates with humans as a teammate

Conversely, when the congruity between ChatGPT and humans is satisfied, individuals' trust in ChatGPT will also be developed. Also, the trust in collaboration context has been extensively documented as a fruitful area of investigation (Cheng et al., 2017, 2021). As such, ChatGPT is more like humans' teammate, working together on collaborative tasks. For instance, it can provide ideas and suggestions for the team, and adapt to the communication styles of team members through mutual learning, further enhancing its usefulness as a teammate.

(3) ChatGPT collaborates with humans as superintelligence

Notably, when the intelligence of ChatGPT makes dimension reduction strike on humans, ChatGPT will collaborate with humans as superintelligence. This means that ChatGPT's intelligence will transcend that of humans. However, if there is an identity recognition conflict for individuals, it puts them at risk of becoming Borgs, that is, cyborg creatures without human individuality (Fügener et al., 2021)

3.2.4. Benefits and risks of ChatGPT-enabled collaboration patterns. Figure 6 summarizes the benefits and risks of different collaboration patterns in mutual learning between ChatGPT and humans.

(1) Tools

Improve search efficiency. ChatGPT has powerful natural language understanding ability, which does not require the specific search terms or syntax. It searches through massive amounts of information, extracts relevant answers from the knowledge network, and greatly improves search efficiency. Interviewee 3 said:

When searching for information, using the internet directly may lead to too much noise, but ChatGPT

provides concise summaries that give more precise answers and better meet our needs.

Increase search time. While the use of ChatGPT improves search efficiency, if an individual's questioning approach is inappropriate, ChatGPT may not comprehend the query, resulting in irrelevant or incorrect responses. This necessitates the individuals to repeatedly alter their questioning, which can increase search time instead. Interviewee 2 said:

I have asked ChatGPT many questions, but sometimes the answers provided are difficult to understand. The responses may contain specialized terms and concepts that require prior knowledge to fully comprehend, and additional clarification may be needed.

(2) Teammates

Improve team motivation. In ChatGPT-enabled collaboration, ChatGPT can act as a teammate and break the awkward atmosphere. Its generated ideas also inspire individuals, improving the team motivation. Interviewee 8 said:

The addition of AI teammates [ChatGPT] sometimes makes group discussions lively because it brings an additional session to discuss ideas proposed by ChatGPT, which can be more engaging and interesting.

Reduce willingness for face-to-face communication.

When using ChatGPT for collaboration, team members may be more inclined to communicate with ChatGPT online and avoid face-to-face communication with others. This may weaken the individuals' desire to express themselves in the real world. Interviewee 12 said:

ChatGPT-enabled collaboration makes me more willing to speak up on collaboration platform, but it also makes me more afraid to express myself in the real world. [Even if everyone sits together], we are typing without much face-to-face communication.

(3) Superintelligence

Enrich and refine ideas. When ChatGPT joins a team as an AI teammate, the machine's intelligence is incorporated into the team. However, with its powerful learning, optimization, language processing, and comprehensive decision-making abilities, ChatGPT is a presence that exceeds that of teammates in the team. This implies that amazing intelligence brings a wealth of knowledge to individuals. For example, ChatGPT enriches and refines ideas that individuals would not have thought of. Interviewee 9 said:

The thought process of ChatGPT differs from that of humans. Sometimes, we may not be able to imagine certain aspects, but ChatGPT can approach problems from a more rational perspective and provide the results we need.

Improve thinking ability. The individuals' thinking ability can be enhanced as ChatGPT showcases remarkable intelligence in collaboration. For instance, team members' cognition, thinking ability and habits towards objects can be expanded upon encountering ChatGPT's answers with some disruptive thinking logic. Interviewee 4 said:

[My] thinking ability has been improved, specifically in terms of independent thinking, categorization, and the ability to draw insights from others' perspectives.

Make the collaborative atmosphere negative. When ChatGPT's abilities transcend humans in collaboration, individuals may realize that their own abilities are inadequate and feel marginalized. Therefore, the collaboration enthusiasm among team members decreases, leading to a negative collaborative atmosphere. Interviewee 6 said:

The use of ChatGPT-enabled collaboration system creates an experience of virtual face-to-face communication, where we share our perspectives and ideas through typing on the platform, rather than using spoken language.

ChatGPT addiction. The phenomenon of ChatGPT addiction in collaboration refers to the excessive dependence of team members on ChatGPT's abilities throughout the collaborative process. This behavior is characterized by an overreliance on ChatGPT for generating ideas, providing solutions, and making decisions, which can potentially hinder the active participation and critical thinking of team members. Interviewee 2 said:

Relying solely on ChatGPT to solve all your problems can lead to a situation where, once it is unable to provide a solution, you may feel helpless and forget that you have the ability to solve the problem yourself.

Cognitive rigidity. In ChatGPT-enabled collaboration, cognitive rigidity manifest as individuals overly relying on ChatGPT's pre-existing knowledge, while ignoring new creative knowledge. This can lead to individuals' fixed and inflexible understanding of tasks and situations, making it difficult to adapt to new demands and changes. Interviewee 1 said:

When ChatGPT proposes an idea, everyone may become fixated on that particular direction and follow its thought process, potentially limiting the exploration of other possibilities and leading to fewer discoveries in other directions.

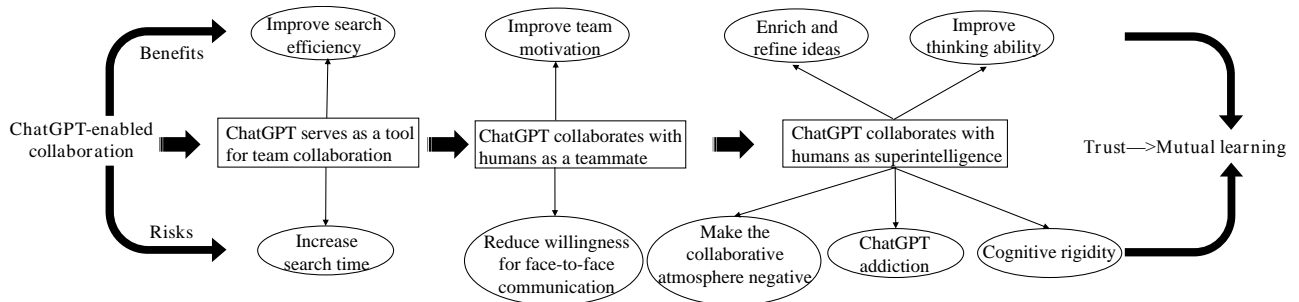


Figure 6. Benefits and risks of ChatGPT-enabled collaboration patterns in mutual learning.

4. Conclusion and future research

4.1. Summary of findings

The findings of this study can be summarized as follows. First, a framework of ChatGPT-enabled collaboration process was established, which illustrated the antecedents and outcomes of different collaboration patterns between ChatGPT and humans. The study found that factors such as ChatGPT's use failure, prior trust/acceptance, self-efficacy and

computer self-efficacy, congruity, accuracy of ChatGPT's responses, and identity recognition conflict were critical in influencing collaboration patterns between ChatGPT and humans. Perhaps most profoundly, our findings reveal that different collaboration patterns would affect individuals' trust in ChatGPT, which in turn affected mutual learning between ChatGPT and humans. We will further refine this framework in the future.

Second, we identified three ChatGPT-enabled collaboration patterns in the field of education: ChatGPT as a tool, teammate, and superintelligence in collaboration. Specifically, when ChatGPT is used as

a tool in a team, it is not much different from previous AI assistant. But when ChatGPT collaborates as a teammate in a team, it signifies that the intelligence of AI contributes to collaboration. And when ChatGPT makes dimension reduction strike on humans, it has transcended the role of teammate as a superintelligence presence. It is crucial to recognize that when individuals encounter identity recognition conflict, they risk becoming Borgs. Future research will continue to ascertain ChatGPT-enabled collaboration patterns based on improved collaboration system.

Third, we analyzed qualitative data to uncover the benefits (improve search efficiency, improve team motivation, enrich and refine ideas, and improve thinking ability) and risks (increase search time, reduce willingness for face-to-face communication, make the collaborative atmosphere negative, ChatGPT addiction, and cognitive rigidity) of ChatGPT-enabled collaboration in the process of mutual learning between ChatGPT and humans. In the future, we plan to establish a holistic model to investigate the relationships between these benefits and risks, different collaboration patterns, trust, and mutual learning between ChatGPT and humans.

4.2. Implications for research

This study makes several theoretical contributions. First, the development of holistic collaboration patterns framework between ChatGPT and humans enriches the literature in the field of human-computer interaction and collaboration. To our knowledge, previous studies have primarily concentrated on specific applications of AI in collaborative processes, such as human-machine dialogues (Cheng et al., 2022), managerial professions (Sowa et al., 2021), creative art (Hitsuwari et al., 2023), and so on, while the findings focusing specifically on the collaborative process has yet to be fully examined. This study presents a comprehensive preliminary picture for human-ChatGPT collaboration in the context of mutual learning, delineating the potential outcomes of the collaborative process in diverse scenarios with meticulous detail. Furthermore, the role of trust in different collaboration patterns and mutual learning between ChatGPT and humans is revealed.

Second, this study identified three different collaboration patterns, including “ChatGPT serves as a tool for collaboration”, “ChatGPT collaborates with humans as a teammate”, and “ChatGPT collaborates with humans as superintelligence” and revealed that ChatGPT may not always a teammate, which has been noted by some scholars. Interestingly, factors such as individuals’ questioning of ChatGPT’s responses,

congruity, identity recognition conflict, trust, and dimension reduction strike may lead to a progressive transformation in its role from being superficial to becoming more significant. This finding provides insights for future research into the antecedents that influence changes in the collaborative relationship between ChatGPT and humans.

Third, in addition to the identification of collaboration patterns, our study has developed benefits and risks in mutual learning between ChatGPT and humans. These include not only the impact of ChatGPT-enabled collaboration on individuals, but also the impact on teams. Although the bright and dark sides of ChatGPT have been examined in prior studies (Dwivedi et al., 2023), the double-edged impact of generative AI in collaboration context represented by ChatGPT deserves to be explored in depth. Our study provides a more complete picture about these benefits and risks.

4.3. Implications for practice

This study provides some practical implications for the collaboration between ChatGPT and humans in education. First, individuals can determine their collaboration patterns with ChatGPT and optimize them. For example, when individuals consider ChatGPT to be just a tool in collaboration, they can strengthen their prior knowledge or acceptance of ChatGPT, such as understanding the skills of using ChatGPT. Additionally, enhancing the congruity between ChatGPT and human, such as trying different conversational styles, can help ChatGPT better serve as a teammate in collaboration, further improving collaboration efficiency.

Second, individuals should be aware of the differences in collaborative patterns when working with ChatGPT in collaboration in the field of education, especially students. Especially when ChatGPT is collaborating with humans as superintelligence, individuals should pay attention to their identity recognition conflict and avoid becoming like Borgs. Accordingly, individuals should maintain different collaboration patterns with ChatGPT based on task differences. As an example, tedious and repetitive tasks should be accomplished in the state of ChatGPT as a tool, while challenging tasks can be effectively collaborated with ChatGPT and even inspired by its superintelligence.

Third, individuals should leverage the benefits that arise from mutual learning between ChatGPT and humans to improve collaboration performance. For example, they can use appropriate question-asking techniques to improve search efficiency when interacting with ChatGPT. Furthermore, potential

risks should be avoided. For instance, if ChatGPT consistently fails to understand a particular question, users should avoid asking the same question repeatedly to minimize search time.

4.4. Limitation and future research

This study has limitations that can guide future research. First, the identification of human-ChatGPT collaboration patterns in this study comes from interview data. In the future, multiple data sources could be collected to avoid overlooking potential collaboration patterns. Second, the sample for the interviews was limited to students, which was a unique aspect of this study as it focused on the collaboration between ChatGPT and humans in the field of education. Nevertheless, future research could expand the application scenarios and investigate collaboration patterns in different fields. For example, applying ChatGPT-enabled collaboration to senior care for elder people/citizen and e-healthcare will foster the development of a digital society. Third, the participants in this study used a self-developed ChatGPT-enabled collaboration system with only two instances of ChatGPT integration. In the future, ChatGPT could be integrated into different phases of collaboration system, and differences between them could be compared for a deeper understanding of mutual learning between ChatGPT and humans.

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