Data Inputs and Contexts for ChatGPT in Education: A Review of Empirical Studies

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Introduction

- Through Socratic dialogues with ChatGPT, students are actively involved in generating ideas, reflecting on learning content, exploring explanations of wrong solutions, and deeply thinking about their solutions (Cronjé, 2023; Han et al., 2023; Balse et al., 2023; Cowan et al., 2023). ChatGPT enriches personalized teaching materials and reduces teachers' workload by generating formative and product feedback to improve learner performance (Zheng & Stewart, 2024; Meyer et al., 2024; Cohn et al., 2024).

- ChatGPT exhibits several weaknesses as well. As a chatbot driven by LLMs, ChatGPT is not good at handling images, especially for the free version. The accuracy of ChatGPT's generated outputs is occasionally questionable (Holderried et al., 2024; Lee et al., 2024), which is limited by the training data [16]. The critical and reasoning abilities of ChatGPT do not satisfy users' expectations (Zhang & Tur, 2024; Kumar et al., 2024). It also presents certain challenges to the traditional formal education system. such as plagiarism, academic dishonesty, productivity, creative and critical thinking decrease hampered by over-reliance on ChatGPT, and superficial learning (Mai et al., 2024; Lo et al., 2024; Zhang & Tur, 2024).

- Even though some education stakeholders try to ban the usage of ChatGPT in education, different voices are expressing their support for meaningfully and effectively using ChatGPT to assist teaching and learning (Mai et al., 2024; Kooli, 2023; Ali et al., 2023). Lo et al. (2024) explains that the misuse of this tool often results from a lack of knowledge and understanding of its proper use and encourages the development of clear guidelines for the acceptable use of AI tools like ChatGPT. How to effectively use LLMs-driven ChatGPT is a complex topic, and one of the main concerns is prompting.

02.07.2025

Research questions

Prompt engineering has become a focal point in efforts to make ChatGPT more effective in educational contexts. Yet, there remains a gap in understanding the types of data embedded within prompts and how they reflect the teaching and learning contexts in which ChatGPT is deployed.

To contribution to the construction of prompts for ChatGPT in education, this review is guided by two research questions about data embedded in prompting:

- RQ1: What general information can be found in empirical articles with prompt details in the field of ChatGPT usage in education (e.g., educational level, knowledge domain, research method, data source embedded in prompting, data collection method)?

- RQ2: What teaching and learning experiences can be summarized from the data fed into ChatGPT and their usage context.

Research methods

- **Search workflow**: PRISMA guidance in research review, including identification, screening, eligibility, Included

- **Database**: Web of Science and Scopus

- **Search string:** "chatgpt* OR gpt* OR chatbot* OR Bing OR Bard OR Copilot" AND "learn* OR educat* OR train* OR teach*".

- **Data analysis**: thematic analysis. We followed the six-step proposed by (Braun & Clarke, 2006). The extracted data were aggregated in excel for further analysis.

- **Data extraction**:

General information: educational level, knowledge domain, research method
Objectives to use ChatGPT: ChatGPT affordances in education
Data: data source (embedded in prompting), data collection method

8,622	➡	495	➡	102
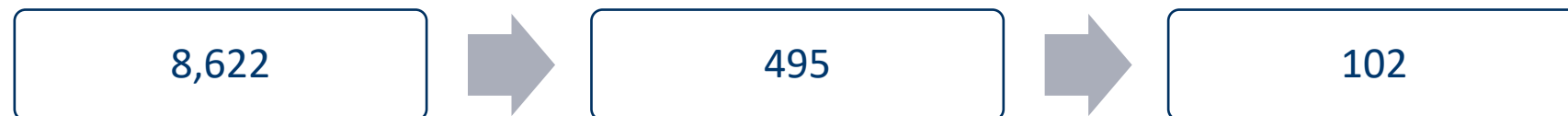
Results

- Regarding the domains, language learning (17, 16.7%) and computer science (16, 15.7%) gained more attention. The second most popular domains were education (12, 11.7%), while the third most popular were chemistry (9, 8.8%), mathematics (9, 8.8%), and medicine (8, 7.8%).

- For the research methods, 57 articles used qualitative methods (accounting for 55.9%), 22 articles used quantitative methods (21.6%), and 23 articles used mixed methods (22.5%).


Main domians

Research methods
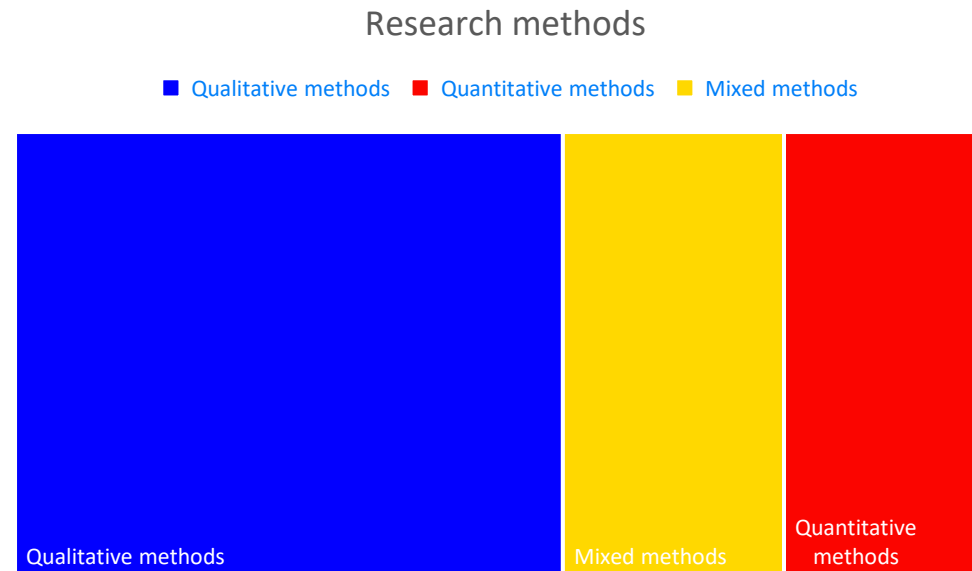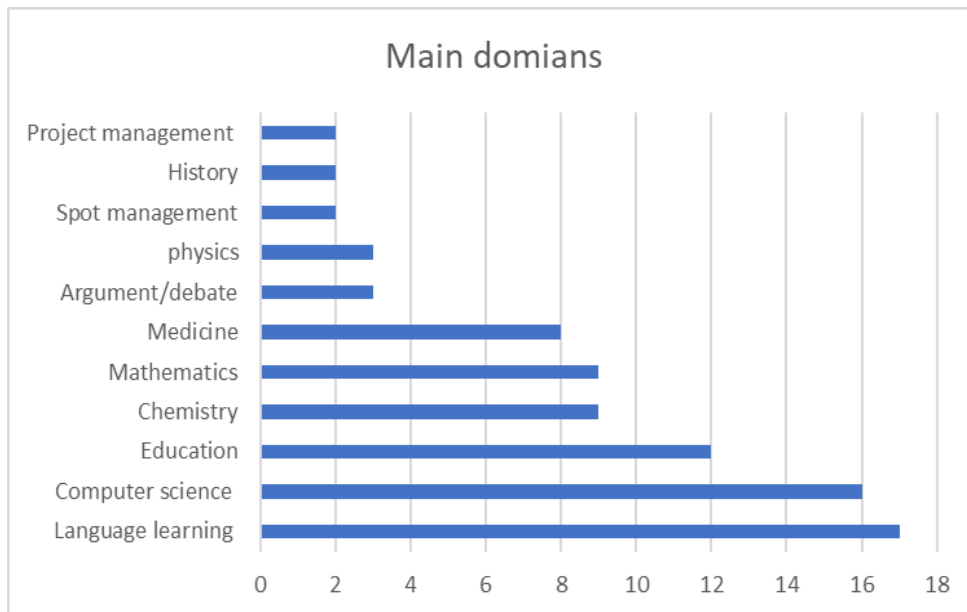
Results

To better understand the construction of prompts in educational scenarios and the tasks at a general level, it is essential to extract the usage scenarios and affordances. More details can be found in Table 1.

As shown in Table 1, ChatGPT provides more diverse affordances in two course phases: during the courses and after the courses.

Stages (n)	ChatGPT support in teaching and learning (n)
Before the courses (32)	1) problem-solving/project-based learning support (4) 2) complex concept explanation or task expression simplification support (2) 3) plan/schedule generation/optimise support (10) 4) virtual role/specific sensitive case creation support (4) 5) test/questions generation/reframing support (8) 6) complementary teaching materials support (4)
During the courses (39)	1) critical thinking support (3) 2) problem-solving/project-based/inquiry-based learning support (12) 3) reasoning support (1) 4) essay/report writing support (7) 5) dialogue/conversation/counselling skills support (4) 6) personalized tutor/coach support (6) 7) concept understanding (1) 8) self-reflection by writing support (2) 9) wrong solution explanation (1) 10) deeply thinking solution support (1) 11) code-tracing questions support (1)
After the courses (31)	1) essay feedback generation support (11) 2) design product feedback generation support (1) 3) code solution generation (1) 4) teaching materials skills tag (1) 5) report generate support (1) 6) code solution feedback generation support (4) 7) assessment feedback generation support (3) 8) peer comments feedback generation support (2) 9) rationales explanation for student answers (1) 10) students' responses/behaviour evaluation support (4) 11) students help seeking behaviour support (1) 12) coach task feedback support (1)

02.07.2025
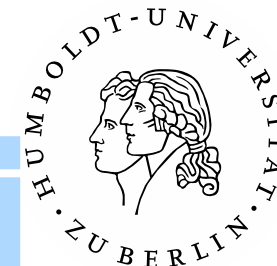
Results

- Regarding data sources embedded into prompting(left figure), We found that the data sources mainly included course-level materials (46, 45.1%), ChatGPT output (22, 21.6%), university-level materials (12, 11.8%), lab collected materials (6, 6%), open access data (6, 6%), textbooks or domain knowledge or questions (4), national level materials (3), MOOCs or online platform (3).

- For data collection methods(right figure), The most common data collection and analysis path involved collecting conversation data between humans and ChatGPT and then comparing the differences between human-generated answers and ChatGPT-generated answers qualitatively or quantitatively.

Sources of data embedded into prompting

Data collection methods for research
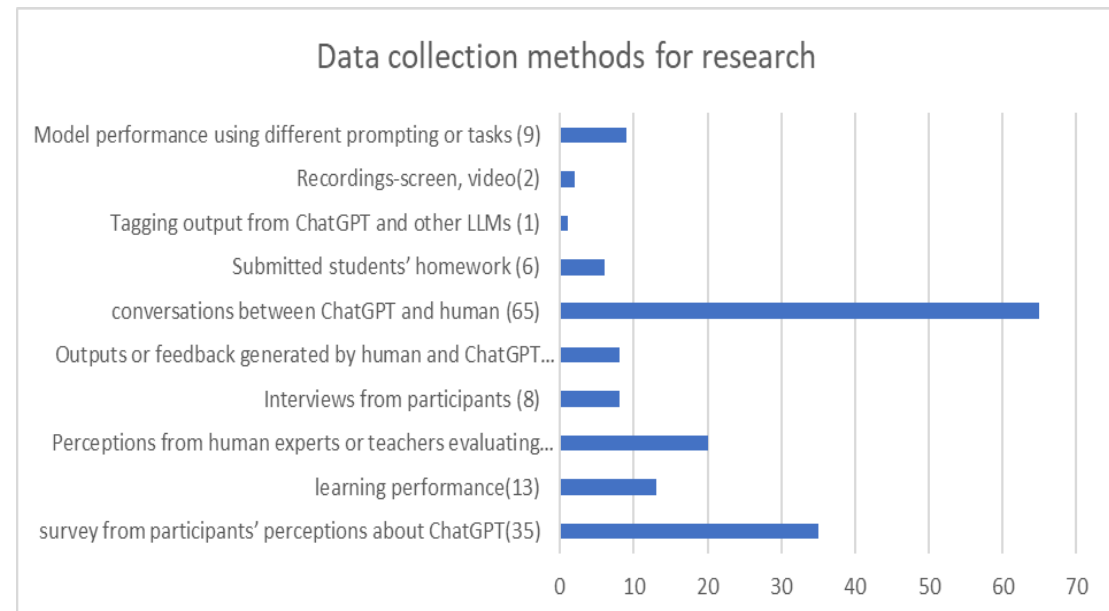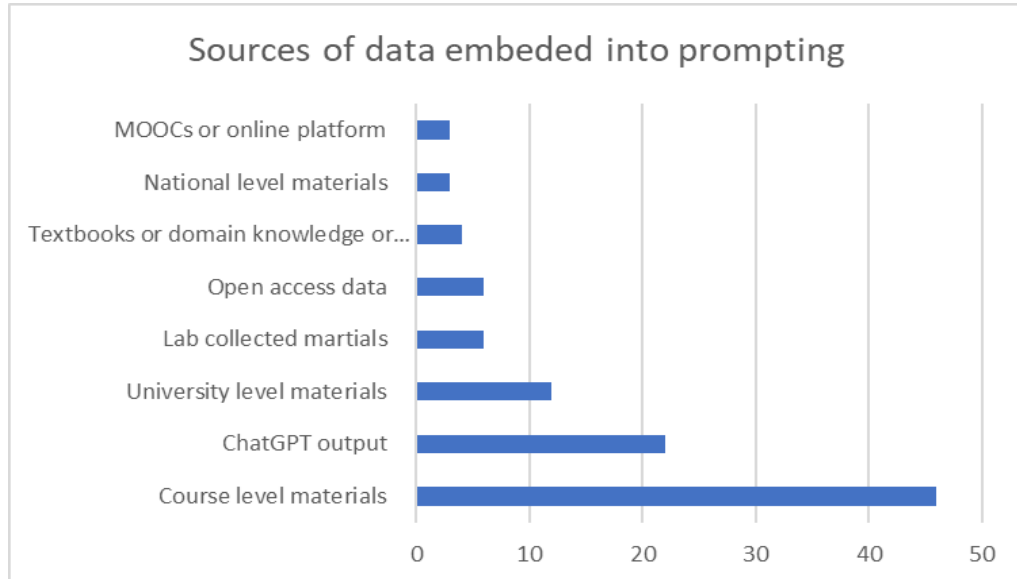
Results

For educators

- Regarding pedagogical aspects, to enhance students' critical or reasoning thinking, teachers and stakeholders should consider investigating pedagogical approaches that leverage ChatGPT and similar GenAI tools in classrooms [4]. For example, integrating ChatGPT into learning by discovering, using ChatGPT to stimulate students deeply think about their solutions, combining other AI tools to generate multimodal products (Cronjé, 2023; Murgia et al., 2023).

- Teachers play an important role in refining outputs from ChatGPT and strategically introduce ChatGPT and similar tools. With expertise in specific domains, teachers can use their prior knowledge and critical thinking skills to adapt ChatGPT outputs to deliver a more personalized educational context for students (Mai et al., 2024; Ansari et al., 2023).

For students

- ChatGPT can provide around-the-clock personalized learning support and problem-solving guidance. For learning or teaching materials that are not customized for a specific domain, learners can use ChatGPT to reformulate the same question statements from a general domain to a specific domain, such as in a probability and statistics course, which could save time for this task [29], whether done by teachers or students.

- Collaborating with ChatGPT or similar GenAIs, students need and would possibly improve digital literacy, AI literacy, and self-reflection skills (Mai et al., 2024; Ansari et al., 2023). Users need to be aware of what tasks to complete or skills to develop, outline a ChatGPT usage workflow, and have alternative solutions when ChatGPT does not meet the task requirements, such as the AI-assisted workflow developed by Pham et al. (2023).

02.07.2025

Conclusion and further studies

■■■ From the results of the source of data embedded in the prompting and data collection method, it can be found that diverse sources of data can be embedded in the prompt, and multiple methods can be used to analyse ChatGPT outputs. Course-level materials and ChatGPT outputs were commonly used. Moreover, users can develop and cumulate prompting archives by collecting prompts and discussing them with other users. This article found that data from conversations between ChatGPT and humans and surveys of users' perceptions were also methods to analyse the effectiveness of prompt construction.

■■■ As shown in ChatGPT affordances in education, GenAI tools take an assistant role to help learners complete tasks, but the important points are still on the cultivation of high-level knowledge and skills. It is deduced that the scaffolding of cognition and metacognition during the ChatGPT usage process would improve students' efficiency and effectiveness of prompting construction. This can be supported by the ChatGPT affordances in the education section. It was found that ChatGPT was adopted to provide support for critical thinking, problem-solving, self-reflection, and deep thinking.

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