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The use of ChatGPT in teaching and learning: a systematic review through SWOT analysis approach

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Introduction: The integration of ChatGPT, an advanced AI-powered chatbot, into educational settings, has caused mixed reactions among educators. Therefore, we conducted a systematic review to explore the strengths and weaknesses of using ChatGPT and discuss the opportunities and threats of using ChatGPT in teaching and learning.

Methods: Following the PRISMA flowchart guidelines, 51 articles were selected among 819 studies collected from Scopus, ERIC and Google Scholar databases in the period from 2022-2023.

Results: The synthesis of data extracted from the 51 included articles revealed 32 topics including 13 strengths, 10 weaknesses, 5 opportunities and 4 threats of using ChatGPT in teaching and learning. We used Biggs's Presage-Process-Product (3P) model of teaching and learning to categorize topics into three components of the 3P model.

Discussion: In the Presage stage, we analyzed how ChatGPT interacts with student characteristics and teaching contexts to ensure that the technology adapts effectively to diverse needs and backgrounds. In the Process stage, we analyzed how ChatGPT impacted teaching and learning activities to determine its ability to provide personalized, adaptive, and effective instructional support. Finally, in the Product stage, we evaluated how ChatGPT contributed to student learning outcomes. By carefully considering its application in each stage of teaching and learning, educators can make informed decisions, leveraging the strengths and addressing the weaknesses of ChatGPT to optimize its integration into teaching and learning processes.

KEYWORDS

ChatGPT, Chatbot, SWOT analysis, 3P model, industry 5.0, teaching and learning

1 Introduction

Industry 4.0 – a concept initiated in 2011 by the Germans, has ushered us into the industrial revolution based on digitization and technology platforms, including automation, artificial intelligence (AI), connected devices, data analytics, virtual-reality systems, digital transformation, and more. However, the technological breakthrough is leading us into a new revolution known as "Industry 5.0" (Xu et al., 2021). Different from the technology-centric nature of Industry 4.0, Industry 5.0 is characterized by value-driven activities (Longo et al., 2020; Xu et al., 2021). In the context of Industry 5.0, humans and machines can collaborate and work together like in the ChatGPT scenario (Longo et al., 2020). Since its initial release in the community on November 30, 2022, ChatGPT has amazed the world with its extraordinary ability to perform extremely complex tasks (Baidoo-Anu and Owusu Ansah, 2023). The strength of ChatGPT lies in its ability to interact through natural conversation, including a series of questions from the user and feedback from the application (Rospigliosi, 2023). ChatGPT stimulates follow-up questions through continuous dialog, creating a different

experience than using other search engines (Rospigliosi, 2023). Regular search engines usually do not keep the history of an answers, and return a list of discrete links to resources based on the ratings of specific keywords used as search terms (Rospigliosi, 2023). Meanwhile, ChatGPT is capable of generating coherent (partially) accurate, systematic and informative responses that integrate and preserve the topic and history of the conversation (Zhai, 2022; Houston and Corrado, 2023). Instead of relying on regular internet searches, many people may think about turning to ChatGPT for many text-related tasks (Cox and Tzoc, 2023).

In the field of teaching and learning, the emergence of ChatGPT has aroused diverse views among educators because its potential applications could revolutionize existing educational approaches (Baidoo-Anu and Owusu Ansah, 2023; Tlili et al., 2023). While some educators have expressed concerns about integrating ChatGPT into educational settings, many other educators present strong arguments in favor of incorporating ChatGPT into education (Halaweh, 2023; Kasneci et al., 2023). With amazing achievements, ChatGPT passed the final exams of the University of Minnesota law school (Kelly, 2023), the US Medical Licensing Exam (Abdel-Messih and Kamel Boulos, 2023; Subramani et al., 2023), and United Kingdom standardized tests (Giannos and Delardas, 2023). Consequently, many schools and teachers have expressed concern about ChatGPT's impact on learners and the potential for cheating on their assignments (Kelly, 2023). Other opinions believe that educators should use ChatGPT as a teaching and learning support tool rather than worrying about its negative effects (Ali et al., 2023; Eager and Brunton, 2023). The incorporation of AI systems and chatbots into the educational domain should be seen as an opportunity for progress, rather than as a source of concern (Kooli, 2023).

In the fierce race on AI Chatbot technology, Google launched Bard AI on February 6 (Alabool, 2023). Shortly after, on February 8 (Alabool, 2023), Microsoft officially launched Bing Chat – an AI Chatbot that allows search engines to respond and interact naturally with users like ChatGPT or Google Bard (Rudolph et al., 2023). These chatbots are quickly embraced by students for supporting their studies (Rudolph et al., 2023). Therefore, policymakers, researchers, and educators should begin discussing how to safely and constructively use AI-Chatbot tools to support student learning (Baidoo-Anu and Owusu Ansah, 2023). Learners can use AI Chatbot tools to perform tasks in the subject area and education should focus on enhancing learners' creativity and critical thinking rather than general skills (Zhai, 2022). Educators should design learning tasks involving AI Chatbot tools to engage learners in solving real-world problems (Zhai, 2022). Furthermore, new assessment task formats need to be developed to prioritize the cultivation of students' creativity and critical thinking abilities, where AI chatbot tools cannot replace (Zhai, 2022).

Up to December 2023, we have identified many systematic studies discussing the significance of ChatGPT in education (Mhlanga, 2023; Sullivan et al., 2023), ethical issues related to ChatGPT (Sallam, 2023), SWOT analysis of ChatGPT (Alabool, 2023; Farrokhnia et al., 2023), the impacts of ChatGPT in education (Lo, 2023), application of ChatGPT in higher education (Chamorro-Atalaya et al., 2023; Ismail et al., 2023; Vargas-Murillo et al., 2023), ChatGPT's impact on student learning (Zirar, 2023). Although these reviews have shed some light on various aspects of using ChatGPT in education, many other important topics have not been reported regarding the analysis of strengths, weaknesses, opportunities and threats (SWOT) of using ChatGPT in teaching and learning. Therefore, in this review, based on existing evidence, we explored the strengths and weaknesses of using ChatGPT and discussed the opportunities and threats of using ChatGPT in teaching and learning.

For the purpose of this study, we used Biggs's Presage-Process-Product (3P) model of teaching and learning to explain the topic of a systematic review related to the use of ChatGPT in teaching and learning. Biggs's 3P model is known to be an outstanding model that explains students' approaches to learning through a systematic model of educational events (Biggs et al., 2001). Students' approaches to learning are explained through the interactions between the three components of the 3P model, with the components named: (1) Presage, referring to student characteristics and teaching context; (2) Process, referring to the specific learning tasks that are undertaken and handled; and (3) Product, referring to learning outcomes (Biggs et al., 2001). These three components interact mutually, forming a dynamic system with a tendency toward equilibrium, and a change in any of them affects the system as a whole (Biggs et al., 2001). When approaching Biggs's 3P model, we believed that analyzing the applications of ChatGPT at each stage of the Presage-Process-Product model was necessary to fully understand its impact on teaching and learning. In the Presage stage, an examination of how ChatGPT interacts with student characteristics and teaching contexts is important to ensure that the technology adapts effectively to diverse needs and backgrounds. In the Process stage, an assessment of ChatGPT's role in teaching and learning activities is necessary to determine its ability to provide personalized, adaptive, and effective instructional support. This stage also involves considering the collaborative opportunities that ChatGPT offers for student engagement. Finally, in the Product stage, an evaluation of how ChatGPT contributes to learning outcomes is essential to determine its effectiveness, ensuring that it is aligned with educational goals and standards. By carefully considering its application in each stage of teaching and learning, educators can make informed decisions, leveraging the strengths and addressing the weaknesses of ChatGPT to optimize its integration into teaching and learning processes.

We posed three research questions:

> What were the strengths, weaknesses, opportunities and threats of using ChatGPT in the Presage stage of the 3P model of teaching and learning reported in existing studies?
>
> What were the strengths, weaknesses, opportunities and threats of using ChatGPT in the Process stage of the 3P model of teaching and learning reported in existing studies?
>
> What were the strengths, weaknesses, opportunities and threats of using ChatGPT in the Product stage of the 3P model of teaching and learning reported in existing studies?

2 Methodology

This study was a systematic review through SWOT analysis. We utilized the PRISMA flowchart (Page et al., 2021) to select research papers, as illustrated in Figure 1.

2.1 Search strategies

For our online search, we used the Scopus and ERIC databases as primary scientific databases (see Figure 1). Complementing our search efforts, we also used the Google Scholar database to explore additional studies in the first 200 to 300 results displayed (Haddaway et al., 2015). The following keyword string was used for each database: ("Chatbot*" OR "ChatGPT" OR "Bing" OR "Bard") AND ("education" OR "teaching" OR "learning").

In the Scopus database, we inputted the keyword string into the search field as "title, abstract, keywords." We further refined our search by limiting it to the subject area "Social sciences," the years "2022–2023," document types "Article, conference paper" and language "English." Timeframe "2022–2023" was chosen because ChatGPT was launched on November 30, 2022, followed by Bing AI and Bard in 2023. Similarly, when conducting our search in the ERIC database, we restricted the search to the years 2022 to the present.

2.2 Research selection

As illustrated in Figure 1, the selection of studies proceeded through four phases.

First phase: In July 2023, we initiated the search in both Scopus, ERIC and Google Scholar databases. However, after the first round of peer review, the reviewer advised us to expand the search keyword string. Therefore, the results of the literature search were retrieved as of December 2023. Along with that, the information in the PRISMA flowchart as shown in Figure 1 was also updated accordingly. This search yielded 678 studies in the Scopus database and 111 studies in the ERIC database. Additionally, we discovered 30 additional studies through Google Scholar. A total of 819 studies were identified.

Second phase: We imported the identified studies into Mendeley Desktop software to identify and eliminate any duplicate studies. This process resulted in the removal of 7 duplicate studies.

Third phase: We believed that the application of ChatGPT in teaching and learning must be very cautious because ChatGPT is 'friend' yet a 'foe' (Leon and Vidhani, 2023; Lim et al., 2023; Lin, 2023). Risks to learners are possible if educators employ ineffective practices of using ChatGPT in educational settings (Ahmed, 2023; Barrett and Pack, 2023). It is claimed that ChatGPT can be useful in teaching and learning activities, but only if teachers adopt effective practices in using this tool (Domenech, 2023; Singh et al., 2023). Meanwhile, empirical studies, with their scientific rigor, objectivity and generalizability, can ensure reliable and valid evidence based on systematic and verifiable processes. Educators and policymakers also often rely on empirical research to make informed decisions about integrating technologies like ChatGPT in educational settings. Therefore, we included any empirical studies, qualitative or quantitative, that reported evidence for understanding the use of ChatGPT in teaching and learning. We excluded all non-empirical studies such as literature reviews, theoretical commentaries, conceptual papers, policy proposals. Additionally, we also excluded papers that were preprints because they had not undergone the peer review process required for publication, raising concerns about the quality of the evidence.

We assessed the remaining 812 studies by examining their titles, abstracts, and keywords, leading to the exclusion of 722 studies. Studies were excluded for the following reasons:

- Studies did not mention ChatGPT in education: 538.
- The potential of extracted data was not relevant to the research question: 129.
- Studies are non-empirical: 45.
- Studies were preprint: 7.
- Studies could not find the source: 3.

Fourth phase: In the final phase, we thoroughly reviewed the full text of the remaining 90 potentially eligible studies. We used 'inter-rater reliability' using 'percent agreement' (McHugh, 2012; Ha et al., 2023) and a calculated consensus ratio of 43/51 = 0.84 (ie 84%). A research team meeting was held to discuss potential included studies where there were differences of opinion between us. We reached consensus to include eight studies in the final sample. Thus, a total of

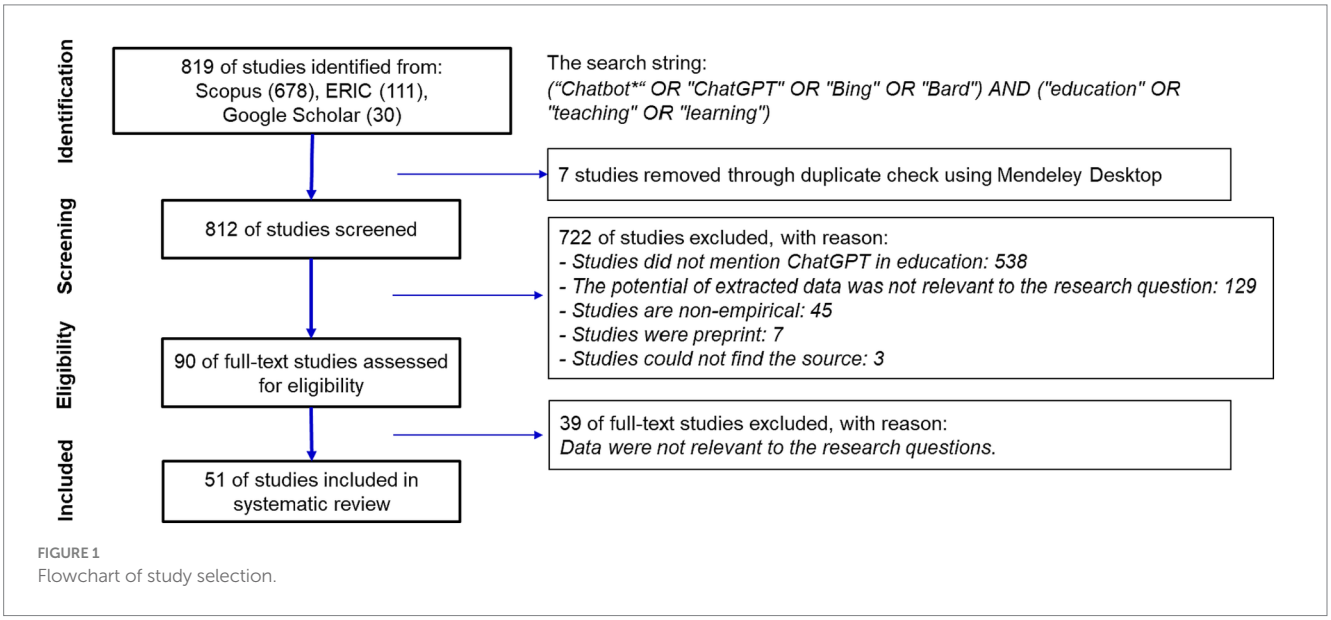

FIGURE 1
Flowchart of study selection.

39 articles were determined to be unrelated to the research question. Thus, this fourth phase resulted in a final sample of 51 articles included for the review.

2.3 Extraction method

In each of the included articles, we collected two sets of data:

- General information of the studies: authors, publication year, place of publication, type of study design, educational level, and knowledge domains.
- Findings from studies: We extracted findings from the studies to facilitate discussions about the strengths and weaknesses of using ChatGPT in teaching and learning, as well as the opportunities and threats associated with its use in teaching and learning.

We aggregated the extracted data in Excel for thematic analysis. The process of building topics involved a mental step in which we identified similar codes and grouped them into topics. To investigate relevant topics within the 51 included articles, we applied the 3P (Presage, Process and Product) model of teaching and learning, as originally proposed by (Biggs et al., 2001). This model provided us with a structured framework of the three elements of "Presage," "Process," and "Product" to guide and categorize the findings related to the use of ChatGPT in teaching and learning settings.

3 Results

3.1 General description of the studies

In this review, we included a total of 51 studies. The general description of the studies is described in Table 1.

All studies were published in academic journals by 2023. Two studies used a combination of ChatGPT, Bing, and Bard in its analysis, while the other studies only mentioned ChatGPT. There were 20 articles using quantitative methods (accounting for 39.22%) and 31 articles using qualitative methods (60.78%). Most studies focused on the application of ChatGPT in the domain of higher education, with a total of 41 articles (accounting for 80.39%). There were 10 articles (accounting for 19.61%) focusing on the general education level.

According to the geographical distribution (see Figure 2), a total of eight articles were conducted in North America, including 6 articles from the United States and 2 articles from Canada. In Europe, 12 studies were conducted, including 4 articles from the United Kingdom, 3 articles from Germany, 2 articles from Bulgaria, 1 article from Spain, 1 article from Romania, and 1 article from Ireland. In Asia, a total of 24 studies were conducted, including 3 articles from China, 3 articles from Hong Kong, 2 articles from Singapore, 2 articles from Thailand, 4 articles from Saudi Arabia, 3 articles from the United Arab Emirates, 2 articles from Türkiye, 1 article from Jordan, 1 article from Vietnam, 1 article from South Korea, 1 article from Jordan and 1 article from Indonesia. Three studies were conducted in South America, including 2 articles from Peru and 1 article from Uruguay. Three studies were conducted in Oceania, including 2 articles from Australia and 1 article from New Zealand. Finally, one study was conducted in South Africa.

Additionally, we used the citation information of the articles in Table 1 to synthesize the data in Figure 3 of this study.

3.2 Domain of knowledge

The articles were explored to determine the focus of content within the educational level and were then presented in Table 2.

The articles were mainly concerned with the knowledge domain of English language education with 11 out of 51 included studies, accounting for 21.57%. The second most popular knowledge domains were health education and computer science, with 5 articles for each knowledge domain (accounting for 9.8%). Three articles focused on the knowledge domain of physics education, accounting for 5.88%. Two articles focused on the knowledge domain of teacher training, accounting for 3.92%. Other knowledge domains, with one article each, included engineering education, business management, chemistry, sports management, tourism, construction, academic advising, education for sustainable development, chemistry education, science education, geography education, math education, biology exam. In addition, 11 articles did not mention specific knowledge domains (accounting for 21.57%). They have focused on a general understanding of using ChatGPT in teaching and learning through applied research methods such as interviews with educators/faculty/students and student surveys.

3.3 SWOT analysis of using ChatGPT in the stages of the 3P model of teaching and learning

The synthesis of evidence from the 51 included articles revealed 13 strengths, 10 weaknesses, 5 opportunities and 4 threats of using ChatGPT in teaching and learning. These topics were then classified into the stages of the 3P model of teaching and learning, as shown in Table 3.

As the results shown in Table 3, we have drawn the following observations:

- In the Presage stage, we identified four strengths of using ChatGPT including positive perception of faculty and students, locating the role of ChatGPT in teaching and learning, developing course materials, and ChatGPT's superiority over other chatbots. Two weaknesses were pointed out, including that ChatGPT is not suitable for beginners, and the teaching designs created by ChatGPT are generic. ChatGPT has potential opportunities to enhance traditional teaching methods, while requiring new skills for users to work with ChatGPT was considered a threat.
- In the Process stage, we identified five strengths of using ChatGPT in the teaching and learning process including personalized learning experiences, providing basic knowledge and reducing teachers' workload, immediate response, supporting idea generation and providing quality explanations, and automated assistance for writing tasks. Meanwhile, five weaknesses were pointed out as limited response length, bias in results, inaccuracy of information, forged citations and references, and lack of motivational improvement in challenging tasks. Three opportunities for using ChatGPT in the teaching and learning process were identified as providing an interactive

TABLE 1 General description of the studies.

Source	Place	Design	Edu. level	Citation scopus	Citation google scholar
Jalil et al. (2023)	United States	Qualitative	HE	19	114
Uddin et al. (2023)	United States	Qualitative	HE	4	14
Clark (2023)	United States	Quantitative	GE	16	28
Keiper et al. (2023)	United States	Qualitative	HE	5	13
Akiba and Fraboni (2023)	United States	Qualitative	HE	1	3
(Branum and Schiavenato, 2023)	United States	Qualitative	HE	2	6
Kooli (2023)	Canada	Qualitative	HE	35	94
Day (2023)	Canada	Qualitative	GE	16	45
Fergus et al. (2023)	UK	Qualitative	HE	33	64
Giannos and Delardas (2023)	UK	Quantitative	HE	18	28
Thirunavukarasu et al. (2023)	UK	Quantitative	HE	28	48
Ross (2023)	UK	Qualitative	HE	1	1
Friederichs et al. (2023)	Germany	Quantitative	HE	8	20
Bitzenbauer (2023)	Germany	Quantitative	GE	6	30
Küchemann et al. (2023)	Germany	Quantitative	GE	0	4
Lozano and Blanco Fontao (2023)	Spain	Quantitative	HE	3	5
Popovici (2023)	Romania	Quantitative	HE	0	0
Kiryakova and Angelova (2023)	Bulgaria	Quantitative	HE	0	1
Ivanov and Soliman (2023)	Bulgaria	Qualitative	HE	27	54
Adams et al. (2023)	Ireland	Quantitative	HE	3	4
Yan (2023)	China	Qualitative	HE	31	78
Wandelt et al. (2023)	China	Quantitative	HE	0	1
Guo and Wang (2023)	China	Quantitative	HE	1	1
Liang et al. (2023)	Hong Kong	Qualitative	GE	0	0
Zhu et al. (2023)	Hong Kong	Qualitative	N/A	5	11
Chan and Hu (2023)	Hong Kong	Quantitative	HE	12	71
Rudolph et al. (2023)	Singapore	Qualitative	HE	85	81
Ouh et al. (2023)	Singapore	Qualitative	HE	0	9
Limna et al. (2023)	Thailand	Qualitative	HE	21	29
Ulla et al. (2023)	Thailand	Qualitative	HE	1	7
Dao and Le (2023)	Vietnam	Quantitative	GE	0	1
Surapaneni (2023)	India	Qualitative	HE	0	0
Jeon and Lee (2023)	South Korea	Qualitative	HE	21	57
Firaina and Sulisworo (2023)	Indonesia	Qualitative	HE	N/A	32
Mohamed (2023)	Saudi Arabia	Qualitative	HE	7	19
Ali et al. (2023)	Saudi Arabia	Quantitative	HE	N/A	86
Allehyani and Algamdi (2023)	Saudi Arabia	Quantitative	GE	0	0
Ahmed (2023)	Saudi Arabia	Qualitative	HE	1	2
Chaudhry et al. (2023)	UAE	Qualitative	HE	13	31
Halaweh (2023)	UAE	Qualitative	HE	50	143
Wardat et al. (2023)	UAE	Qualitative	GE	23	46
Firat (2023)	Türkiye	Qualitative	HE	30	67
Yilmaz and Karaoglan Yilmaz (2023)	Türkiye	Quantitative	HE	10	24
Sallam et al. (2023)	Jordan	Qualitative	HE	19	64
Muñoz et al. (2023)	Peru	Quantitative	HE	9	22
Limo et al. (2023)	Peru	Quantitative	HE	3	8
Jauhiainen and Guerra (2023)	Uruguay	Quantitative	GE	0	3
Nikolic et al. (2023)	Australia	Qualitative	HE	14	32

(Continued)

TABLE 1 (Continued)

Source	Place	Design	Edu. level	Citation scopus	Citation google scholar
Cooper (2023)	Australia	Qualitative	GE	73	190
Stojanov (2023)	New Zealand	Qualitative	HE	4	16
van den Berg and du Plessis (2023)	South Africa	Qualitative	HE	1	2

The citation collection date was December 26, 2023.
HE, higher education; GE, general education; N/A, not available.
UK, United Kingdom; UAE, United Arab Emirates.

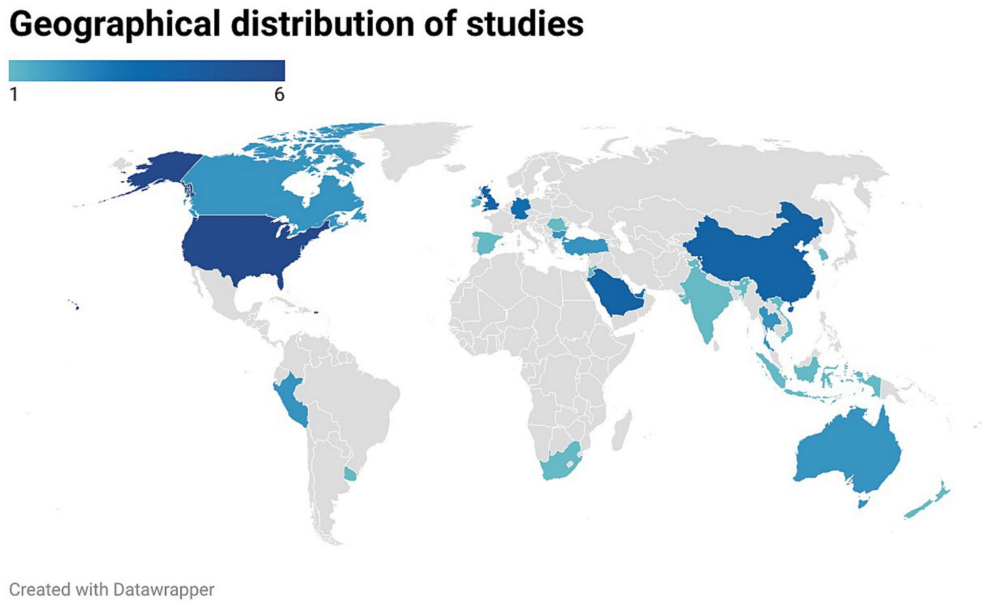

FIGURE 2
Geographical distribution of studies (image created with Datawrapper).

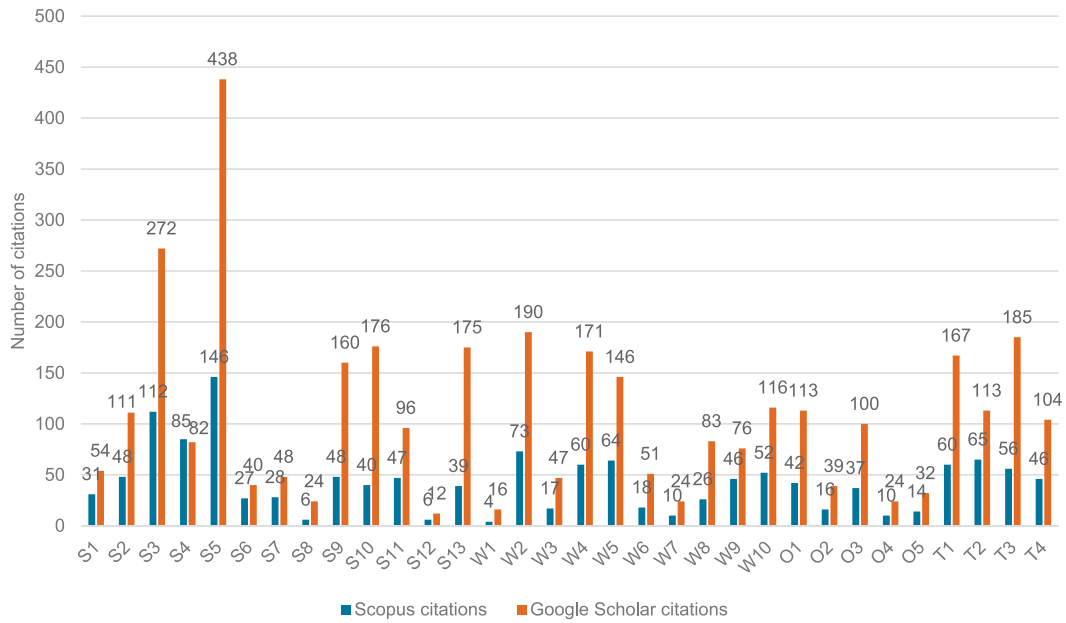

FIGURE 3
Citations of topics.

TABLE 2 Domain of knowledge.

Education level	Knowledge domains	Sources	N	%
Higher education	Engineering education	Nikolic et al. (2023)	1	1.92
	Business management	Chaudhry et al. (2023)	1	1.92
	Chemistry	Fergus et al. (2023)	1	1.92
	BMAT, TMUA, LNAT and TSA	Giannos and Delardas (2023)	1	1.92
	Sports management	Keiper et al. (2023)	1	1.92
	Health education	Branum and Schiavenato (2023), Friederichs et al. (2023), Sallam et al. (2023), Surapaneni (2023), and Thirunavukarasu et al. (2023)	5	9.91
	Computer science, programming	Jalil et al. (2023), Ouh et al. (2023), Popovici (2023), Stojanov (2023), and Yilmaz and Karaoglan Yilmaz (2023)	5	9.91
	Tourism	Ivanov and Soliman (2023)	1	1.92
	Construction	Uddin et al. (2023)	1	1.92
	Language studies and English language learning	Ahmed (2023), Ali et al. (2023), Allehyani and Algamdi (2023), Guo and Wang (2023), Jeon and Lee (2023), Mohamed (2023), Muñoz et al. (2023), Ross (2023), Rudolph et al. (2023), Ulla et al. (2023), and Yan (2023)	11	21.14
	Academic advising	Akiba and Fraboni (2023)	1	1.92
	Schoolteacher education and teacher training	Lozano and Blanco Fontao (2023) and van den Berg and du Plessis (2023)	2	3.84
	Education for sustainable development	Adams et al. (2023)	1	1.92
	N/A	Chan and Hu (2023), Firaina and Sulisworo (2023), Firat (2023), Halaweh (2023), Kiryakova and Angelova (2023), Kooli (2023), Limna et al. (2023), Limo et al. (2023), Stojanov (2023), Wandelt et al. (2023), and Zhu et al. (2023)	11	21.14
General education	Chemistry education	Clark (2023)	1	1.92
	Science education	Cooper (2023)	1	1.92
	Geography education	Day (2023)	1	1.92
	History education	Jauhiainen and Guerra (2023)	1	1.92
	Physics education	Bitzenbauer (2023), Küchemann et al. (2023), Liang et al. (2023)	3	5.76
	Math education	Wardat et al. (2023)	1	1.92
	High School Biology Exam	Dao and Le (2023)	1	1.92

BMAT, biomedical admissions test; TMUA, test of mathematics for university admission; LNAT, law national aptitude test; TSA, thinking skills assessment.

environment and needs-based responses, scaffolding for personalized learning, and providing prompt writing skills for students. Meanwhile, plagiarism, copyright issues and academic dishonesty were considered threats.

- In the Product stage, strengths of using ChatGPT were identified as improved learning outcomes, ability to work with a variety of assessment tasks, ability to evaluate writing tasks and provide feedback, and moderate success in exams. Meanwhile, three weaknesses were pointed out as decreasing critical thinking, performance differences between subjects, and lack of insight in all types of assessment tasks. Opportunistically, ChatGPT can be used as student scaffolding for assessment tasks. Cheating and gaining an advantage in exams, and difficulties in building performance assessment models were considered threats to using ChatGPT in teaching and learning.

In Figure 3, we visualized the citation totals of topics related to using ChatGPT in teaching learning to inform the topics that have attracted the most interest among fellow researchers.

As shown in Figure 3, topics S3 (developing course material) and S5 (providing personalized learning experiences) were the two topics receiving the greatest interest among fellow researchers, with total citations in Scopus of 112 and 146, respectively, and in Google Scholar of 272 and 438, respectively. Fellow researchers have shown more interest in topics S2 (locating the role of faculty and ChatGPT), S3 (developing course material), S5 (providing personalized learning experiences), S9 (Automated assistance for writing tasks), S10 (improving learning outcomes), S13 (moderate success in exams), W2 (the generality of teaching designs), W4 (bias in results), W5 (inaccuracy of information), W10 (lack of insight in all types of assessment tasks), O1 (complementation and enhancement of traditional teaching methods), O3 (scaffolding for personalized learning), T1 (new skills requirements), T2 (plagiarism, copyright issues and academic dishonesty), T3 (cheating and gaining an advantage in exams) và T4 (building performance assessment models) than in the remaining topics, with total citations for each topic recorded to be greater than 100 times in Google Scholar, and about 50 times in Scopus. We also noted that all 51 included studies were published in

TABLE 3 SWOT analysis of using ChatGPT in teaching and learning.

Components	Topics	Sources	Stages of 3P model		
			Presage	Process	Product
Strengths	S1: Positive perceptions of faculty and students	Allehyani and Algamdi (2023), Bitzenbauer (2023), Kiryakova and Angelova (2023), Limna et al. (2023), Lozano and Blanco Fontao (2023), and Ulla et al. (2023)	✓		
	S2: Locating the role of faculty and ChatGPT	Ivanov and Soliman (2023) and Jeon and Lee (2023)	✓		
	S3: Developing course material	Adams et al. (2023), Chaudhry et al. (2023), Cooper (2023), Ivanov and Soliman (2023), Jauhiainen and Guerra (2023), Keiper et al. (2023), and Küchemann et al. (2023)	✓		
	S4: ChatGPT's superiority over other chatbots	Dao and Le (2023) and Rudolph et al. (2023)	✓		
	S5: Providing personalized learning experiences	Chan and Hu (2023), Firat (2023), Halaweh (2023), Kooli (2023), and Sallam et al. (2023)		✓	
	S6: Providing basic knowledge and reducing the teacher's workload	Limna et al. (2023), Ross (2023), and Wardat et al. (2023)		✓	
	S7: Immediate response	Limna et al. (2023) and Mohamed (2023)		✓	
	S8: Supporting idea generation and providing quality explanations	Akiba and Fraboni (2023), Kiryakova and Angelova (2023), Liang et al. (2023), Ouh et al. (2023), and Zhu et al. (2023)		✓	
	S9: Automated assistance for writing tasks	Chan and Hu (2023), Yan (2023) and Zhu et al. (2023)		✓	
	S10: Improving learning outcomes	Ali et al. (2023), Chaudhry et al. (2023), Muñoz et al. (2023), Stojanov (2023), Uddin et al. (2023), Wandelt et al. (2023), and Yilmaz and Karaoglan Yilmaz (2023)			✓
	S11: Ability to work with a variety of assessment tasks	Fergus et al. (2023) and Nikolic et al. (2023)			✓
	S12: Ability to evaluate writing tasks and provide feedback	Zhu et al. (2023) Popovici (2023), and Guo and Wang (2023)			✓
	S13: Moderate success in exams	Clark (2023), Friederichs et al. (2023), Jalil et al. (2023) and Keiper et al. (2023)			✓
Weaknesses	W1: Not suitable for beginners	Allehyani and Algamdi (2023) and Stojanov (2023)	✓		
	W2: The generality of teaching designs	Cooper (2023)	✓		
	W3: Limitation of answer length	Chaudhry et al. (2023) and Stojanov (2023)		✓	
	W4: Bias in results	Kooli (2023), Sallam et al. (2023), van den Berg and du Plessis (2023), and Zhu et al. (2023)		✓	
	W5: Inaccuracy of information	Limna et al. (2023), Sallam et al. (2023), Surapaneni (2023), Ulla et al. (2023), and Wardat et al. (2023)		✓	
	W6: Forged citations and references	Branum and Schiavenato (2023) and Day (2023)		✓	
	W7: Lack of motivational improvement in challenging tasks	Yilmaz and Karaoglan Yilmaz (2023)		✓	
	W8: Decreasing critical thinking	Mohamed (2023) and Sallam et al. (2023)			✓
	W9: Performance differences between subjects	Giannos and Delardas (2023) and Thirunavukarasu et al. (2023)			✓
	W10: Lack of insight in all types of assessment tasks	Fergus et al. (2023), Nikolic et al. (2023), Ouh et al. (2023), Popovici (2023), and Zhu et al. (2023)			✓

(Continued)

TABLE 3 (Continued)

Components	Topics	Sources	Stages of 3P model		
			Presage	Process	Product
Opportunities	O1: Complementation and enhancement of traditional teaching methods	Kooli (2023) and Mohamed (2023)	✓		
	O2: Providing an interactive environment and needs-based responses	Chaudhry et al. (2023) and Limo et al. (2023)		✓	
	O3: Scaffolding for personalized learning	Ahmed (2023), Ouh et al. (2023), Yan (2023) and Zhu et al. (2023)		✓	
	O4: Providing prompt writing skills for students	Yilmaz and Karaoglan Yilmaz (2023)		✓	
	O5: Scaffolding for assessment tasks	Nikolic et al. (2023)			✓
Threats	T1: New skills requirements	Halaweh (2023) and Yilmaz and Karaoglan Yilmaz (2023)	✓		
	T2: Plagiarism, copyright issues, and academic dishonesty	Branum and Schiavenato (2023), Chaudhry et al. (2023), Firaina and Sulisworo (2023), Sallam et al. (2023), and Yan (2023)		✓	
	T3: Cheating and gaining an advantage in exams	Giannos and Delardas (2023), Jalil et al. (2023), Nikolic et al. (2023), and Zhu et al. (2023)			✓
	T4: Building performance assessment models	Chaudhry et al. (2023), Fergus et al. (2023), and Ouh et al. (2023)			✓

2023, and total citations were collected cross-sectionally in December 2023. Therefore, citation tracking over a sufficiently long period of time will be necessary to observe trends more clearly in the interest of fellow researchers in the topic of using ChatGPT in teaching and learning.

4 Discussion

4.1 Using ChatGPT in the presage stage of the 3P model of teaching and learning

4.1.1 Strengths

4.1.1.1 Positive perceptions of faculty and students

Both faculty and students generally hold a positive perception of the use of ChatGPT in teaching and learning (Limna et al., 2023). For example, English teachers exhibit positive attitudes towards ChatGPT and acknowledge its diverse applications (Allehyani and Algamdi, 2023; Ulla et al., 2023). University lecturers generally have positive attitudes about using ChatGPT in their teaching practice (41.4%) (Kiryakova and Angelova, 2023). Furthermore, students also have a positive opinion about the integration ChatGPT into the classroom (Bitzenbauer, 2023; Chan and Hu, 2023; Lozano and Blanco Fontao, 2023). They do not consider it as a threat to the educational system as long as the data generated by ChatGPT is verifiable (Lozano and Blanco Fontao, 2023). The benefits of ChatGPT extend beyond the classroom, as students realize its relevance and integration into their daily lives (Bitzenbauer, 2023). This tool supports and empowers students to apply their knowledge to real-life situations and solve real-life problems effectively.

4.1.1.2 Locating the role of faculty and ChatGPT

The use of ChatGPT is said to be able to revolutionize education (Ivanov and Soliman, 2023). This technology has the potential to reshape the three key roles of faculty in the education ecosystem. The primary role of faculty involves coordinating disparate resources with quality pedagogical decisions (Jeon and Lee, 2023). By leveraging AI capabilities, teachers can provide students with diverse and relevant learning materials, thereby enhancing the overall educational experience. The second role of faculty involves encouraging students to become active investigators (Jeon and Lee, 2023). Through interactions with ChatGPT as interlocutors, students are motivated to explore and deepen their understanding of topics of interest, fostering curiosity and self-learning. Lastly, the third role of faculty centers on raising the ethical awareness of AI among the students (Jeon and Lee, 2023). Faculty can use this tool to engage students in discussions about the ethical implications of AI usage, cultivating a deeper understanding of transparent and accountable AI implementation.

ChatGPT assumes four distinct roles in the educational process including interlocutor, content provider, teaching assistant, and evaluator (Jeon and Lee, 2023). As a content provider, ChatGPT enriches traditional teaching resources with a huge amount of information. In its role as a teaching assistant, ChatGPT assists faculty in their teaching tasks and enables more personalized interaction with students. As an interlocutor, ChatGPT facilitates meaningful dialogue with students and encourages active participation. Lastly, ChatGPT takes on the role of evaluator, providing real-time feedback and assessment to students, thereby driving continuous improvement in their learning journey. In general, digital teachers, aided by AI technologies such as ChatGPT, can handle many of the cognitive tasks that human educators have previously performed (Ivanov and

Soliman, 2023). This transformation promises to create a more personalized and productive learning environment, enabling faculty to focus on higher-order thinking skills, and facilitate deeper and more meaningful learning experiences.

4.1.1.3 Developing course materials

ChatGPT has proven to be a valuable tool in helping faculty to create course materials efficiently (Keiper et al., 2023; van den Berg and du Plessis, 2023). For example, in the field of tourism education, ChatGPT can support effective text generation such as task assignments and research papers (Ivanov and Soliman, 2023). In sustainability education, ChatGPT enriches contextual content, providing relevant and engaging material to enhance the learning experience for students (Adams et al., 2023). In the field of science education, ChatGPT has demonstrated its ability to create a science unit using the 5E model on the topic of renewable and non-renewable energy sources, along with high-quality rubrics and quizzes (Cooper, 2023). Thus, science teachers can use ChatGPT to generate ideas when designing science units, rubrics, and quizzes (Cooper, 2023). Additionally, ChatGPT is also smart enough to write assignments, case studies, project reports, and work-based problems (Chaudhry et al., 2023). For example, when using ChatGPT for developing physics tasks, no difference was observed in the accuracy of the designed task (Küchemann et al., 2023). Most students prefer to study comprehensive historical materials modified by ChatGPT (Jauhiainen and Guerra, 2023). Overall, ChatGPT can play an active role in assisting faculty in creating engaging and innovative course materials.

4.1.1.4 ChatGPT's superiority over other chatbots

In a comparative analysis of ChatGPT with other chatbots (Bard and Bing Chat) in an interdisciplinary test, the results revealed that none of these chatbots achieved an "A" grade or a "B" grade (Rudolph et al., 2023). Notably, ChatGPT-4 and its predecessor outperformed all other chatbots (Rudolph et al., 2023). In contrast, Bing Chat and Bard exhibited lower performance on the test, resembling students at risk of failing, with a mean grade of "F" (Rudolph et al., 2023). In another example, ChatGPT exhibited superior flexibility across a range of questions of varying difficulty and context on a high school biology exam, compared to Bing and Bard (Dao and Le, 2023). These findings highlight the degree of difference in effectiveness and performance between chatbot models and the superiority of ChatGPT in tests.

4.1.2 Weaknesses

4.1.2.1 Not suitable for beginners

A study has shown that the responses generated by ChatGPT can be superficial and may not always exhibit logical consistency or coherence (Stojanov, 2023). Additionally, there may be cases where the answers are contradictory, raising concerns about the accuracy of information provided (Stojanov, 2023). Teachers expressed concern that beginners lacking the necessary knowledge and skills to interact critically with ChatGPT may have difficulty using the technology effectively (Allehyani and Algamdi, 2023; Stojanov, 2023). For such learners, identifying inaccurate or misleading information in generated content can be difficult. Conversely, more advanced learners who already possess prior knowledge and have developed critical thinking skills are likely to benefit more from interacting with ChatGPT (Stojanov, 2023). They can distinguish and evaluate the quality of information provided by the system, using their existing knowledge as a basis for comparison. Therefore, providing appropriate tutorials and scaffolding for beginners can help them navigate the technology more effectively, while also offering advanced learners to interact with ChatGPT in a way complement their existing knowledge and critical thinking skills.

4.1.2.2 The generality of teaching designs

In a specific situation, although ChatGPT was capable of generating a scientific unit, the output could be generic and might require further improvement (Cooper, 2023). Teachers should critically assess and tailor the science unit designs created by ChatGPT to their particular teaching context (Cooper, 2023). It is important to realize that despite advances in AI, it cannot replace the expertise of science teachers (Cooper, 2023). Teachers play a key role in refining and adapting the outputs of ChatGPT's science unit designs to fit their teaching context. By combining the power of AI tools like ChatGPT with the expertise of science teachers, a powerful synergy can be achieved, delivering a richer and more personalized educational experience for students.

4.1.3 Opportunities

4.1.3.1 Complementation and enhancement of traditional teaching methods

The role of ChatGPT should be viewed as a valuable tool for complementing and enhancing traditional teaching methods (Mohamed, 2023). As we enter an era dominated by AI systems and chatbots, adapting to this new reality becomes essential (Kooli, 2023). Embracing AI technologies like ChatGPT allows educators and students to harness the benefits they offer, such as instant access to vast amounts of information and personalized learning experiences. By incorporating ChatGPT into an educational setting, educators can provide students with an additional resource to support their learning journey. It is important to remember that ChatGPT should be viewed as an aid, not a replacement for human expertise, judgment, and creativity (Kooli, 2023). While ChatGPT can be a powerful tool, human instruction is still important in guiding students' critical thinking, fostering creativity, and providing context and perspective.

4.1.4 Threats

4.1.4.1 New skills requirements

The emergence of new technologies in teaching and learning, such as ChatGPT, requires students to have different skill sets than previous generations (Halaweh, 2023). As access to vast amounts of information becomes available, students need to develop skills for critically analyzing, evaluating, and interpreting information. Cultivating critical thinking can help students to make informed decisions, solve problems effectively, and distinguish reliable sources from misinformation (Halaweh, 2023). Additionally, presentation skills are becoming increasingly important for successful learning in sharing knowledge, collaborating effectively, and engaging in meaningful discussions (Halaweh, 2023). Educators play an important role in cultivating students' critical thinking and presentation skills. Through metacognitive strategies, open discussions, and opportunities for public speaking and presentations, educators can equip students with

these essential tools to learn effectively from tools like ChatGPT (Yilmaz and Karaoglan Yilmaz, 2023).

4.2 Using ChatGPT in the process stage of the 3P model of teaching and learning

4.2.1 Strengths

4.2.1.1 Providing personalized learning experiences

There are many benefits to using ChatGPT in teaching and learning, including providing an engaging and personalized learning experience (Chan and Hu, 2023), as well as increased accessibility to a wide variety of content and resources (Halaweh, 2023). By meeting individual learning interests and needs, personalized learning experiences can promote inclusiveness and equal access to education (Kooli, 2023). The integration of ChatGPT in teaching and learning opens up many opportunities to enhance the learning journey, customize personalized instruction methods, and revolutionize the role of educators (Firat, 2023). Through its adaptive nature, ChatGPT can assist students in grasping complex concepts and exploring topics that align their interests and learning pace. For example, in the field of health education, ChatGPT proves particularly advantageous by enhancing personalized learning, clinical reasoning and understanding of complex medical concepts (Sallam et al., 2023). By addressing specific medical queries, ChatGPT assists medical students and practitioners in their pursuit of knowledge and qualifications.

4.2.1.2 Providing basic knowledge and reducing the teacher's workload

In the few existing studies, ChatGPT has demonstrated its potential as a valuable tool in providing foundational knowledge in various educational contexts. For example, ChatGPT has proven to be a great aid for studying ancient languages such as Classical Latin, and Classical Sanskrit (Ross, 2023). It serves as a great aid for students in grasping grammar and vocabulary, checking translations, and even finding inspiration for composition tasks (Ross, 2023). The tool's capabilities significantly contribute to the acquisition and mastery of these languages. Within the domain of mathematics education, it has been acknowledged that ChatGPT can enhance students' educational success by providing them with a fundamental understanding of mathematical concepts and related topics (Wardat et al., 2023). By answering common questions and providing immediate responses to students, ChatGPT can reduce the workload of teachers (Limna et al., 2023). This allows educators to focus more on higher-level tasks such as discussions, assessments, and personalized learning experiences (Limna et al., 2023).

4.2.1.3 Immediate response

ChatGPT has been recognized as a valuable tool for providing immediate feedback, addressing a variety of questions, and assisting students (Chan and Hu, 2023; Limna et al., 2023; Mohamed, 2023). It allows students to receive timely guidance and corrections, thereby facilitating their understanding and progress. As an example, in the domain of English education, teachers appreciate how quickly and accurately responds of this tool to various types of questions, making it as a trusted resource for both educators and learners (Mohamed, 2023).

4.2.1.4 Supporting idea generation and providing quality explanations

Existing studies have reported ChatGPT's ability to support idea generation and provide quality explanations in a variety of knowledge domains. ChatGPT often generates reasonable responses in conversations, providing specialized solutions and guidance for tasks ranging from simple to complex (Zhu et al., 2023). For example, ChatGPT generated surprisingly high-quality answers in the area of academic advising for students, written in an authoritative tone, and especially, adept at addressing general career-related questions, such as career prospects, in a clear and comprehensive manner (Akiba and Fraboni, 2023). In the field of physics education, ChatGPT can solve some physics calculation tasks, explaining problem solutions at the human level (Liang et al., 2023). ChatGPT can build Java programming solutions accurately, characterized by high readability and well-structured organization (Ouh et al., 2023). Overall, ChatGPT was an effective means of supporting teaching and learning activities, arousing interest, activating and engaging learners (Kiryakova and Angelova, 2023).

4.2.1.5 Automated assistance for writing tasks

Existing studies emphasized the valuable role of ChatGPT in supporting structural idea generation and enhancing composition writing (Chan and Hu, 2023; Yan, 2023). The power of ChatGPT lies in its ability to produce text or content that closely resembles human expression (Zhu et al., 2023). Therefore, integrating ChatGPT into an automated workflow can maximize efficiency in composition writing tasks (Yan, 2023).

4.2.2 Weaknesses

4.2.2.1 Limitation of answer length

ChatGPT has restrictions on the length of the task created (Chaudhry et al., 2023). It is limited in the number of words that can be generated per answer, which may affect the complexity and depth of the answers provided (Stojanov, 2023). These limitations may pose challenges for users seeking in-depth and comprehensive feedback from ChatGPT. When dealing with complex questions or topics, the inability of ChatGPT to produce lengthy responses can result in incomplete or insufficient explanations. Furthermore, repeated questioning does not always lead to clarification of certain aspects (Stojanov, 2023). ChatGPT responses can remain consistent and unchanged, even after multiple attempts to extract additional information or obtain elaboration.

4.2.2.2 Bias in results

Several studies have noted that the use of ChatGPT in teaching and learning can result in the generation of misleading and inaccurate content (Kooli, 2023; Sallam et al., 2023). It can introduce inaccurate, fabricated and misleading information into its output (Zhu et al., 2023) and its potential biases (van den Berg and du Plessis, 2023). Being an AI language model, ChatGPT responses are generated based on patterns and information gathered from a huge amount of data. This data may inherently contain biases present in the sources from which it was obtained. Consequently, these biases can inadvertently influence ChatGPT's responses and potentially leading to unequal or unfair treatment of certain topics, opinions, or even groups of people (Kooli, 2023). Such unintended consequences can pose challenges in

educational settings where equitable and unbiased access to information is paramount (Kooli, 2023).

4.2.2.3 Inaccuracy of information

Both faculty and students have voiced concerns regarding the inaccuracy of information provided by ChatGPT and the potential diminishment of personal interaction with faculty (Limna et al., 2023). Although ChatGPT can be a valuable tool, its responses may not always be completely accurate or reliable (Sallam et al., 2023; Ulla et al., 2023). This can lead to the dissemination of inaccurate or misleading information, posing a challenge for educators in ensuring the accuracy of the content provided to students. For example, in the field of math education, the accuracy and effectiveness of ChatGPT can depend on various factors, including equation complexity, input data, and instructions for the tool (Wardat et al., 2023). While ChatGPT can be useful in providing general information, its limitations can become apparent when dealing with more complex math problems. Similarly, in the field of health education, it has also been noted that the risks associated with ChatGPT-generated content can inadvertently lead students to absorb false or inaccurate information (Sallam et al., 2023). ChatGPT is not considered a provider of accurate information for application in medical education to improve learning and assessment (Surapaneni, 2023). These concerns underscore the importance of using ChatGPT judiciously and complementing the benefits of ChatGPT with human expertise.

4.2.2.4 Forged citations and references

An examination of citations and references generated by ChatGPT revealed that they were, in fact, spurious (Day, 2023). In clinical research, it was found that references cited as evidence included incorrect journal information, and many of the studies summarized by ChatGPT observed to be patently false, including providing fabricated data (Branum and Schiavenato, 2023). The evidences have raised concerns about the initial optimism surrounding research-enabled technology (Day, 2023). Furthermore, it also highlights the possibility of students misusing ChatGPT in an academic setting, including the creation of fake citations and references (Day, 2023).

4.2.2.5 Lack of motivational improvement in challenging tasks

One study has shown that relying on AI tools alone may not be suffice to boost student motivation when they encounter challenging programming tasks (Yilmaz and Karaoglan Yilmaz, 2023). Therefore, faculty should explore and implement alternative motivational strategies to ensure that students stay motivated in the face of complex programming challenges (Yilmaz and Karaoglan Yilmaz, 2023). By combining these strategies with AI tools like ChatGPT, faculty can create a holistic learning experience that encourages students to stay motivated and committed to learning.

4.2.3 Opportunities

4.2.3.1 Providing an interactive environment and needs-based responses

By using ChatGPT as a tool for tailored feedback and interactive exchange, faculty can foster a supportive and empowering learning environment for students. ChatGPT can be utilized to provide students with their needs-based responses (Chaudhry et al., 2023). Faculty can harness the potential of ChatGPT to create more engaging and interactive learning environments for their students (Limo et al., 2023). Through interactive sessions with ChatGPT, students can actively participate in their education by asking questions, seeking personalized feedback, and accessing additional information to enhance their knowledge (Limo et al., 2023). This personalized approach empowers students to take responsibility for their learning journey and fosters a sense of autonomy and ownership over their education (Limo et al., 2023).

4.2.3.2 Scaffolding for personalized learning

ChatGPT has the potential to become a valuable tool for students, especially in light of the growing demand for personalized learning support (Zhu et al., 2023). For example, in programming courses, ChatGPT serves as an important support tool for students who are looking to overcome programming challenges and explore alternative methods to solve code problems (Ouh et al., 2023). The potential applicability of this tool in second language writing pedagogy has also been pointed out (Yan, 2023). Although ChatGPT can supplement the learning process of students, it does not replace the role of teachers (Ahmed, 2023).

4.2.3.3 Providing prompt writing skills for students

To maximize the benefits of ChatGPT in teaching and learning, it is important to provide students with prompt writing skills (Yilmaz and Karaoglan Yilmaz, 2023). Prompt writing skills enable students to interact with ChatGPT effectively and efficiently. Students who can clearly articulate their questions, ideas and concerns in written form being more likely to receive accurate and relevant responses from the AI system (Yilmaz and Karaoglan Yilmaz, 2023). Faculty can play an important role in nurturing students' prompt writing skills. By providing regular writing opportunities, providing constructive feedback, and encouraging active participation in AI-driven learning environments, faculty can assist students in developing the writing skills necessary to derive the most benefit from AI tools like ChatGPT.

4.2.4 Threats

4.2.4.1 Plagiarism, copyright issues and academic dishonesty

Using ChatGPT-generated content in an educational setting comes with inherent risks. Plagiarism, copyright issues, and academic dishonesty are some of the potential concerns associated with relying solely on AI-generated content (Sallam et al., 2023). Faculty also expressed concern about threats to academic integrity and educational equity that may arise from the misuse or improper attribution of such content (Yan, 2023). More worrisome is that ChatGPT passed Turnitin's academic integrity tests, which can help to detect potential plagiarism and ensure authorship verification, commonly used by faculty in educational institutions (Chaudhry et al., 2023). In clinical research, the system has been found to be opaque in how it collects data to answer questions and sometimes fabricates seemingly plausible information, making it an unreliable tool (Branum and Schiavenato, 2023). Therefore, to minimize the risks associated with content generated by ChatGPT, students should scrutinize and verify the information provided by the system using more accurate and reliable sources (Firaina and Sulisworo, 2023).

4.3 Using ChatGPT in the product stage of the 3P model of teaching and learning

4.3.1 Strengths

4.3.1.1 Improving learning outcomes

Learning with ChatGPT is effective in achieving the overall educational goals because learners actively engage in the active learning process, including motivation, beliefs, metacognitive skills, and knowledge (Chaudhry et al., 2023; Muñoz et al., 2023; Stojanov, 2023). For example, a study in the field of programming education found that the use of ChatGPT significantly improved computational thinking skills, self-programming abilities, and motivation among students in the experimental group compared to the control group (Yilmaz and Karaoglan Yilmaz, 2023). Additionally, it also makes a significant difference in terms of creativity, algorithmic thinking, collaboration, critical thinking, and problem-solving skills across various programming tasks, as well as influencing students' attitudes and expectations (Yilmaz and Karaoglan Yilmaz, 2023). In English education, ChatGPT has the potential to motivate learners in the cultivation of their reading and writing skills (Ali et al., 2023). In the construction industry education, the use of ChatGPT as an intervention has proven to be beneficial in assisting construction hazard identification, leading to hazard recognition rates exceeding 25% (Uddin et al., 2023). In programming education, the use of ChatGPT is beneficial to student learning processes and outcomes (Yilmaz and Karaoglan Yilmaz, 2023), improving programming skills (Wandelt et al., 2023). The findings support the idea that policymakers should enable the integration of ChatGPT into educational settings as a way to enhance students' learning outcomes (Muñoz et al., 2023).

4.3.1.2 Ability to work with a variety of assessment tasks

In the field of engineering education, ChatGPT was able to pass most online quizzes, 4/6 of the numerical tasks (Nikolic et al., 2023). It excels in programming tasks, succeeding in writing tasks based on critical thinking and reflection (Nikolic et al., 2023). ChatGPT has demonstrated its ability in research-related writing tasks that involve fact-finding (Nikolic et al., 2023). Its ability to support components of project-based and lab-based writing tasks adds to its value as an aid in engineering education (Nikolic et al., 2023). With questions surrounding knowledge and understanding, especially those using verbs like "describe" and "discuss," ChatGPT produced good answers (Fergus et al., 2023). By leveraging ChatGPT, students can receive valuable guidance and support in their engineering learning endeavors.

4.3.1.3 Ability to evaluate writing tasks and provide feedback

Several studies have reported the potential of using ChatGPT in supporting teachers to assess students' writing tasks and provide feedback (Zhu et al., 2023). More specifically, in programming courses, ChatGPT was observed to perform very well in evaluating codes in students' programming assignments (Popovici Alabool, 2023). In English language writing tasks, ChatGPT generated significantly more feedback than teachers, mainly focusing on content-and language-related issues (Guo and Wang, 2023). ChatGPT's ability to evaluate English writing tasks has been seen in evenly distributing attention among three main aspects of feedback including content, organization, and language (Guo and Wang, 2023).

4.3.1.4 Moderate success In exams

In various educational fields, ChatGPT has shown relatively impressive performance and capabilities, as evident in recent studies. In the field of health education, ChatGPT can correctly answer 2/3 of all multiple choice questions at the level of the German state licensing exam in Progress Test Medicine and outperformed almost all medical students in years 1–3 (Friederichs et al., 2023). In the field of sports education, ChatGPT can produce quality, complete, and accurate responses to short-answer questions (Keiper et al., 2023). Similarly, in high school Chemistry, for closed-ended questions, ChatGPT excels in identifying concepts even when the questions have many chemical symbols (Clark, 2023). For open-ended questions, ChatGPT's responses exhibit powerful language processing with higher performance on questions that can be solved with more general information than questions requiring specific skills (Clark, 2023). In the field of software testing, ChatGPT successfully answered 77.5% of the questions tested (Jalil et al., 2023). Among these questions, ChatGPT can give correct or partially correct responses in 55.6% of cases and offered correct or partially correct interpretation of responses in 53.0% of cases (Jalil et al., 2023). Overall, these findings underscore ChatGPT's potential as an educational tool, particularly in providing quick and accurate answers to a wide variety of test question types across various domains.

4.3.2 Weaknesses

4.3.2.1 Decreasing critical thinking

Some English teachers have expressed concerns about the potential impact of ChatGPT on students' critical thinking, as well as the potential for reinforcing biases or misinformation (Mohamed, 2023). Easy access to information through ChatGPT can prevent students from actively engaging in independent research and critically analyzing sources, hindering the development of essential skills in critically evaluating information. In the field of health education, risks with ChatGPT have been pointed out regarding the decline in students' critical thinking and communication skills (Sallam et al., 2023). Relying solely on ChatGPT for information can make students overly dependent on this tool, potentially lead to a lack of proficiency in critically assessing medical knowledge and effectively communicating complex concepts (Sallam et al., 2023). Thus, encouraging students to cross-verify information and engage in active learning can help reduce the risk of over-reliance on AI-generated content and reinforce the importance of cultivating these essential skills.

4.3.2.2 Performance differences between subjects

In the context of the Applied Knowledge Test for the Royal College of General Practitioners, the performance of ChatGPT was found to be different depending on the subject type (Thirunavukarasu et al., 2023). However, this variation did not correlate with the difficulty level of the questions (Thirunavukarasu et al., 2023). ChatGPT also only achieved an average overall performance of 60.17%, which is lower than the recent 2-year average (70.42%) (Thirunavukarasu et al., 2023). Similarly, when examining standardized United Kingdom entrance tests, such as the BioMedical Admissions Test (BMAT), Test of Mathematics for University Admission (TMUA), Law National Aptitude Test (LNAT) and Thinking Skills Assessment (TSA), significant differences in the

performance of ChatGPT were observed across these tests (Giannos and Delardas, 2023). The percentage of correct answers was significantly lower than that of incorrect answers in BMAT part 2 and TMUA paper 1 and paper 2 (Giannos and Delardas, 2023). In LNAT and TSA, ChatGPT has demonstrated moderate success (Giannos and Delardas, 2023). These findings indicated that the effectiveness of ChatGPT may be influenced by the specific subject and form of testing. While ChatGPT can provide valuable insights and explanations, its performance may vary depending on the nature of the question and the topic presented.

4.3.2.3 Lack of insight in all types of assessment tasks

ChatGPT was reliable enough to assist learners with passing exams, yet it may not provide all answers correctly, especially in more complex or multipart questions (Nikolic et al., 2023). Although ChatGPT was able to provide reasonable explanations, it was generally prone to errors and inaccurate responses (Nikolic et al., 2023). Furthermore, the current version of ChatGPT cannot handle complex diagram-based numerical questions (Nikolic et al., 2023). In coding tasks, ensuring assessment integrity can be challenging unless closely monitored, as students might attempt to clandestinely leverage ChatGPT (Nikolic et al., 2023). ChatGPT was ill-equipped for handling experimental writing assignments (Nikolic et al., 2023). In project and research writing tasks, limitations related to citations and references can result in distorted information (Nikolic et al., 2023). Additionally, ChatGPT has limitations in addressing application and interpretation questions, as well as non-textual information (Fergus et al., 2023). ChatGPT has difficulty with coding exercises that contain non-textual descriptions, leading to invalid solutions (Ouh et al., 2023). In a programming test, ChatGPT provided correct answers in 68% of cases but only about half of them were legible solutions (Popovici, 2023). In the field of mathematics education, ChatGPT has also demonstrated a profound lack of understanding of geometry and an inability to effectively correct misconceptions (Fergus et al., 2023; Zhu et al., 2023).

4.3.3 Opportunities

4.3.3.1 Scaffolding for assessment tasks

ChatGPT can play a multifaceted role in assisting students with assessment tasks. More specifically, ChatGPT can function as a Socratic tutor in numerical tasks (Nikolic et al., 2023). ChatGPT can assist students in generating ideas, information, structure, summary, and pointing them in the right direction for further investigation of project tasks (Nikolic et al., 2023). Additionally, ChatGPT can serve as a scaffolding for students, assisting them in structuring their writing assignments based on critical thinking and reflection (Nikolic et al., 2023). For research-related writing assignments, students can leverage ChatGPT by entering sections of research papers, resulting in simplified summaries that facilitate comprehension of complex concepts (Nikolic et al., 2023). In experimental writing tasks, ChatGPT can offer some suitable options or direct students toward defining their research questions and experimental methodologies (Nikolic et al., 2023). During the paragraph-writing process, ChatGPT can provide editing assistance, improving the quality and coherence of their writing (Nikolic et al., 2023). By fulfilling these diverse roles, ChatGPT can enhance the student learning experience by providing effective guidance and instruction.

4.3.4 Threats

4.3.4.1 Cheating and gaining an advantage in exams

The use of ChatGPT as a means to pass exams has raised significant concerns regarding academic integrity and the potential for fraud (Jalil et al., 2023). The risk of abusing AI Chatbot tools like ChatGPT to gain an unfair advantage in exams is a pressing issue in the education system (Giannos and Delardas, 2023; Zhu et al., 2023). To minimize these risks, several strategies can be employed. For example, using figure-and table-based quizzes can reduce student cheating (Nikolic et al., 2023). In numerical tasks, applying direct tests can serve as a safeguard against fraud (Nikolic et al., 2023). For programming tasks, incorporating requirements beyond ChatGPT's direct text input capabilities, such as figures and tables, can enhance the integrity of assessments (Nikolic et al., 2023). However, it is worth noting that in project-based tasks, ChatGPT, when in the hands of an experienced ghostwriter, could potentially be exploited for fraudulent purposes (Nikolic et al., 2023). Therefore, it is essential to have clear expectations and strict assessment criteria to prevent students from misusing ChatGPT (Nikolic et al., 2023). In conclusion, despite these concerns, the responsible and supervised use of ChatGPT can be a valuable tool within an educational context.

4.3.4.2 Building performance assessment models

Schools contemplating the integration of ChatGPT for in-class and at-home assignments may need to reassess their current performance-based assessment models (Chaudhry et al., 2023; Ouh et al., 2023). Traditional assessment tools, such as knowledge-based quizzes, problem-solving questions, critical thinking exercises, and creative writing, may not be sufficient in verifying student learning and accomplishment when no means exist to authenticate the authorship of work (Chaudhry et al., 2023). ChatGPT-generated content can easily be considered by students as their own, and simply submitting it on time can help them achieve top marks (Chaudhry et al., 2023). To address this issue, schools should consider the incorporation of more complex assessment methods such as problem-solving, data interpretation, and case studies that go beyond simple knowledge-based questions (Fergus et al., 2023). Such assessments challenge students to apply critical thinking, analyze information, and demonstrate their understanding of the topic in a way that ChatGPT cannot easily create.

5 Conclusion

We can summarize the results of the SWOT analysis on the use of ChatGPT in teaching and learning as shown in Figure 4 below.

A SWOT analysis of the use of ChatGPT in teaching and learning has revealed a spectrum of strengths and promising opportunities, but it also comes with certain weaknesses and threats. These findings can further explain the four paradoxes of ChatGPT including: ChatGPT is 'friend' yet a 'foe', ChatGPT is 'capable' yet 'dependent', ChatGPT is 'accessible' yet 'restrictive', ChatGPT is 'popular' when 'banned' (Lim et al., 2023).

It is not surprising that ChatGPT elicits mixed feelings among educators (Baidoo-Anu and Owusu Ansah, 2023; Tlili et al., 2023). Some educators expressed the view of banning the use of ChatGPT in educational institutions because of concerns about its negative effects. However, it is an obvious fact that when an emerging technology, especially ChatGPT, is born, learners quickly adopt it for learning

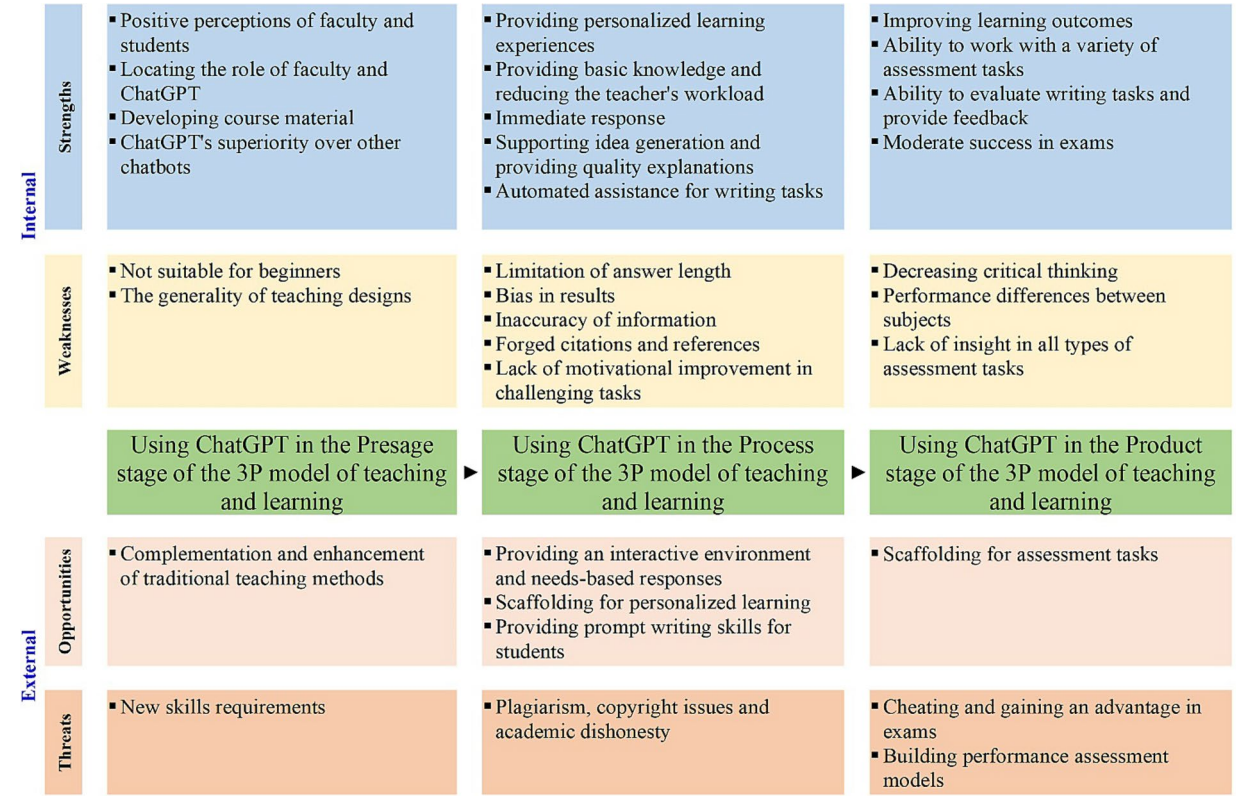

FIGURE 4
SWOT analysis of using ChatGPT in teaching and learning.

purposes (Ng'ambi, 2013). If schools run away with emerging technologies, it could create a dichotomy between technologies supported and used in educational institutions, and technologies owned and used by learners (Ng'ambi, 2013). The gap between technologies that are supported and used for teachers and those used for learners has put pressure on educators to "play the game of catch-up," leading to the use of ineffective pedagogy for emerging technologies (Ng'ambi, 2013). As a result, efforts to ban the use of emerging technologies in educational institutions have so far failed, and the same may be true of ChatGPT.

In a more favorable scenario, we should use ChatGPT as a valuable learning tool (Ali et al., 2023; Eager and Brunton, 2023). We need to pay special attention in identifying and addressing the weaknesses and potential threats posed by smart students who can always find ways to use new technologies like ChatGPT for their assignments (Farrokhnia et al., 2023). In a long-term scenario, we should consider about adapting the curriculum to integrate ChatGPT into education in a meaningful way. For example, learning objectives should emphasize the development of students' higher learning skills such as creativity and critical thinking. The design of learning assignments can allow students to use ChatGPT to create essays on a variety of topics and require them to explain the rationale and justification for their products.

The results of the literature review show that, despite its limitations, educators and students perceive the use of ChatGPT to be beneficial for enhancing learning efficiency and effectiveness (Firaina and Sulisworo, 2023). There is no doubt that we will soon experience a new era of education where AI Chatbot tools like ChatGPT will play an increasingly prominent role (Kooli, 2023). Ignoring or avoiding the presence of AI in our lives is impractical (Kooli, 2023). It is said that, if we ignore the development of AI, we can be swept away as obsolete technologies when they overtake us (Ross, 2023). Instead, we need to adapt our academic system to incorporate these new AI and chatbot technologies (Kooli, 2023). The emergence of new and powerful AI technologies can indeed be intimidating, but they are becoming an integral part of our daily lives (Ross, 2023). Just as we recognize the incredible potential of programs like ChatGPT, so will our students (Ross, 2023). They can teach themselves how to utilize these tools for their benefit, which may lead to misconceptions in their learning (Ross, 2023). Therefore, educators should allow students to use ChatGPT in their classroom activities, as learners can use it wherever possible (Halaweh, 2023).

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

DM: Conceptualization, Supervision, Validation, Writing – review & editing, Data curation, Funding acquisition, Project

administration. CD: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft. NH: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Supervision, Validation, Visualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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