

Teaching Practice Using ChatGPT in Higher Education

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Abstract: ChatGPT is an Artificial Intelligence (AI) chatbot platform developed by OpenAI. Several studies have highlighted the advantages and disadvantages of integrating ChatGPT into teaching methodologies and knowledge generation within higher education. We conducted a survey involving 86 professors within the Computer Science field in Brazil. Our findings indicate that professors are utilizing ChatGPT for content generation and the creation of teaching materials, including practical exercises, slides, assignments, and tests. Moreover, they view ChatGPT as a potential facilitator of learning by fostering interaction between students and professors. In the realm of knowledge production, professors are leveraging ChatGPT for tasks such as aiding in the composition of research papers or articles and generating automatic summaries. However, as per the professors' perceptions, a notable limitation of ChatGPT is its inability to provide bibliographic references for the content it delivers. Most professors believe that ChatGPT can be used as a support tool in higher education to generate knowledge. However, it is essential to address the challenges associated with the lack of bibliographic references in the content provided by ChatGPT.


1 INTRODUCTION


ChatGPT is a chatbot platform with Artificial Intelligence (AI) developed by OpenAI (Wu et al., 2023). ChatGPT was made available to the public on November 30th, 2022. It relies on a combination of multilingual natural language and programming languages to offer comprehensive and adaptive responses (Zhuo et al., 2023). According to Teubner et al. (Teubner et al., 2023a): OpenAI's GPT-3 (Generative Pre-trained Transformer 3) is a premier Large Language Model (LLM) and can handle a wide range of natural language processing tasks without any need for finetuning. Its largest variant features 175 billion parameters and has been trained on 570 GB of a wide range of text data, including books, press articles, Wikipedia, blogs, and other


web content (300 billion words in total). As a result, it can reliably produce texts that are read as if written by humans.


ChatGPT achieved one million users in just five days after its release (Chartr, 2022) and 100 million users in two months (Paris, 2023). Thus, it has drawn numerous users' attention, who interact with the platform and post comments on social media daily (Zhuo et al., 2023). In the educational context, mainly in higher education, studies present the advantages and disadvantages of students and professors using ChatGPT. Advantages are: chatGPT has a positive impact on the teaching-learning process (Rueda et al., 2023), it offers numerous opportunities for professors and lecturers to develop ideas (Halaweh, 2023), (Qadir, 2023a), very useful as a support for educational work (Rahman and Watanobe, 2023), both students and faculty can benefit from this tool (Javaid et al., 2023), faculty can save time on numerous tasks by using these technologies (Javaid et al., 2023), students can use it as a support tool (Javaid et al., 2023), this tool can increase student engagement and satisfaction (Firat, 2023), It can

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enhance learning experiences and transform the role of educators (Firat, 2023), it offers learners the chance to improve their language skills (Fauzi et al., 2023), increases collaboration, time efficiency and effectiveness (Fauzi et al., 2023), variations in translation quality among high-resource languages (Zhuo et al., 2023), generation of socially safe and unbiased responses in open-ended dialogues (Zhuo et al., 2023), and so on.

The disadvantages are the need for professors to be trained to use the tool properly (Rueda et al., 2023), (Halaweh, 2023), (Rahman and Watanobe, 2023), (Javaid et al., 2023), lack of common sense in its use and others Difficulties in complex reasoning (Rahman and Watanobe, 2023), Many students use ChatGPT to manage and deliver their work without learning anything (Castillo et al., 2023), it is important to use these tools with caution, as they can be misleading (Qadir, 2023a), as inadequate comprehension of low-resource languages (Zhuo et al., 2023), the possibility of bypassing safety features, and generations of dangerous, immoral, or illegal responses (Zhuo et al., 2023), and the like.

When asked how it could help professors in higher education, ChatGPT answered the following it could help by 1) providing them with relevant and up-to-date information on a wide range of topics; 2) generating ideas for course content, such as discussion topics, reading materials, or case studies; 3) creating automated assessments, such as quizzes or exams, that can be graded quickly and efficiently; 4) providing language support, such as translations or explanations of complex concepts; 5) generating personalized learning recommendations, such as recommended readings or study materials, based on individual student needs.

Kung et al. (Kung et al., 2023) analyzed the performance of ChatGPT when taking the United States Medical Licensing Exam (USMLE) in Step 1, Step 2CK, and Step 3. According to the authors, ChatGPT demonstrated a high level of agreement and perception. These results indicated that ChatGPT has the potential to help with medical education and potentially in clinical decision-making. Other authors have identified positive and reactive ways of using ChatGPT in academia (Shoufan, 2023; Joyner, 2023; Zhai, 2023a). For example, Pickell et al. (Pickell and Doak, 2023) suggested five ideas for helping professors avoid excessively using ChatGPT in text elaboration, such as requesting comparisons of theories or subjects with more current models and integrating their personal experiences in light of the requested topic. Similarly, Firat (Firat, 2023) suggested potential applications of ChatGPT in

transforming auto-didactic Experiences and Open Education, such as offering interactive exercises and games catered to the learner's particular learning needs and delivering personalized suggestions for learning materials and resources based on a learner's individual needs and objectives. According to the author, this interactive and individualized support can improve learning and encourage engagement and motivation.

Zhai (Zhai, 2023b) experimented with ChatGPT to automatically generate a performance-based assessment task. The results suggest that ChatGPT has the potential to solve the most challenging science learning problems through the development of automatic assessment and classification, learning guidance, and automatic recommendation of learning materials. Despite positive findings, this study suggests that ChatGPT cannot replace professors, and professors need professional knowledge to use ChatGPT for educational purposes. Phillips et al. (Phillips et al., 2022) explored how ChatGPT3 could extract and summarize student chat in a collaborative application in a learning environment. ChatGPT was able to correctly attribute states such as frustration and confusion, reliably synthesize missing statements in the source text, and effectively ignore extraneous noise in student chat. The paper discussed how this abstract could help professors understand student collaboration in collaborative learning environments.

Considering the above, it is vital to research the current role of ChatGPT in higher education teaching, how it can be used, and how it is being used to improve learning and knowledge production in higher education in the context of computer science. Given this context, the aim of this research is to i) identify proposals for using ChatGPT to improve learning and knowledge production in the higher education of computer science; ii) identify how ChatGPT is currently being used by professors in the computer science area in the context of learning and knowledge production; and iii) identify advantages and disadvantages of using ChatGPT, proposing actions to mitigate.

The findings of this research demonstrate that computer science professors utilize ChatGPT as a supportive tool in the preparation of educational content to be used with students. For instance, they employ it in creating exercises, assignments, and supplementary materials, as well as in the development and subsequent grading of exams administered to students. The professors further affirm that ChatGPT functions as a mediator in the teaching and learning process, facilitating interaction between students and professors. This interaction

holds significant importance within the context of computer science as it motivates students, enabling them to constantly seek knowledge updates. This applies to both students and professors who need to stay up-to-date with new technologies daily. Moreover, having the support of a computational tool minimizes workloads and saves time, allowing them to allocate their efforts toward other activities.

In the remainder of this paper, we describe the background and related work in Section 2. Afterward, we introduce our research design in Section 3 and present our results in Section 4. Eventually, we discuss the implications for research and practice along with the study limitations and threats to validity in Section 5 and draw our conclusion by outlining future research directions in Section 6.

2 RELATED WORK

The use of ChatGPT in teaching and knowledge generation has been the subject of many discussions and studies. While New York City's Department of Education bans ChatGPT in public schools (Rosenblatt, 2023), others encourage its use in the classroom (Zhai, 2023b; Phillips et al., 2022), as the author of a scientific article (Thunström et al., 2023), for research (Teubner et al., 2023b), among others. In the context of teaching, George et al. (George et al., 2023) mentioned that the education industry has a lot to gain from ChatGPT capabilities as it can offer students personalized learning experiences tailored to their specific needs. According to the authors, professors can make lesson plans for each student based on their interests and abilities and provide immediate feedback as they progress through material or assignments. GPT chat also allows professors to grade student work faster by automatically grading it.

Firat (Firat, 2023) researched how ChatGPT can transform autodidactic experiences and open education. According to this author, ChatGPT chat can encourage student autonomy and improve learning experiences and can provide individualized suggestions for reading material and other resources or interactive assignments and activities that meet students' unique requirements and learning objectives. ChatGPT can offer interactive exercises and games that meet a student's specific learning needs and offer personalized suggestions for learning materials and resources based on a student's individual needs and goals. This interactive and individualized support can enhance learning and encourage engagement and motivation.

Zhai (Zhai, 2023b) presented a pilot study in the middle school context using ChatGPT. The author concluded that ChatGPT has the potential to help educators and school systems address challenges related to assessment practices in the implementation of the Science subject. ChatGPT can improve assessment development efficiency, provide personalized learning, and assist in evaluating and reporting student performance, optimizing the educator's time and effort. However, it cannot provide emotional support, critical thinking, and the development of problem-solving skills in science learning. In short, ChatGPT provides tools to enhance and complement the work of professors but is not a substitute for them. Professors must be able to assess the quality and relevance of the information provided by ChatGPT and make necessary decisions about its use in the classroom.

Phillips et al. (Phillips et al., 2022) studied how a new GPT 3 model can summarize and analyze student chat conversations in computer-supported collaborative applications in learning environments. The authors concluded that ChatGPT could allow the professor to make inferences about the nature of student collaboration, such as viewing summaries of student conversations in real-time to identify frustrated and confused students. Although ChatGPT has limitations, according to the authors, it would not hinder ChatGPT from being a substantial asset to professors.

In the context of writing texts, Shidig (Shidiq, 2023) identified that Artificial Intelligence offers many educational facilities, such as using various systems, such as virtual mentors, voice assistants, innovative content, smart classrooms, automatic assessment, and personalized learning. ChatGPT's understanding of human language greatly facilitates creative writing, such as poems, short stories, novels, or other types of writing whose quality is equivalent to human work. The author discusses ChatGPT and its impact on students' lack of creativity in writing skills.

Pickell et al. (Pickell and Doak, 2023) suggested five ideas for dealing with ChatGPT in a learning environment, also considering the context of writing texts by students. First, the authors identified that generic essay questions are highly susceptible to cheating through the GPT. Overly generic and common writing topics were already susceptible to plagiarism and cheating, and ChatGPT is quite adept at delivering correct writing but also often cliched. Therefore, the first idea would be to get students to build better projects that connect, analyze, judge, design, and present new ideas as an alternative to

minimizing the use of ChatGPT in this context.

Qadir (Qadir, 2023b) analyzed several ChatGPT responses regarding education and suggested a series of questions, such as using it responsibly and as a complement, not the primary source; using critical thinking over its responses; among others. In addition, the author states that ChatGPT has the potential to offer personalized and compelling learning experiences, providing students with personalized feedback and explanations, as well as creating realistic virtual simulations for practical learning. However, it is also essential to consider that ChatGPT can perpetuate prejudices or even generate and spread misinformation. According to the author, AI in education raises ethical concerns, such as the potential for unethical or dishonest use by students and the potential unemployment of humans.

Cotton et al. (Cotton et al., 2023) mentioned that using GPT-3 in higher education could offer many benefits, including greater engagement, collaboration, and accessibility. It can be used for language translation, summarizing, answering questions, generating text, and custom assessments. However, these tools also raise challenges and concerns, particularly regarding academic honesty and plagiarism. For example, GPT-3 can facilitate cheating, and it can be difficult to distinguish between human and machine-generated writing. The authors further examine the opportunities and challenges of using GPT-3 in higher education, focusing on these tools' potential risks and rewards and how universities can address their challenges. According to the authors, universities should carefully consider the potential risks and rewards of using these tools and take steps to ensure they are used ethically and responsibly. This may involve developing policies and procedures for their use, providing training and support for students and faculty, and using various methods to detect and prevent academic dishonesty.

Researching the identification of methods and tools to detect content generated by ChatGPT, Pegoraro et al. (Pegoraro et al., 2023) provided a comprehensive overview of evaluating the latest techniques' ability to differentiate between responses generated by ChatGPT and those produced by humans. Several tools were evaluated, such as Stylometric Detection of AI-generated Text, ZeroGPT, OpenAI Text Classifier, GPTZero, and Hugging Face. The evaluation results demonstrate that none of the existing methods can effectively detect content generated by ChatGPT. According to the authors, the exceptional ability of GPT to deceive detectors reinforces the need to ongoing efforts to improve the accuracy and robustness of text detection

techniques in the face of increasingly sophisticated technologies generating content by AI.

In the context of knowledge production, Burger et al. (Burger et al., 2023) presented an overview of the current state of AI use in research, highlighting recent trends and developments in the field. The authors present guidelines for using AI in the scientific research process. The guidelines have been developed for case literature review, but the authors believe these instructions can be adjusted to many research fields. The authors highlight the advantages and limitations of AI today in any research using AI. Advantages include objectivity and repeatability in research processes currently subject to human error. general-purpose models, the understanding of which is essential to use them correctly in research.

Thunstrom et al. (Thunström et al., 2023) explored the potential of a system to co-author an academic work based on the criteria proposed by the International Committee of Medical Journal Editors (ICMJE). The authors used the GPT-3 to write a review article on the topic of their choice: the effects of sleep deprivation on cognitive function. The system was asked to comply with the four main criteria for co-authorship as recommended by the ICMJE: contribute with design or conception, critically redact or review, approve the final version, agreement to be held accountable. The results showed that the system could meet the criteria, although it has difficulties in referencing.

Teubner et al. (Teubner et al., 2023b) analyze various aspects of how GPT chat and similar technologies may interfere with knowledge production and teaching. Regarding the production of knowledge using AI, they suggest that ChatGPT and other similar tools can lead to a situation where the ability to read and interpret different text options becomes more important than the ability to write them. According to the authors, knowledge workers interacting with ChatGPT will prove their worth based on a combination of skillful solicitation (considering that questions to be better answered have to be better crafted), quick quality control, and adaptation of responses. Faculty and students must be sensitized to take ultimate responsibility for whatever they deliver. Academic policies can demand transparency about where and how AI assistants are used. The current state of generative AI technology represented by ChatGPT is impressive but, as demonstrated, can be flawed and misused. However, it sure is just a preview of what is to come. Professors in the area of computer science and other areas need to understand the implications of this and study how to adapt the teaching of their disciplines to ensure that the next

generations of professionals can take advantage of the benefits offered in an ethical, efficient, and productive way.

3 STUDY SETTINGS

In this study, we adopted a quantitative approach using a survey questionnaire as the primary research method to capture the perceptions of higher education professors. The following research questions were used to guide this work:

RQ.1: How ChatGPT is being used in higher education in the context of computer science?

RQ.2: How does the use of ChatGPT impact the production of knowledge and teaching practice (advantages and disadvantages)?

The survey population target was composed of higher education professors from both public and private institutions. There was a control question at the beginning of the survey to filter the participants and ensure we got responses only from our target audience. The participants were recruited through personal contacts and social networks. In total, we invited 140 professors to participate in the research.

All the authors of this paper were involved in the design and validation of the survey questions. Two authors described the survey questions and the others validated them. The survey consisted of 18 questions, 12 closed-ended and 6 open-ended questions, as shown in Table 1. The complete survey is available in our survey supplementary material available at <https://zenodo.org/records/10257915>.

We used the Office Forms platform¹ to create the survey. The form started with the informed consent term presenting the conditions to participate in this survey and the research contacts for eventual questions regarding the survey. Participants were not required to present any data that would reveal their identities to preserve their anonymity, although there was an optional field for them to provide their emails in case there were any follow-up questions. The survey was available online for 36 days and the average time to respond was 11 minutes and 31 seconds.

We carried out a pilot with two professors from a federal public university and one professor from a private university, and their suggestions for improvement were all implemented. The objective was to validate understanding mainly with open

questions. After the pilot, some questions were changed. Consequently, the pilot responses were discarded in the data analysis. Table 1 presents all survey questions.

Surveys collect qualitative and quantitative information to provide an overview of the current status relating to a phenomenon (Kitchenham and Pfleeger, 2008). In quantitative analysis, we use descriptive statistics, for example, to represent and describe participant characterization data. We used Grounded Theory to perform open and axial (Wuetherick, 2010) coding to analyze the open questions. Grounded Theory is a method of inductively generating theory from collected data (Stol et al., 2016). Studies often include unstructured text, for example, interview transcripts, surveys, field notes, and so on. However, they can include structured text, diagrams and images, and even quantitative (Corbin and Strauss, 2014) data.

4 RESULTS AND DISCUSSIONS

4.1 Demographic Information

Eighty-six (86) university professors from different Brazilian states responded to the survey. Only two states had no representatives, Minas Gerais and Piauí. Thirty-seven (37) participants work at federal universities in Brazil, 13 at state universities, 11 at federal institutes, 7 at private colleges, 9 at private universities, and 8 at university centers (private). Most participants have between 10 and 15 years of experience as professors from higher education and work with Software Engineering and Programming Language disciplines. Table 2 provides an overview of the profile of survey participants.

Regarding how long professors have been using ChatGPT, 56% of them reported that it was between 1 and 3 months, 31% that they used it less than one month, 10% that between 4 and 6 months and only 3% of participants claimed to have used it for more than six months. It is important to highlight that ChatGPT was made available to the public on November 30th, 2022, and that this research was carried out between April to May 2023. Therefore, we can infer that most respondents had already been using chatGPT for 1 to 3 months or more. Despite the short period of use (1 to 3 months), compared to the availability of chatGPT (5 months), use over 1 to 3 months was considered a good representation of the perception of chatGPT.

¹<https://forms.office.com>

Table 1: Survey Questions.

Demographic Information	
1. Email - Optional response	
2. In which state do you currently live?	
3. What is the nature of your work and/or organization?	
4. How long have you been working as a higher education professor?	
5. What is your area of teaching?	
6. What is your educational background?	
Use of ChatGPT	
7. ChatGPT was made available in Nov/2022. For how many months have you been using ChatGPT?	
8. In my opinion, ChatGPT will have a significant impact on all areas of knowledge.	
9. In my opinion, ChatGPT will have a significant impact on education, especially in higher education.	
10. Have you already used any of these techniques in your teaching with ChatGPT?	
11. Please cite the main results of the application of these techniques (positive or negative).	
12. What other techniques have you used in your teaching? What were the results (positive and negative)?	
13. Have you used any of these techniques when developing research, articles, or texts with ChatGPT?	
14. In your perception, what are the main problems with using ChatGPT in higher education? Is there any way to mitigate them?	
15. In your perception, what are the main advantages of using ChatGPT in higher education teaching?	
16. In your perception, is there a need for training professors to be able to use ChatGPT in higher education more effectively? Why?	
17. The use of ChatGPT in teaching will be permanent. It will be a new tool to be used in teaching and knowledge generation.	
18. Regarding the previous question, could you inform us why?	

Table 2: Demographic Information Sample.

Variable	Categories	%	#
Organization	Federal University	43.2	37
	State University	15.11	13
	Federal Institute	12.8	11
	Private College	8.14	7
	Private University	10.3	9
	University Center	9.3	8
Disciplines	Software Engineering	59.30	51
	Programming Language	27.9	24
	Requirements Engineering	20.9	18
	Artificial Intelligence	18.6	16
	Database	9.3	8
	Systems Analysis	8.14	7
	Software Quality	8.14	7
	Data Structure	5.8	5
	Computer Networks	2.3	2
	Distributed Systems	2.3	2
	Other disciplines	16.3	14
	Education	PhD	38.0
Postdoctoral		44.2	24
Master's degree		18.6	16
Master's degree student		3.5	3
PhD student		4.6	4
Specialization		1.2	1

4.2 RQ.1

Regarding the changes ChatGPT may induce, 90% of the professors who participated in the survey strongly agree or agree that ChatGPT will have much impact in all areas of knowledge and that ChatGPT will have much impact in the educational area, mainly in higher education, as presented in Q08, Q09, and

Q17 of Figure 1. This result confirms the findings of George et al. (George et al., 2023) and Kalla et al. (Kalla and Smith, 2023), who identified in their research that ChatGPT would impact several areas of knowledge. Furthermore, our results regarding the impact of ChatGPT on education also confirm the findings of other related works (Qadir, 2023b; George et al., 2023; Firat, 2023; Zhai, 2023b; Phillips et al., 2022).

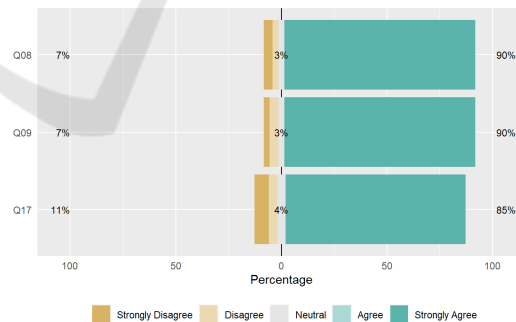


Figure 1: Participants' perception about the ChatGPT's impact.

As for using ChatGPT as a teaching assistant, 62% of professors have already used ChatGPT in the creation of content to be worked with students in the classroom; 42% to generate questions and answers to specific domains of knowledge; 35% used it to answer student questions since once the GPT model is trained, it can be used to answer student questions in real-time; 32% of professors used ChatGPT to

support the preparation of a subject's teaching plan or to create a chat room, respectively, as shown in Figure 2, and previously found by other works (Firat, 2023; Zhai, 2023b; Phillips et al., 2022). Furthermore, our findings also confirm the results presented by ChatGPT itself, which indicates a series of suggestions for educational activities that can be used in higher education, such as creating a chat room using GPT technology, training the GPT model with data related to the course content; automatically generate a performance-based assessment task; automatic grading of student's written responses; designing exercises and interactive games that meet the specific learning needs of the student.

Some of the activities most mentioned by the professors participating in the survey in the use of ChatGPT to support teaching were not mentioned in ChatGPT's response to our query, such as a) support in the elaboration of content to be worked with students and b) support in the elaboration of the teaching plan of a discipline. Another different response from a professor was:

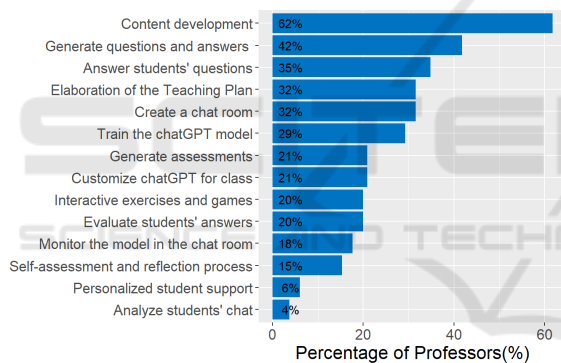


Figure 2: Ways in which professors have been utilizing ChatGPT in their teaching activities.

"[...] I have been using GPT templates since version 2 and have had positive results in transcribing my texts into a language style suitable for students. Academic and purely formal language can easily give way when requesting the rewriting of my texts using other writing styles. Another use that I have practiced is to request the elaboration of topics for slides considering a text, generally authorial, provided by me."

Regarding the advantages and disadvantages or limitations of ChatGPT in the perception of professors, the advantages most cited by them were: 1) Streamlines the professor's activities, supporting the construction of didactic content; 2) Its use provides greater motivation, interaction, participation, and learning on the part of students;

3) Speeds up the generation of exercises and questions/answers about the didactic content to be worked on in the classroom with the students; 4) Facilitates the elaboration and preparation of the teaching and discipline plan; and 5) Generates ideas for interesting activities to be carried out in the classroom with students.

Some of these advantages had already been identified previously by Firat (Firat, 2023; Zhai, 2023b; Cotton et al., 2023). It is essential to highlight some of the reports of the professors who participated in the survey on how they used ChatGPT in the context of teaching in higher education and the results achieved by them, as seen in the transcripts below:

"[...] ChatGPT allowed the generation of user stories in different contexts. I was able to quickly provide several examples to students in class. It played the role of the stakeholder while conducting the business rule definition activity of the practical case study."

"[...] I generated some questions to ask students during class and collected the responses in ChatGPT. After I applied the questionnaire to the students, we compared the students' answers with the answers given by ChatGPT and they were very similar."

"[...] I was able to identify syllabic for other subjects similar to my subject and capture specific objectives to be added to the teaching plan. In addition, I was able to elaborate on content of interest to the students, which is more current and there was a greater motivation on their part when I said that I had collected from ChatGPT and that we could compare the results together and analyze what they thought of the answers. It was a very interactive and participatory class."

Regarding the disadvantages or limitations of the use of ChatGPT to support professors' activities, the answers most mentioned by the participants were: 1) Interesting and comprehensive information, but no bibliographic reference; 2) Need to check the results obtained and sometimes perform an adjustment or correction of the ChatGPT responses; 3) It is necessary to elaborate more elaborate and specific questions to obtain success in the query; 4) Need to train the model to use it more effectively; and 5) Copyright concerns. Some responses from professors about the disadvantages or limitations of using ChatGPT were:

“[...] I was able to quickly generate a quiz on a data structure topic for students to take in class. However, ChatGPT may have generated the same questionnaire for several other professors, making the activities repetitive.”

“[...] The use of the tool allowed an ethical discussion in the classroom. Much of the content presented does not provide citations/bibliographic references, which can lead to disorderly plagiarism. This is worrying since it is necessary to mention who carried out certain experiments.”

“[...] ChatGPT tutorials and tips facilitate student learning, making access to information faster and more efficient. However, it is necessary to be aware of the origin of the information sent by ChatGPT, since it does not share the source of the information and some of it may not be reliable.”

In none of the previous studies, the lack of bibliographic references and the need to check the responses received were mentioned as limitations of the ChatGPT. This is an important finding of our research since it is a limitation that needs to be considered, mainly due to the problems that can be provoked by using texts without being referenced. Although Pickell et al. (Pickell and Doak, 2023) detected a citation issue, they did not mention their absence as a disadvantage. The need for well-designed questions for ChatGPT to answer more accurately confirms the findings of Qadir (Qadir, 2023b) and Teubner et al. (Teubner et al., 2023b). Regarding the concern with copyright versus ChatGPT, we identified this topic as a concern of other authors from other areas of knowledge (B.D.Lund and Wang, 2023; Cox and Tzoc, 2023).

Professors also use some techniques to support the following teaching activities: elaboration of student evaluations, planning and elaborating activities and corrections; provision of questions and answers; creating examples, creating exercises, and solving more didactic problems. It is important to note that most of the responses mentioned using ChatGPT in the most varied contexts within higher education teaching, demonstrating that professors are using ChatGPT with great creativity and responsibility. Some responses were:

“[...] I have been working in remote teaching, and I have made summarized texts from the transcription of classes in an automated way. Passing only the video link, I extract the text and generate the summary through the Google API and OpenAI. I also use this summary to validate compliance with the lesson plan. I used ChatGPT to suggest contexts for applying Problem-Based Learning. The quantity and quality of assertive suggestions for the construction of case studies are phenomenal. However, it is necessary to have knowledge to perceive failures of contexts.”

“[...] I’ve already asked a group of students to solve questions and check the answers with ChatGPT. We had the same amount of wrong answers that needed to be evaluated. The lack of knowledge and maturity of students can lead to a wrong path. I have carried out these activities in the classroom so that students can mediate these issues.”

“[...] ChatGPT can support as a mediator in the preparation of didactic content, but it should not be the only source to be consulted by the professor, also because it is necessary to have a theoretical basis based on the literature.”

Professors also identified some problems using ChatGPT and suggested some ways to mitigate them. The main problems and mitigation identified were: 1) The lack of bibliographical references – ChatGPT should cite adequate references for its answers; 2) Plagiarism by students — always check the generated information; 3) The constant need to analyze and evaluate the answers with a critical view — have a knowledgeable person to analyze the answers; and 4) The need to formulate questions concisely and effectively to avoid inconsistent and untrue information – train the model to mitigate possible errors.

We transcribed some problems identified by professors and possible mitigation for them:

“[...] It is necessary to make students aware that ChatGPT is a collaborative tool and not a substitute for the process of generating and transferring knowledge.”

“[...] The generation (production) of automated texts can atrophy the human ability to write with quality. I have tried to mitigate this problem by having students write the assignments in their own handwriting, not allowing the digital delivery of any activity. In addition, I request that each work be explained orally to the whole class.”

“[...] Using ChatGPT does not provide correct answers if the question is not well worded. It is necessary to analyze and evaluate the answers. One way to mitigate this would be to use ChatGPT as a support tool for students to make this analysis in relation to the answers obtained.”

It is interesting to highlight that Orduña and Clavijo (Orduña-Malea and Cabezas-Clavijo, 2023) also identified other problems regarding references to non-existent papers (ghost bibliographic references). According to these authors, the use of Large-Language Models based which generates plausible but fake bibliographic references.

4.3 RQ.2

In order to understand how the use of ChatGPT could impact the production of knowledge and the activities of professors in the classroom, we investigated the perception of professors regarding the advantages of using ChatGPT in higher education teaching. Table 3 displays the categories and subcategories after coding responses. The *production of teaching material* category was the most mentioned by the participants, and most of them use ChatGPT to prepare practical exercises and slides to be used in the classroom with students.

We transcribed some of the professors' answers. For example, respondent #R27 and #R48 said, respectively:

“[...] Using ChatGPT can improve student and professor knowledge in a given area, making the learning process faster, easier, and more efficient.”

“[...] ChatGPT can be used as a tool support in the learning process, allowing better interaction between students and professors, as well as sharing knowledge between them in a collaborative, fun, and instantaneous way.”

We investigated whether professors think there is a need for faculty training to use ChatGPT more effectively in higher education teaching. Most professors (60) stated that training is not necessary for professors to be able to use ChatGPT. According to participants, ChatGPT is intuitive and user-friendly.

Teubner et al. (Teubner et al., 2023b) have stated that the increase in productivity with the use of ChatGPT will depend on the user's proficiency in using the technology, that is, individuals who already have difficulty with Information Technologies, certainly not will benefit from the tool. Thus, a new survey with professors from other areas of knowledge would be necessary to verify whether the ease and

Table 3: Categories and subcategories of advantages and disadvantages of using ChatGPT in higher education.

Category	Subcategory	# Cited
Production of teaching material	Development of practical exercises	77
	Preparation of slides	69
	Development of user stories	58
	Development of use cases	51
	Development of tasks	50
Increased efficiency	Development of tests	48
	Increased productivity	83
	Automation of tasks	79
Advanced knowledge	Support in task execution	71
	Support in knowledge sharing	71
	Quick response time	65
	Easy access to information	55
Learning mediator	Problem-solving	37
	Facilitation of interaction among students	67
Usability	Acceleration of learning	32
	Ease of use	68
Disadvantages	User-friendly interface	8
	Risk of plagiarism by students	15
	Students cannot fully trust the information	5
	Students settle in, always looking for chatGPT and not reading or consulting books	3
	You need to know how to ask questions correctly to get more appropriate answers	3
Mitigation	Train chatGPT to have more efficient responses	12
	Students and professors must be trained to be able to use technology more efficiently	11
	It is necessary to develop anti-plagiarism tools for this context	11
	Use chatGPT as a learning support technology and not as a substitute	8
	Use other technologies in conjunction with chatGPT	3
Students must be encouraged to question ChatGPT answers	2	

productivity mentioned by professors in the area of computer science about using ChatGPT are related or not to the proficiency in IT of these professors.

That is, it is necessary to investigate whether it is not necessary to train users to use ChatGPT efficiently and effectively.

Regarding the continuous adoption of ChatGPT, 85% of professors agreed or fully agreed that ChatGPT will be a permanent tool in higher education teaching, coexisting with other existing methods. Many respondents also noted that ChatGPT could provide academic and pedagogical support for professors and students due to its user-friendliness and quick response time. As examples, participant #R23 and #R69 stated, respectively:

"[...] Like other research and teaching tools, there will be some future tool that will replace or bring other forms of learning, but it is inevitable that its use will become fundamental in higher education teaching."

"[...] ChatGPT helps us a lot in preparing content to be used in the classroom and provides us with a lot of updated information in real-time. Thus, it is impossible for it to fall into disuse, especially with the evolution of AI, which is present in all our day-to-day tasks. We cannot close our eyes to the advancement of educational support tools."

Regarding preparing research articles or texts with ChatGPT, the survey results indicated that 74% of the participating professors used ChatGPT to generate answers to specific knowledge domains. Additionally, 53% of respondents utilized the tool for research paper or essay writing support by providing a thesis statement and key points as a model. Also, 43% of professors reported using ChatGPT to generate text in a particular style or tone, allowing for draft versions of research papers or other written materials. Another 42% of professors used the tool to automatically summarize articles or documents, making it easier to stay up-to-date with current research. Furthermore, 38% of professors utilized ChatGPT to support their literature review process, generating article summaries or providing a list of relevant articles on a specific topic or keyword. Finally, 17% of professors used the tool to analyze large volumes of text data such as social media posts or news articles, providing insights and identifying patterns, as demonstrated in Figure 3.

Teubner et al. (Teubner et al., 2023b) mentioned that one of the positive points of using ChatGPT is the improvement of researchers' linguistic skills in a non-native language. According to the authors, the use of ChatGPT should facilitate the communication of these researchers, for example, in academic or legal writing, helping to prevent linguistic discrimination

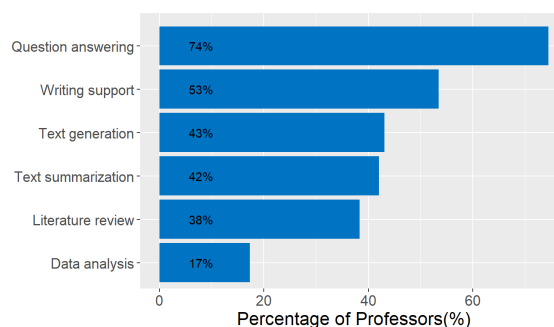


Figure 3: Ways in which professors have been utilizing ChatGPT in their research activities.

with non-native speakers.

5 THREATS TO VALIDITY

This study is subject to some validity threats that must be considered when interpreting the findings. Firstly, although the survey was anonymous and confidential, some respondents may have provided inaccurate, incomplete, or biased information for various reasons, such as social desirability or fatigue. Moreover, the authors' subjectivity may have influenced the interpretation of the data (Lazar et al., 2017).

As the survey relied on self-reported data from educators, the responses may be subject to their lack of self-knowledge. For instance, some respondents may have overestimated or underestimated their ChatGPT use, competence, or attitudes or let their personal views be influenced by their professional roles or responsibilities. Furthermore, while our study focused on investigating the use of ChatGPT in the SE field, we designed broader research questions to encompass higher education in general. This approach aimed to explore similarities and differences in ChatGPT usage across various educational contexts, including SE. We acknowledge that explicitly highlighting the SE filter in the questionnaire would have been beneficial to gather more specific insights. However, it's important to note that our study exclusively involved computing professors as participants. This deliberate selection ensured that the data collected remained focused on the SE field, despite the questionnaire's broader scope. The expertise and experiences of these computing professors informed their responses, providing valuable insights into computing education. Another limitation of the study is that it focused solely on the perceptions of Brazilian professors. As the survey was conducted only in Brazil, the results may not represent professors' views, practices,

and challenges in other countries or cultures. This limits the external validity and results generalization considering this sample of participants.

6 CONCLUSIONS

In this study, we investigate proposals for using ChatGPT to improve learning and knowledge production in the field of computer science; to identify how ChatGPT is currently being used by professors in the computer science field in the context of learning and knowledge production; and to identify the advantages and disadvantages of using ChatGPT, proposing actions to mitigate them. ChatGPT offers numerous opportunities for professors and lecturers to develop ideas that can be used as support for educational work. It can enhance learning experiences and transform the role of educators. We surveyed 86 professors from public and private universities in Brazil to collect their perceptions of ChatGPT. Professors are using ChatGPT to prepare teaching material for classroom use, mainly in constructing exercises, tasks, and tests. In addition, they consider that ChatGPT facilitates the activities that a professor needs to perform in higher education teaching, such as preparing teaching plans for the subjects they teach. In the professors' perception, ChatGPT also improves students' motivation, interaction, participation, and learning during classes.

Some disadvantages of ChatGPT were identified, such as unreliable information, the risk of plagiarism and accommodation by students, and the need to know how to ask correctly to receive more accurate answers. Some actions were identified to mitigate or exclude these disadvantages, such as students must be encouraged to question chatGPT responses, use of chatGPT to support learning, training to better use chat effectively, and development of anti-plagiarism tools, among others. Furthermore, it was identified that ChatGPT also provides interesting and comprehensive information but does not provide any bibliographic reference of the contents presented to its users, which is considered a significant problem by professors. In future work, we intend to investigate the use of ChatGPT in other areas of knowledge and compare it with the perceptions of professors in the area of computer science. In addition, we want to identify which techniques are used by professors from other areas of knowledge and if they have more or fewer difficulties in using this tool compared to professors of computer science.

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