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## POTENTIALS OF CHATGPT IN COMPUTER PROGRAMMING: INSIGHTS FROM PROGRAMMING INSTRUCTORS

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### ABSTRACT

Aim/Purpose	This study aims to investigate the perceptions of programming instructors among the Information Technology faculty members at AL al-Bayt University regarding the effectiveness of ChatGPT in supporting the programming instructional process. This study also aims to explore their experiences concerning the potential benefits and adverse impacts of such technology on students and instructors.
Background	Successfully integrating ChatGPT into programming instruction requires addressing its advantages, disadvantages, and concerns of such emerging AI-based technology. However, balancing the advantages and disadvantages, as well as addressing the concerns of using ChatGPT, poses critical challenges. This research posits that the appropriate use of ChatGPT for programming instruction, along with a careful weighing of its potential benefits against potential negative impacts, presents a promising solution and is essential for its success. However, little is known about integrating ChatGPT into programming instructional methods and their possible effects because of insufficient results from the literature for generalization. Pedagogical designs considering teaching strategies and appropriate measures should be added to the literature on integrating AI chatbots for programming instruction.
Methodology	The research data were collected in this study through in-depth interviews with programming instructors from the School of Information Technology at AL al-Bayt University. A qualitative research design was adopted in this study to arrive at in-depth perceptions of IT programming instructors on integrating ChatGPT into programming instruction. Convenience sampling was used to select 12 programming instructors among IT faculty members who had familiarity with ChatGPT during their programming instruction experience. A total of 26 one-

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on-one interviews with the participants were conducted personally to elicit detailed and precise information on the advantages and disadvantages of using ChatGPT for programming instruction. Each interview consisted of questions that aimed to investigate the opinions and experiences of programming instructors on ChatGPT's potential and capabilities to complement traditional teaching methods, enhance students' programming learning, and support instructors in their instruction. The data were accurately read and coded to identify relevant themes and patterns from the participants' answers to the research questions. A qualitative thematic analysis was conducted to analyze the collected transcribed data through participant interviews.

Contribution	This study is the first to focus on the perceptions of programming instructors and contributes to the ongoing discourse on the integration of AI, particularly ChatGPT, in programming education. The contribution lies in highlighting the positive and negative aspects of using ChatGPT and discussing the potential complementary role of ChatGPT alongside traditional teaching methods. The participants' perceptions reported by this study provide valuable insights and evidence that could serve as a guide for the programming instructional process.
Findings	The perceptions result in this study demonstrated several advantages of ChatGPT that make it useful for the programming instruction process, including practical code applications, personalized and interactive learning, a wide range of programming problems and alternative solutions, accessibility, no programming knowledge required, debugging and feedback capabilities, and clear code explanations. Indeed, the perceptions of the participants revealed that ChatGPT can enhance students' learning by providing personalized and interactive programming practices, assisting them in coding and program writing, helping them practice the best solutions for real-life programming problems, and creating their own programs and solutions. The participants' perceptions also revealed the ability of ChatGPT to support the efficiency of programming instructors and save their time and effort by providing new instructional practices, helping address the individual learning needs of their students, assisting in performance assessment, and recommending lesson plans and teaching strategies. By contrast, several perceptions on the potential drawbacks and negatives of using ChatGPT in programming education were reported, including inaccurate responses, undesired responses, response integrity, limited programming resources, technology limitation, unstructured learning, and a lack of real programming elements. Similarly, several concerns were revealed, including ethical and transparent use, privacy and security of students' data, social impact and replacement of human interaction, over-reliance, and controlling students' online behavior. Overall, the participants suggested a complementary role for ChatGPT that balances its potential benefits against its negative impacts to best enhance traditional programming teaching methods.
Recommendations for Practitioners	The perceptions recommend practitioners develop new teaching strategies, curriculum designs, in-class activities, and course outlines for programming curricula incorporating ChatGPT efficiently. Practitioners also need to mitigate the adverse effects of ChatGPT and embrace such AI technologies rather than banning them in several ways. Additional effort is required from instructors to assign programming tasks that require applying programming knowledge and critical thinking instead of simple or trivial tasks that can be obtained directly. Instructors and students should be upskilling their competencies and practices to

meet the critical thinking and question-asking competencies required to satisfy the new demands of AI technology with appropriate support from their institutes. IT faculties need to adopt a teaching approach with a complementary role for ChatGPT that balances its potential benefits against its negative impacts to best enhance traditional programming teaching methods and maximize its benefits for students and instructors.

Recommendations for Researchers	Researchers need to understand the factors enhancing the integration of ChatGPT and the ways of designing and implementing teaching strategies compatible with such AI technologies. Researchers are recommended to explore the impact of ChatGPT on other learners and subjects and its effects on their critical thinking and creativity.
Impact on Society	The perceptions in this study are helpful for instructors, students, and curriculum developers, provide additional knowledge on integrating AI chatbots into their courses, and offer valuable input for developing effective use of AI in programming instruction and pedagogical practices. The perceptions could positively influence the job market and contribute to the development of human capital by equipping learners with the latest technologies and programming technologies.
Future Research	Additional research should be conducted to explore and measure the effect of ChatGPT on students' engagement and class collaboration. Further experimental studies on other topics in different environmental variables are also recommended.
Keywords	computer programming, programming instructors, ChatGPT, programming instruction

## INTRODUCTION

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Programming skills are a critical requirement for the development of primary business fields, especially in education. All business fields, including education, are moving toward digitalization and require individuals with high-level programming skills (Eteng et al., 2022; González-Pérez & Ramírez-Montoya, 2022; James, 2021). Computer programming is an essential capability for learners to develop and excel in their personal and professional lives and provides them with higher opportunities in the AI-equipped world. Consequently, learners, teachers, and educational institutes need to integrate the latest technologies into their educational processes, i.e., programming instruction. Programming skills play an important role in education by fostering critical thinking and problem-solving skills and improving computational thinking with digital confidence. In response, educational systems enforce programming learning on a broad scale, which extends to students other than IT disciplines and across several subjects and levels (Alam, 2022; Husain & Al-Shayeb, 2023; Strawhacker & Bers, 2019). Programming learning is crucial for creativity and innovation. Individuals with solid programming skills, even if not software developers, can understand the digital environment and solve problems in many areas of life (Liu et al., 2022; Su et al., 2022).

Common approaches for programming teaching require cooperation among students to provide adequate education. However, students are reluctant to work with others for programming learning and consider cooperation a challenge, especially on group projects (López-Pimentel et al., 2021; Malik et al., 2020; Sullivan & Strawhacker, 2021; Wei et al., 2021). Passive students in teamwork are treated equally to active students with suitable contributions (Yilmaz et al., 2020). Individual programming learning can help overcome such challenges and support each student in creatively participating in programming tasks. Indeed, the hands-on programming approach can be helpful for students to learn and practice programming (Handur et al., 2016; Yilmaz & Karaoglan Yilmaz, 2023).

Computer programming is a complex field that requires additional supplementary effort from students to understand and grasp its concepts and from teachers to deliver the learning objectives. For example, additional knowledge is required on data structures and algorithms, as well as familiarity with the latest technologies to understand abstract concepts, debugging, and troubleshooting. Students with advanced programming experience need new programming problems and examples in addition to those from limited traditional sources. Personalized learning that enables participation in programming tasks is also an important requirement. Indeed, additional support with the latest technological approaches that provide personalized and interactive programming learning with instant feedback may be more helpful for students to better handle its complexity (Yilmaz & Karaoglan Yilmaz, 2023). With the inability of several traditional approaches to improve programming teaching and learning, AI-based chatbots, such as ChatGPT, have emerged as a promising solution that helps address such requirements and overcome its challenges.

AI-based chatbots, such as ChatGPT, offer a personalized and interactive learning experience through their ability to respond to various types of programming prompts, generate human-like and immediate responses, and tailor the responses to the needs of each individual. ChatGPT can also generate diverse programming examples and alternative code solutions. The instant feedback and immediate responses by ChatGPT can provide the required materials, practices, and examples that illustrate programming concepts and demonstrate challenging programming issues, especially programming tasks such as code completion and correction, code prediction, code optimization, error detection, and fixing (Raman et al., 2023). Personal interaction with ChatGPT can provide customized learning experiences with abilities, such as an unlimited number and type of questions, search for advanced programming topics, adapt to individual needs, and provide the required materials, practices, and examples supporting the learning process.

However, the way to deploy such new emerging tools within the programming classroom and their implications are not well understood (Ngo, 2023). ChatGPT can produce written work, but it may not necessarily improve high-level skills required for programmers, such as problem-solving and critical thinking (Qureshi, 2023). Several concerns have been raised about ChatGPT, such as its ability to solve educational tasks and assignments, quizzes, and exams (Mohamed, 2023). A research gap exists regarding the specific insights and recommendations for IT faculty members (i.e., programming instructors) regarding the potential benefits and drawbacks of integrating ChatGPT into programming instructional methods.

Addressing such concerns can help develop pedagogical practices and effective programming instruction significantly. Little is known about the role of ChatGPT and its capabilities for programming instruction from the viewpoints and experiences of programming instructors. According to recent AI studies, it is crucial to understand the implications and appropriate employment practices of AI technologies in computer programming instruction for efficient integration that improves learning outcomes (L. Chen et al., 2020; Hargreaves, 2023; Sun & Hoelscher, 2023). IT faculty members and programming instructors must understand the advantages, limitations, and concerns of using AI technologies in education, including the deployment of ChatGPT to enhance programming instruction and complement traditional programming instructional methods. From this point of view, this study aims to investigate the perceptions of programming instructors from IT faculty members at AL al-Bayt University about the effectiveness of ChatGPT in supporting programming instruction, as well as reveal its advantages and disadvantages for students' learning and instructors' instruction. Participants' perceptions may lead to superior AI-based educational tools for programming and provide insight into the opportunities and challenges of its integration with traditional teaching methods. This study aims to accomplish its objectives by addressing the following questions:

**RQ 1:** What are the advantages and benefits of using ChatGPT in programming instruction for students and instructors, as identified by programming instructors?

**RQ 2:** What are the disadvantages and concerns of using ChatGPT in programming instruction for students and instructors, as identified by programming instructors?

**RQ 3:** How can ChatGPT be integrated within traditional programming instructional methods to enhance students' learning and the efficiency of instructors, as identified by programming instructors?

However, integrating ChatGPT into programming instructional methods and understanding their possible effects are limited and require more attention. Pedagogical designs with appropriate teaching strategies and measures should be added to the literature on integrating AI chatbots for programming instruction. This study is the first to focus on the perceptions of programming instructors and contributes to the ongoing discourse on the integration of AI, particularly ChatGPT, in programming education. The contribution lies in highlighting the positive and negative aspects of using ChatGPT and discussing the potential complementary role of ChatGPT alongside traditional teaching methods. The participants' perceptions reported by this study provide valuable insights and evidence for researchers, practitioners, and educators regarding the issues of using ChatGPT and guide instructional designers to apply appropriate measures, which add a valuable dimension to the existing literature. These perceptions could serve as a guideline for the programming instructional process.

## BACKGROUND AND LITERATURE

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Solid programming education is necessary for students' success during their degree by increasing their technology awareness and improving their job creativity in the current digital world (Dorotea et al., 2021; Noh & Lee, 2020). Programming skills are essential for students to conduct problem-solving with analytical and algorithmic thinking, which ultimately improves their personality, academic, and work performance (Agbo et al., 2019; Tikva & Tambouris, 2021). As programming education progresses, students first learn fundamental programming concepts and languages to gain coding skills for simple programs. Students then move toward more complex programming concepts that depend on data structures and algorithms to increase their ability to test, debug, and maintain programming solutions for real-world programming problems (Gordon et al., 2022; Siegfried et al., 2021).

A wide range of programming online platforms and programming tools enable individuals to access programming instruction and learn software development skills (Lindberg et al., 2019; Zinovieva et al., 2021). Codecademy, Udemy, and Coursera platforms offer various programming courses ranging from beginners to advanced levels (Oktavia et al., 2018; Sharov et al., 2021). Such programming environments attract and help students improve their programming skills and understand its concepts. However, they focus on a specific programming topic and require some prior programming knowledge. AI-based language models, which differ from such programming environments and tools, can interact with people using their natural language, do not require prior knowledge, and offer different methods for programming learning (Jalil et al., 2023; Yilmaz & Karaoglan Yilmaz, 2023). ChatGPT, which is an ordinary AI chatbot, uses natural language processing and machine learning technologies to understand and respond to users' needs in their natural language without using specific syntax or concepts (OpenAI, 2023). This approach facilitates programming learning for learners without programming knowledge (Surameery & Shakor, 2023).

The integration of ChatGPT in an educational context has been studied to investigate its benefits and challenges for revealing valuable insights into its impact (Lo, 2023). Halaweh (2023) emphasizes the need for responsible implementation strategies when integrating ChatGPT into educational settings, which acknowledges the risks of overreliance and the generation of inaccurate information. Baidoo-Anu and Owusu Ansah (2023) discuss the benefits of ChatGPT in promoting teaching and learning, including personalized instruction, critical thinking development, and reduced teacher workload. Sok and Heng (2023) comprehensively review the benefits and risks associated with ChatGPT in education and research, emphasizing the need for mitigation strategies and the integration of other tools

and resources. Furthermore, Geerling et al. (2023) discuss the potential impact of ChatGPT on formal assessments in higher education. Mhlanga (2023) provides insights into the responsible and ethical use of ChatGPT in education, highlighting the need for transparency, fairness, and privacy protection. Adiguzel et al. (2023) examine the transformative potential of ChatGPT in revolutionizing education through personalized learning and interactive experiences. Farrokhnia et al. (2023) use the SWOT analysis to outline the strengths and weaknesses of ChatGPT and discuss its opportunities for and threats to education.

The effectiveness of ChatGPT may vary across subjects. According to Lo (2023), the performance of ChatGPT varies across subject domains, which ranges from outstanding (e.g., economics) and satisfactory (e.g., programming) to unsatisfactory (e.g., mathematics). Researchers have explored the potential of ChatGPT in the education of different subjects, such as mathematics (Sánchez-Ruiz et al., 2023; Wardat et al., 2023), economics and finance (Geerling et al., 2023), and medical education (Arif et al., 2023; Khan et al., 2023; Lee, 2023). However, a noticeable gap exists in the application of ChatGPT within programming education (Zheng, 2023). The current literature lacks substantial attention to the effective integration of ChatGPT within traditional programming instruction methods and its support to students and teachers. Several studies have focused on useful applications for AI models like ChatGPT in program coding to explore its potential to take over the role of programmers (Zarifhonarvar, 2023). For instance, research has explored the potential roles of ChatGPT in coding and reported several useful applications, such as code generation (Kashefi & Mukerji, 2023), code optimization (Biswas, 2023), code documentation (Haleem et al., 2022), code review (Jalil et al., 2023), and debugging assistance (Surameery & Shakor, 2023).

Accordingly, given that the focus of this study is on computer programming pedagogical context, the capabilities of ChatGPT for programming education have been investigated concerning several useful and specific predetermined perspectives, such as solving questions of the software testing curriculum, automatic bug fixing in code, application in engineering education, a support tool for HTML code, and the future of common programming practices (Rahman & Watanobe, 2023). Yilmaz and Karaoglan Yilmaz (2023) investigated the effect of using ChatGPT for programming education on students' computational thinking skills, programming self-efficacy, and motivation. The results revealed the ability of ChatGPT to benefit the students and improve their computational thinking skills, programming self-efficacy, and motivation. E. Chen et al. (2023) leveraged ChatGPT to provide programming code explanations for students to improve their programming skills effectively. Jalil et al. (2023) examined the performance of ChatGPT in answering practical questions for the software testing curriculum. The results revealed that ChatGPT can be used effectively in software testing and training because it responds to most questions and provides correct or partially correct answers with correct explanations in half of the cases. Surameery and Shakor (2023) examined ChatGPT's ability to solve programming bugs. They indicated that ChatGPT can play a positive role in solving programming bugs by providing debugging assistance, bug prediction, and bug explanation to help solve programming problems. Tian et al. (2023) assessed the performance of ChatGPT in programming assistants, especially code generation, program repair, and code summarization. Their research indicated that ChatGPT handles typical programming challenges with the ability to summarize explanations of incorrect code effectively. Qureshi (2023) evaluated and addressed the prospects and obstacles associated with utilizing ChatGPT as a tool for learning and assessment in fundamental programming courses. The results revealed ChatGPT's ability to improve academic performance and help attain high scores. Logozar (2023) investigated ChatGPT's ability to solve fundamental programming tasks in C and C++ languages and used it on a freshman programming test. The results revealed that ChatGPT passes the exam with very good grades, which outperforms most students by providing high-quality solutions with the ability to adapt or change their solutions according to additional demands.

Indeed, the considerable research reviewed in this study demonstrates several benefits of using ChatGPT in programming education and its efficiency in supporting students to perform learning

tasks, including skill enhancement (Biswas, 2023; Yilmaz & Karaoglan Yilmaz, 2023), motivation (Huang et al., 2023), and learning outcomes (Qureshi, 2023). The ability of ChatGPT to provide fast, correct, and high-quality code solutions is also reported (Logozar, 2023). Meanwhile, several limitations to using ChatGPT in programming are observed, including potential biases and the inability of ChatGPT to process visual information; privacy and security issues when exposing students' information to ChatGPT during their interactions; and misuse of ChatGPT by obtaining ready solutions without understanding (Fiialka et al., 2023; Rahman & Watanobe, 2023). Megahed et al. (2023) found that ChatGPT may generate incorrect programming codes and cannot accurately detect and resolve programming errors. ChatGPT may surpass requests by providing code suggestions and additional information, which may be inaccurate, without asking. ChatGPT lacks emotions and reflections about students' behavior and engagement (Tlili et al., 2023).

However, studies that explicitly focus on the integration of ChatGPT in programming instruction and explore the potential benefits, issues, and challenges are lacking. The potential benefits of incorporating ChatGPT into programming instruction, such as personalized feedback, code generation, and improved problem-solving abilities, deserve further investigation. Building upon its efficiency in several educational domains, ChatGPT holds promise as a valuable tool for enhancing students' programming learning experiences and supporting their instructors. Therefore, the gap in the existing literature can be filled by exploring and evaluating the use of ChatGPT in programming education. This research enables educators and learners in programming to harness the potential of ChatGPT while addressing the specific challenges and requirements of the field.

In response, this study proposes to explore programming instructors' perceptions of ChatGPT to reveal potential benefits, capabilities, and concerns of its integration with programming education. Extensive discussion with programming instructors during the interviews is critical to obtain rich details and reveal further hidden or unexpected insights that may not have been highlighted previously. Programming instructors have practical experience and observations with a large number of students, either in a programming laboratory or classroom. In the context of this study, experience and observations are obtained from programming instructors during interaction and collaboration with their students while using AI technologies for programming learning. In fact, programming instructors provide the necessary theoretical programming knowledge in the classroom that is aligned with the learning outcomes, and students usually use ChatGPT during their study as a complementary tool to answer a wide range of programming questions and inquiries to enhance programming learning. The instructors might use ChatGPT to generate cases and problems and act as mentors to guide and support students by monitoring and controlling their usage to ensure they obtain the right knowledge properly. Thus, the perceptions and attitudes of instructors toward the ChatGPT experience are connected with their knowledge of its benefits, capabilities, and concerns that might impact their overall experience.

This observation is evident in a recent study by Mohamed (2023), where ten faculty members perceive ChatGPT as a valuable tool for complementing and enhancing traditional teaching methods. They acknowledge the usefulness of ChatGPT in providing rapid and accurate responses to a wide range of questions, while others express concerns that ChatGPT might hinder students' development of critical thinking and research skills. Another study by Qasem et al. (2023) found that faculty members perceive ChatGPT as an essential tool for language learning that enhances students' language skills and promotes their active learning. Kohnke (2023) reported that faculty members believe that AI chatbots provide personalized feedback to students to improve their skills. Moreover, a study by Hew et al. (2023) revealed that faculty members appreciate the convenience and accessibility of AI chatbots in providing immediate responses, which help save time and reduce workload for students and teachers. Tlili et al. (2023) investigated stakeholders' perceptions of the use of ChatGPT in education. The participants perceived ChatGPT as useful, which suggests that ChatGPT is efficacious in increasing the chances of educational success and has a satisfactory degree of quality and accuracy of

information. However, the participants raise several ethical concerns (e.g., plagiarism and cheating) and educational concerns (e.g., appropriateness and absence of emotions).

Precisely for programming education, Zheng (2023) gathered perspectives from students and feedback from the instructor (i.e., the author) on using ChatGPT to learn Python programming for data science education. Part of his survey investigated the ability of ChatGPT to produce high-quality programming coding with little or no human effort. The results show that half of the students provide satisfactory results, and they believe ChatGPT can help produce programming codes. Zheng stated that ChatGPT can produce perfect answers for popular algorithms but may not work effectively for complex ones. Padilla et al. (2023) extracted information and insights from students regarding their use of ChatGPT in programming learning to investigate the benefits and challenges. The study revealed several benefits of employing ChatGPT for programming, including efficient coding, understanding complex codes, and its capability to be used as a problem-solving tool. However, Padilla et al. highlighted critical issues and challenges, such as data privacy and ethical concerns, plagiarism tendencies, and contextual understanding limitations.

Table 1 presents a comprehensive summary of previous studies that discuss perceptions of faculty members or students in education, particularly in the context of computer programming, to illustrate the relationships and distinctions among them.

**Table 1. Comprehensive summary of previous studies on ChatGPT applications**

Research focus	Perspective	Study
Perceptions on ChatGPT	General educational context	(Tlili et al., 2023)
	Specific educational context	(Hew et al., 2023; Kohnke, 2023; Mohamed, 2023; Qasem et al., 2023)
	Programming education, students' perceptions only	(Padilla et al., 2023; Zheng, 2023)
	Programming education, instructors' perceptions	This study
Investigate/evaluate the programming capabilities of ChatGPT from a particular perspective	Computational thinking skills, programming self-efficacy, and motivation	(Yilmaz & Karaoglan Yilmaz, 2023)
	Programming code explanation	(E. Chen et al., 2023)
	Software testing and training	(Jalil et al., 2023)
	Solving programming bugs	(Surameery & Shakor, 2023)
	Programming assistant: code generation, program repair, and code summarization	(Tian et al., 2023)
	Academic performance in programming	(Qureshi, 2023)
	Solving C++ programming tasks	(Logozar, 2023)
	Multiple and comprehensive programming perspectives	This study

Nevertheless, several research gaps have been identified and addressed in this study. First, little is known about the integration of AI into programming instruction, especially ChatGPT, without addressing its potential benefits and adverse impacts on programming education. Among the few existing studies, insights and perceptions of programming instructors based on their practical experience



and observations during programming teaching are lacking. Specific insights and recommendations for integrating ChatGPT with traditional programming teaching methods and its capability to enhance students' programming learning and support their instructors are also missing.

This study is conducted to fill such gaps in research with several unique contributions that diverge from prior research. This study is the first to focus on the perceptions of programming instructors that serve as guidelines for efficient integration of AI, particularly ChatGPT, in programming education. This study addresses both positive and negative aspects of using ChatGPT and discusses the potential complementary role of ChatGPT alongside traditional teaching methods. This study provides comprehensive, valuable insights and recommendations that help exploit and maximize ChatGPT's benefit and mitigate its adverse impacts. This research posits that a balanced approach between the potential benefits and negative impacts of ChatGPT can improve programming instruction and better aid students, instructors, and other traditional programming teaching methods. In this concept, understanding the capabilities of ChatGPT and addressing its advantages and concerns contribute significantly to successful integration within programming instruction.

## **METHODOLOGY**

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The research data in this study was collected through in-depth interviews with programming instructors from the School of Information Technology at AL al-Bayt University. A qualitative research design was adopted in this study to arrive at in-depth perceptions of programming instructors on the integration of ChatGPT into programming instruction. A convenience sampling was used to select twelve programming instructors among IT faculty members who were familiar with ChatGPT during their programming instruction experience. The interviews were conducted several times with each participant according to the data collection requirements. Thus, 26 in-depth interviews with the participants were conducted personally to elicit detailed and precise information regarding the advantages and disadvantages of using ChatGPT for programming instruction. Each interview consisted of questions to investigate their opinions and experiences concerning its potential and capabilities to complement traditional teaching methods, enhance students' programming learning, and support instructors in their instruction. Consequently, the data collected from the interview questions were processed and analyzed using qualitative thematic analysis to identify patterns and themes and provide valuable insights into the potential role of ChatGPT in programming education.

### ***PARTICIPANTS***

The participants in this study were programming instructors selected from the faculty members in the School of Information Technology at AL al-Bayt University. The selection was based on their experience in programming instruction and familiarity with ChatGPT, which allows for a practical exploration of its capabilities and potential benefits and concerns. Faculty members with extensive and recent experience in teaching various programming languages to students at different levels over the past few years were selected to ensure rich responses and diverse perspectives. In addition, although the participants were chosen carefully to ensure the reliability of the findings, their familiarity with ChatGPT was further investigated using a scale ranging from one (indicating a lack of familiarity) to five (indicating a high level of familiarity). With an average familiarity score of 3.75, the convenient sample comprised 12 qualified participants for the study (Croker, 2009). In other words, 12 participants with adequate experience in programming instruction and familiarity with ChatGPT were included and considered in the study sample among the IT faculty members (i.e., 34 members). The number of participants adopted aimed to obtain an in-depth understanding of the phenomenon and enrich the findings of this study (Merriam & Tisdell, 2015). This convenience sampling assisted in capturing the essence of the subjects' experiences, discerning shared patterns, and developing themes (Creswell & Creswell, 2017).

As shown in Table 2, 12 participants with significant and varying levels of experience in computer programming instruction, including males and females, who held an MA or PhD in IT-related fields,

were interviewed. Each participant was interviewed personally, at least once, to elicit detailed and precise information about the advantages and disadvantages of using ChatGPT for programming instruction and to investigate his/her opinions and experiences regarding its potential and capabilities to complement traditional teaching methods, enhance students in programming learning, and support instructors in their instruction. Participants with varying levels of experience and qualifications help reveal valuable insights from different perspectives and varied viewpoints with rich, comprehensive, non-biased opinions.

**Table 2. Study participants (Programming Instructors: PIs)**

Participants (PIs)	Gender	Qualification	Experience/ years	Familiarity with ChatGPT
PI 1	Female	MSc in Computer Science	18	5
PI 2	Male	MSc in Computer Science	13	4
PI 3	Female	Ph.D. in Computer Science	5	3
PI 4	Male	Ph.D. in Computer Science	4	5
PI 5	Male	Ph.D. in Computer Science	9	4
PI 6	Male	Ph.D. Information Systems	12	4
PI 7	Female	Ph.D. Computer Information Systems	15	2
PI 8	Female	MSc in Information Systems	8	3
PI 9	Female	MSc in Information Systems	11	2
PI 10	Male	MSc in Computer Information Systems	6	5
PI 11	Male	MSc in Computer Information Systems	5	5
PI 12	Male	Ph.D. in Computer Information Systems	11	3

### ***DATA COLLECTION***

The data on the implications of integrating ChatGPT into programming teaching methods and their most important advantages and disadvantages for students and instructors were obtained from the selected participants, who were programming instructors, through in-depth and detailed personal interviews. Each interview session lasted approximately 40 minutes on average and was transcribed for analysis. Interviewing is a useful technique when conducting a phenomenological study of a few selected individuals because it helps participants provide their insights and share their experiences. Interviews offer convenience and speed features as a valuable and efficient method for qualitative research, especially when the study sample participant works within the same institute (Meda et al., 2023; Merriam & Tisdell, 2015). Accordingly, extensive discussions with programming instructors during the interviews were conducted carefully and repeatedly to obtain rich details and reveal further hidden or unexpected insights that may not have been previously highlighted. The interviews were conducted several times with each participant according to the data collection requirements.

### ***DATA ANALYSIS***

A qualitative thematic analysis method was used to analyze carefully and rigorously the collected transcribed data through participant interviews. The data were read and coded accurately to identify relevant themes and patterns from the participants' answers corresponding to the research questions. Consequently, the generated codes were categorized into more extensive themes and carefully analyzed to explore the connections and relationships between themes and subthemes. Such a comprehensive systematic method facilitates a comprehensive and profound understanding of the obtained data and provides robust insights and valuable findings that contribute significantly.

### ***ETHICAL CONSIDERATIONS***

All participants were informed and consented to this study, with the ability to withdraw from the study at any time. Each participant in the study was assigned a pseudonym to ensure confidentiality and anonymity throughout the study.

### **INTERVIEW INSTRUMENT**

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The research interviews serve as the primary instrument in this study, which consists of questions designed to address the research objectives. These in-depth interviews consist of several questions developed to investigate the experiences and perceptions of programming instructors from the IT faculty members at AL al-Bayt University regarding the effectiveness of ChatGPT in supporting programming instruction and uncover its potential benefits and adverse impacts on students and instructors. The interview questions were developed based on relevant and reliable sources, such as literature reviews, previous studies, and expert opinions. In addition, unambiguous and simple words, phrases, and concepts that are acceptable and understandable to the participants were adopted. This approach supports the design of unbiased, non-leading, and neutral questions that do not influence or manipulate responses.

The first question was developed to provide the advantages of using ChatGPT in programming instruction. The second question focused on the enhancement effect of ChatGPT on students' learning experiences in programming instruction. The third question explored the use of ChatGPT to support the efficiency of programming instructors during the instructional process. The fourth question asked about the disadvantages and drawbacks encountered while using ChatGPT for programming instruction. The fifth question addressed the concerns and potential ethical or privacy issues related to integrating ChatGPT within programming instruction. The sixth question explored the integration of ChatGPT with traditional programming teaching methods for its enhancement. The last question asked participants to provide their predictions on the future role of ChatGPT in developing programming instruction. The responses were transcribed and analyzed carefully to understand programming instructors' perceptions and insights into the role of ChatGPT as a programming instructional tool for students and instructors.

Consequently, the interview questions were reviewed and validated by a jury of experts in technology-based learning and programming instruction to ensure validity. The jury of experts evaluated the ability of the interview questions to gather responses that satisfied the research questions and fulfilled the objectives of the study. Consequently, the jury specified certain issues and provided syntactic and semantic suggestions and advice, including deleting, merging, and replacing specific aspects to improve the clarity and relevance of the interview questions. Finally, after performing the required updates and modifications for improved validity, the jury approved the validity of the questions and their appropriateness and consistency with the research objectives.

### **RESULTS**

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The responses and perceptions of the programming instructors are summarized and presented in the following sections according to the research questions.

#### ***ADVANTAGES OF USING CHATGPT FOR PROGRAMMING INSTRUCTION***

Several advantages and benefits of using ChatGPT in programming instruction for students and instructors were identified by the participants. The obtained perceptions were organized into themes to construct an overall understanding of the instructors' experience regarding the main advantages of programming instruction. For example, one participant states, "One amazing thing about ChatGPT is its ability to provide a program code for a specific problem, that is,  $n$  factorial, with several pro-

programming languages upon request. This feature enables students to compare the programming languages, understand their strengths and weaknesses, and select a language that is best suitable for that programming problem.” Accordingly, the advantages of using ChatGPT as perceived by most programming instructors as themes are listed in Table 3. Most programming instructors agree on essential benefit themes, including practical applications, personalized learning, a wide range of programming problems and alternative solutions, interactive learning, accessibility, no programming knowledge required, debugging and feedback, and clear explanations.

**Table 3. Advantages of using ChatGPT for programming instruction**

Practical applications	ChatGPT can execute program code and provide the output result. This feature allows students to apply their theoretical knowledge practically by running any code, trying the results, and repeatedly modifying upon request. This helps understand programming concepts better and demonstrates more accurate and appropriate code-writing guidelines. Indeed, students can perform self-evaluation and test their code before submission. Accordingly, students become more confident when writing programming tasks and assignments.
Personalized learning	ChatGPT can provide customized learning experiences by tailoring the resources, examples, and feedback to each student’s unique needs, according to individual characteristics. This feature improves the learning experience of students.
Wide range of programming problems and alternative solutions	ChatGPT trains on a vast knowledge base using diverse resources such as learning materials, examples, and online programming courses. This training enables learners to gain experience with a wide range of programming problems and alternative solutions. As a result, the programming proficiency of the students is enhanced.
Interactive learning	ChatGPT allows learners to ask and search advanced topics about programming and generate programmer-like and immediate responses. Learners obtain interactive learning when engaged in conversational information exchanges. This feature helps increase the motivation and engagement of the students.
Accessibility	ChatGPT can be accessible without installing any specific tool or software. Therefore, it is an accessible, cost-effective, and time-efficient programming learning alternative.
No programming knowledge required	Learners can interact with ChatGPT using their natural and understandable language. This feature allows fresh students, even those with no programming knowledge, to understand programming concepts and solve problems. Accordingly, the learning progress of programming for students at different levels is facilitated.
Debugging and feedback	Interactions with ChatGPT allow learners to focus on primary programming skills like debugging, fixing errors, and receiving code suggestions explained practically through real-world cases. This helps students obtain and follow informal programming rules and best practices to improve their programming tasks and assignments.
Clear explanations/ Demonstrations	ChatGPT provides clear and multiple alternative demonstrations for challenging programming issues. This feature helps students attain advanced levels of understanding in programming.

In addition, to obtain more useful insights with rich details, the participants were asked precisely to provide their thoughts regarding the ability of ChatGPT to enhance students' programming learning. The programming instructors have different perspectives on the enhancing effect of ChatGPT on programming learning for students. One instructor perceived ChatGPT as an important tool providing interactive programming practices, such as completing the code, suggesting code solutions, and reducing syntax errors. These personalized interactive practices may help students improve their programming skills and increase their confidence in writing programs and projects. The responses of two instructors indicate the helpfulness of ChatGPT in coding and program writing assistance by offering students prompt and precise feedback on their programming performance. Other instructors address the ability of ChatGPT to provide student-wide opportunities to practice the best solutions for real-life programming problems rather than a textbook or limited in-class programming sources. Another response reports the ability of ChatGPT to significantly boost student motivation and engagement in the programming learning process when they can modify the code to create their own programs and solutions for programming assignments. For instance, this participant states, "One common case I am observing involves students asking for program code to solve a problem. They then use this code as a new prompt for ChatGPT to test the output. With each execution, students modify the code to observe and understand the functionality. Having such in-depth programming learning capability in real-time, anytime, and anywhere is interesting." This feature results in a positive and dynamic learning environment. In summary, all participants agree that students can have a new and exciting way of learning programming when ChatGPT is integrated properly into the programming curriculum, and it will significantly impact their writing program proficiency and software development.

Furthermore, in the same context, the participants were also asked precisely to provide their thoughts regarding the ability of ChatGPT to support the efficiency of programming instructors during their programming instruction. The participants indicated several capabilities and features for ChatGPT that can be used to support and improve their efficiency in the programming instructional process. One of the instructors stated that ChatGPT could help instructors evaluate and assess students' performance by providing accurate, immediate feedback about their assignments and programming task performance. This feature can save their time and reduce their effort, especially for a large number of students. Some instructors consider ChatGPT helpful for instructors by enhancing their students' engagement in programming tasks anytime, anywhere, especially before lectures. This way helps reduce instructional effort and enables instructors to use class time effectively to address other complex new programming issues. Other instructors believe that ChatGPT can assist instructors in the instructional and explanation process by creating diverse and more real-life and realistic programming examples and demonstrations as a new method for delivering programming instruction. One of the participants viewed ChatGPT as an instrument that may help instructors identify difficulties where learners are struggling and provide better solutions and personalized student recommendations based on their data. This feature allows instructors to improve their instructional practices. Another respondent believed that ChatGPT can help instructors address the individual learning needs of their students by offering customized feedback and guidance for each student. Accordingly, instructors can provide more individualized instruction. Finally, one participant believed that ChatGPT might help programming instructors manage classes by providing helpful teaching strategies, offering efficient lesson plan recommendations, and preparing quizzes and exams. For example, this participant reported, "I am using ChatGPT to support the instructional design and provide an outline for my lectures by reminding me of what necessary programming skills and concepts should be included." In conclusion, integrating ChatGPT into programming instructional methods can support instructors' activities, save time, and reduce effort.

### ***DISADVANTAGES AND CONCERNS OF USING CHATGPT FOR PROGRAMMING INSTRUCTION***

Several disadvantages perceived by the participants were organized into themes for better organization and simplicity. For example, one participant stated: “The accuracy of the responses of ChatGPT depends on the type of questions provided. If the question is too general and lacks context, then the responses will not be satisfactory and cannot solve the programming problem totally. Providing questions that are sufficiently specific is critical, and I think this task is difficult for students.” Accordingly, the disadvantages of using ChatGPT, as perceived by most programming instructors as themes, are presented in Table 4. Most programming instructors agree on the disadvantage themes, including undesired answers, limited resources (data structures and algorithms), technology limitation, unstructured learning, inaccurate feedback, response integrity, and a lack of actual programming elements.

**Table 4. Disadvantages of using ChatGPT for programming instruction**

Inaccurate responses	Errors in recommendations and inaccurate feedback that ChatGPT potentially provides for programming questions represent an issue for educators. ChatGPT might generate inaccurate or incorrect code that does not work properly when entered into programming software.
Undesired responses	Owing to the poorly formatted question or the complexity of the problem, ChatGPT may not understand all types of questions and thus give an undesired answer. This answer may be correct and can be executed through programming software, but it is incomplete to satisfy the requested programming problem requirements. Additional effort from students is needed to compare and validate the output.
Response integrity	The provision of alternative answers, which contradict previous answers on the same programming inquiry, can confuse students and reduce the reliability of the provided code.
Limited programming resources	ChatGPT may provide insufficient information on all programming algorithms and data structures to answer some programming questions. Therefore, learners may need to search for additional resources or tools to address their issues.
Technology limitation	Technical limitations create issues such as processing overhead requirements, slow response time, or the need for a high-quality connection, which may negatively impact the learning experience.
Unstructured learning	Learners may use ChatGPT for programming topics randomly without a structured approach. No specific guidance or plan is available for learners to follow during knowledge acquisition, especially when studying programming topics outside the classroom. This inadequacy requires additional learning management effort to achieve their learning goals.
Lack of real programming elements	ChatGPT does not provide a natural environment for programming applications for learners to execute and test their tasks. Learners may need to search for additional tools to run and manage the coding of their programming projects, especially for developing GUI-based applications.

The programming instructors express several concerns regarding the integration of ChatGPT into programming instruction. One major concern reported by several instructors is the potential abuse of ChatGPT by students seeking easy-to-obtain programming solutions, especially unmotivated students. Ethical concerns arise when students rely mainly on programs and codes generated by ChatGPT without developing the necessary skills. ChatGPT can facilitate cheating by providing ready solutions for programming assignments and tasks, which undermines students' efforts to think or understand. The use of such solutions and tasks must conform to ethical and transparent practices to improve student achievement. Two participants expressed concerns about the privacy and security of students' data. Privacy concerns arise from the exposure of students' private information to ChatGPT through repetitive interactions, especially when all conversations are stored, reviewed, and used to improve the ChatGPT system. Another social impact concern expressed is the potential for ChatGPT to provide interaction, guidance, and support that might replace human instructors' interaction. Human interaction is necessary for students' development.

Similarly, another instructor expressed concern about losing sight of teacher interaction and its importance for students, especially in the early stages of programming teaching. The over-reliance concern is observed by instructors when their students rely on ChatGPT to complete assignments, find errors, and receive code suggestions on all other tasks. This over-reliance can negatively affect their critical thinking, problem-solving, and programming skills, which ultimately lowers their creativity. For instance, one participant states, "I noticed several students depend on ChatGPT to solve all required programming tasks and assignments by obtaining ready and high-quality solutions. This availability limits their ability to achieve learning objectives and hinders the development of critical thinking skills." Other instructors are concerned with controlling students' online behavior while surfing the web using ChatGPT during either in-class or out-class time. Students can be distracted easily, and such technology can be misused to obtain ready solutions, especially for simple or trivial programming tasks, quizzes, and even programming exams. In conclusion, the instructors emphasize that addressing these challenges is crucial. They stress the importance of taking action to reduce negative impacts, minimize errors, and benefit students. Using ChatGPT for programming instruction should be approached carefully. The potential benefits of ChatGPT should be weighed against its negative impacts on the learners before integration.

### ***ROLE OF CHATGPT IN ENHANCING TRADITIONAL PROGRAMMING TEACHING METHODS***

All participants stated a complementary role for ChatGPT alongside traditional methods of programming instruction instead of replacing them. ChatGPT can use other traditional programming resources in different ways. One instructor expressed the potential of ChatGPT to provide a dynamic learning source represented by rich and unlimited programming examples and problems that complement standard examples. This instructor stated, "I can generate a limited number of examples during the instruction of a specific programming aspect, such as a nested for loop. However, ChatGPT enables me to obtain several practical examples immediately to better illustrate the applications of such aspects within an actual program. I can execute each example, illustrate the output, and respond to any question practically." Two instructors consider ChatGPT a learning source that can complement traditional programming instruction methods by providing new programming cases, problems, and solution practices with the latest updates, which is possible inside and outside the classroom. Students can study programming through direct resources such as textbooks, lectures, and videos. ChatGPT helps them learn additional programming skills through new real-life programming problems. One participant stated, "Students can have additional opportunities for dealing with real-life programming case studies and more diverse programming problems. They can provide precise prompts that deeply focus on their issues for ChatGPT, without any limit, until it is resolved." Another response stated that students can receive prompt feedback on their programming tasks and assignments as guidance for the best solutions. Some instructors also note that ChatGPT can complement and enhance traditional programming teaching methods by providing additional explanations

and clarifications of programming concepts, syntax, and functions, which can be helpful for learners, particularly beginners, to understand the programming.

Some other participants viewed ChatGPT as a complementary tool that aided students in a better understanding and practicing of programming. ChatGPT facilitates the transition from simply reading programming examples to executing the code and trying out the results in several ways with multiple dynamic code alternatives. Students can input the desired code as prompts for ChatGPT, even if it contains errors, and then obtain the output result. This feature helps students apply and practice what they have learned and perform and practice programming skills, such as writing, completing, enhancing the code, and fixing errors through interaction with ChatGPT. Several responses about students' interaction with ChatGPT and its ability to support traditional instructional methods are presented. Even guidelines to ask and inquire about the ChatGPT appropriately can be a concern for several disciplines. Students can overcome this issue in the programming learning case. The reason is that the requirements and inquiries in programming instruction are clear and precise, including inputting specific code to find errors, suggesting or generating alternative code, executing the code, and checking the output. Indeed, students can prompt and inquire about ChatGPT for their programming learning requirements. Dealing with the responses of ChatGPT is also less complex and understandable due to the nature of the obtained feedback and responses, which can be a program code, specified errors in the code, and even new suggested code, all of which are clear and direct to understand.

The last respondents perceive that the feature of ChatGPT that allows students to describe their desired learning needs and requirements using their natural language and perform self-learning studies is helpful for appropriateness for various students' levels and backgrounds. In summary, according to the instructors, ChatGPT can complete other traditional programming resources by providing a dynamic and practical learning source, prompt feedback about programming performance, and additional explanations and illustration programming skills, which enhance the appropriateness of self-learning.

The programming instructors stated their beliefs on the future role of ChatGPT in programming instruction to obtain a complete picture and overall vision. The participants agreed on the central role of ChatGPT in the future of programming instruction. Specifically, ChatGPT will become a more sophisticated and effective tool for programming instruction and assessment, providing students with personalized and interactive learning experiences. ChatGPT offers improved assessment, a more integrated component of programming instructors' activities, a tool for training, a tool for enhancing software development, a tool for error detection and fixing, and a tool for improving programs and coding. For example, one of the participants stated, "With the continued development of ChatGPT and its abilities to understand each student's capabilities and learning style, and its ability to simulate and visualize the output responses, ChatGPT is expected to become a compulsory requirement in higher education, especially in the programming discipline. This expectation is due to the customized responses that best support students to understand data structures and advanced programming concepts creatively."

Indeed, the participants asserted the critical role of ChatGPT in providing students with personalized and effective learning experiences while also serving as a resource for programming instructors. ChatGPT is becoming a valuable resource for programming instructors in creating lesson plans and designing programming tasks and exercises tailored to individual student needs. ChatGPT can also assist in grading and provide insights into student progress, which allows instructors to track better and address areas of difficulty. These critical roles can be enhanced as ChatGPT improves its ability to adapt to individual learning styles for the development of critical thinking and problem-solving skills. Improvements in human-like interaction can also increase engagement and motivation among learners and enhance the connection with programming instruction.



Meanwhile, although ChatGPT can be a helpful tool, it cannot replicate the unique perspectives and experiences that human instructors bring to the classroom. Some are skeptical about ChatGPT's ability to replace human instructors entirely in the future. ChatGPT should be used with other teaching methods and tools and under instructors' supervision to mitigate its concerns and limitations. The limitations of ChatGPT should be considered and used appropriately to supplement, rather than replace, human interaction and engagement in programming instruction.

## DISCUSSION

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This section explores the ability of ChatGPT to enhance programming instruction based on the perceptions of IT faculty members, especially programming instructors. Precisely, it identifies the effectiveness of ChatGPT in supporting the programming instructional process and explores its most important advantages and disadvantages for students and instructors. The discussion provides insights into the best ChatGPT practices in programming teaching by summarizing the findings of the study. The participants' perceptions related to the first research question suggest that the most essential benefits of ChatGPT for enhancing programming instruction are practical applications, personalized learning, a wide range of programming problems and alternative solutions, interactive learning, accessibility, no programming knowledge is required, debugging and feedback, and clear explanations. Indeed, programming instructors indicate debugging and feedback insight as an advantage that offers the ability to interact with ChatGPT and focus on debugging, fixing errors, and code suggestions as primary programming skills. This perception is consistent with earlier results by Surameery and Shakor (2023) that indicate the ability of ChatGPT to help solve programming bugs by providing debugging assistance, bug prediction, and bug explanation. In addition, the advantage of interactive learning is reported due to ChatGPT's ability to motivate students when engaged in conversational programmer-like information exchanges. This perception concurs with those of Yilmaz and Karaoglan Yilmaz (2023), who find that ChatGPT can support students and improve their motivation toward programming. The potential of ChatGPT to provide clear explanations regarding challenging programming issues, as perceived by the programming instructors, is in line with the observation of Jalil et al. (2023), who examine and prove the ability of ChatGPT to provide correct answers with correct explanations for the majority of given programming questions and tasks. However, the other advantages found in the current study are new insights that diverge from existing literature and contribute to programming instruction.

To this end, the participants' perceptions reveal that integrating ChatGPT into traditional programming instructional methods is essential for students and instructors. The results of the interviews reveal that ChatGPT has the potential to enhance students' learning and support the efficiency of their instructors in programming instruction. The participants state that ChatGPT can support students during their in-class or out-of-class programming learning by providing personalized and interactive programming practices, assisting them in coding and program writing, helping them practice the best solutions for real-life programming problems, and creating their own programs and solutions. This feature can help develop their programming skills, increase their confidence in writing programs, and lead to a positive and dynamic learning environment that boosts motivation and engagement. The potential of ChatGPT to enhance students' learning by assisting them in coding and program writing concurs with the results in previous research (E. Chen et al., 2023; Logozar, 2023; Tian et al., 2023), which affirms the ability of ChatGPT to explain programming code for students, provide programming assistance through code generation and program repair, and offer high-quality solutions for fundamental programming tasks. Similarly, the potential of ChatGPT to enhance students through personalized and interactive programming practices concurs with the findings of Qureshi (2023), who demonstrates a positive effect of incorporating ChatGPT on students' programming practices to improve their academic performance. However, helping students practice the best solutions for real-life programming problems and creating their own programs and solutions are unique insights revealed in the present study.

The participants provided exclusive insights into the abilities of ChatGPT to enhance the programming instructors and support them in their programming instructional tasks, which contributes new findings to this study. ChatGPT helps instructors save time and effort by providing new instructional practices and addressing the individual learning needs of their students. ChatGPT also assists in performance assessment and recommends lesson plans and teaching strategies.

By contrast, several perceptions on the potential drawbacks and concerns of using ChatGPT in programming education are reported, including inaccurate responses, undesired responses, response integrity, limited programming resources, technology limitation, unstructured learning, and a lack of real programming elements. The programming instructors indicate inaccurate responses to ChatGPT due to the common program errors they obtain through student assignments. This perception is consistent with those of Jalil et al. (2023) and Megahed et al. (2023), who indicate that ChatGPT generates incorrect programming codes and fails to detect and resolve errors. This perception also concurs with Mogali's (2023) earlier results, who obtained several errors and inaccurate information from ChatGPT when used for educational purposes. The limited programming resource disadvantage is perceived through a few cases where ChatGPT may not have sufficient information regarding specific newly emerging algorithms to respond. This insight is supported by Perkins (2023), who indicates that ChatGPT has limited knowledge and may fail to provide up-to-date responses. The other themes are key contributions from the participants of the current study exclusively for programming instruction.

Similarly, several concerns are revealed, including ethical and transparent use, privacy and security of students' data, social impact and replacement of human interaction, over-reliance, and controlling students' online behavior. However, such concerns revealed in this study are consistent with earlier findings in the literature that are discussed as common concerns about integrating ChatGPT but discussed within general educational contexts rather than emphasizing programming and its consequences and their mitigating details. For example, Mhlanga (2023) discusses ethical concerns for integrating ChatGPT in education. Privacy of students' data is indicated by Tlili et al. (2023) when revealing sensitive data through their interaction with ChatGPT. The social impact and ability of ChatGPT to replace humans are stressed by Adiguzel et al. (2023). Relying on ChatGPT to perform all educational tasks without mental effort is asserted by Sok and Heng (2023). The theme of controlling students' online behavior is uniquely mentioned in the present study.

Ultimately, regarding ChatGPT's role in enhancing traditional programming teaching methods, the participants suggest a complementary role for ChatGPT that balances its potential benefits against its negative impacts to best enhance traditional programming teaching methods. These perceptions are consistent with those of Mohamed (2023), who revealed that ChatGPT can complement traditional EFL teaching methods in different ways. Indeed, the participants' perceptions in the present study indicate that the successful integration of ChatGPT in programming teaching can complement and support their instructional methods, including providing students with additional and more diverse real-life programming problems with multiple alternative solutions, performing additional programming skills, receiving instant feedback and guidance on their programming tasks, obtaining additional explanations and programming examples, and trying the results practically in several ways. Indeed, the ability of ChatGPT to help students perform additional programming skills and provide additional explanations and programming examples is in line with the findings of E. Chen et al. (2023), who indicate the efficiency of ChatGPT in providing programming code explanations for student and improving their programming skills. The other insights are contributions provided by the participants in the current study specified for teaching programming languages.

In summary, the participants' perceptions reveal new benefits for integrating ChatGPT into programming instruction that diverges from existing literature and contributes to programming instruction, including practical applications, personalized learning, a wide range of programming problems, and alternative solutions, and no programming knowledge is required. The abilities of ChatGPT to help

students practice the best solutions for real-life programming problems and create their own programs and solutions are unique insights revealed in the present study. Moreover, participants provide exclusive insights into the abilities of ChatGPT to efficiently enhance the programming instructors by saving time and effort, providing new instructional practices, helping address the individual learning needs of their students, and managing class tasks.

Comparatively, the participants' perceptions reveal new potential drawbacks and limitations of using ChatGPT in programming education that diverge from existing literature, including undesired responses, response integrity, technology limitation, unstructured learning, and a lack of real programming elements. Furthermore, several concerns are revealed, including ethical and transparent use, privacy and security of students' data, social impact and replacement of human interaction, over-reliance, and controlling students' online behavior. Overall, the participants suggest a complementary role for ChatGPT that balances its potential benefits against its negative impacts to best enhance traditional programming teaching methods and maximize its benefits for students and instructors. However, challenges and limitations of using ChatGPT, such as the inability to draw and create visual arts, process multiple tasks, and lack of emotion, are not fully addressed by the participants of this study.

The participants' perceptions in this study indicate that ChatGPT supports the programming instructional process and is helpful for students and their instructors in programming teaching and instruction. Understanding the capabilities and advantages of ChatGPT, as well as learning how to ask questions systematically and creatively, helps maximize the programming outputs generated from ChatGPT. This understanding can help provide better solutions to programming problems and offers advanced opportunities to enhance students' understanding of problem-solving and algorithmic thinking. Students can be assisted in solving complex programming problems and continue to receive high-quality programming learning through ChatGPT to accelerate their programming knowledge (Rahman & Watanobe, 2023). Similarly, instructors can use ChatGPT to arrange an instructional plan for programming teaching and prepare topic-related content, presentations, and questions for quizzes and exams. The perceptions recommend that careful consideration of the disadvantages and concerns is crucial. Integrating ChatGPT into educational contexts should be approached cautiously to ensure ethical use and maximize the benefits derived from ChatGPT (Mhlanga, 2023). The advantages and disadvantages of ChatGPT need to be weighed carefully, and several measures should be taken to maximize the benefits of ChatGPT and minimize potential negative impacts. Educating students and instructors on ethical concerns, assigning advanced tasks requiring human intervention and critical thinking to prevent cheating, promoting independent programming learning and practice, protecting student privacy, and fostering necessary thinking skills are helpful measures to mitigate the negative impacts of ChatGPT. Awareness of each concern and its suitable measures help protect students and ensure that ChatGPT enhances learning outcomes and benefits students and instructors to mitigate its negative impacts and ensure that it complements human instructors rather than replacing them. Ultimately, this feature ensures that students continue to receive high-quality programming learning, which facilitates the teaching process.

## CONCLUSION

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This study aimed to investigate the perceptions of faculty members, especially programming instructors, at AL al-Bayt University on the effectiveness of ChatGPT in supporting the programming instruction process. Another aim was to explore their experiences with the potential benefits and adverse impacts of such technology. The participants' perceptions in this study demonstrate several advantages of ChatGPT that make it useful for the programming instruction process, including practical code applications, personalized and interactive learning, a wide range of programming problems and alternative solutions, accessibility, no programming knowledge required, debugging and feedback capabilities, and clear code explanations. By contrast, several perceptions on the potential drawbacks and negatives of using ChatGPT in programming instruction are reported, including inaccurate re-

sponses, undesired responses, response integrity, limited programming resources, technology limitation, unstructured learning, and a lack of real programming elements. Similarly, several concerns are revealed, including ethical and transparent use, privacy and security of students' data, social impact and replacement of human interaction, over-reliance, and controlling students' online behavior. Overall, the participants suggest a complementary role for ChatGPT that balances its potential benefits against its negative impacts to best enhance traditional programming teaching methods. However, they believe successfully integrating ChatGPT into the programming instruction process requires a balanced approach between potential benefits and negative impacts to better aid their students and instructors.

This study is the first to focus on the perceptions of programming instructors during their experience and their students using ChatGPT in programming extensively. The contribution lies in highlighting the positive and negative aspects of using ChatGPT and discussing the potential complementary role of ChatGPT alongside traditional teaching methods. The study concludes that, although faculty members perceive several limitations and concerns for integrating ChatGPT, a cautious approach that appropriately balances potential benefits against negative impacts before integrating ChatGPT into learning can significantly mitigate their adverse effects and achieve quality programming instruction. Understanding the capabilities of ChatGPT to exploit, as well as its concerns to overcome, helps maximize the programming outputs generated from ChatGPT. This understanding can help provide better solutions to programming problems and offers advanced opportunities to enhance students' understanding of problem-solving and algorithmic thinking. Students can be assisted in solving complex programming problems and continue to receive high-quality programming learning by ChatGPT to accelerate their programming knowledge. Similarly, the instructors can use ChatGPT to arrange an instructional plan for programming teaching and prepare topic-related content, presentations, and questions for quizzes and exams.

Exploring programming instructors' perceptions from their field of experience enables gaining valuable and unique insights and evidence for practitioners such as policymakers, instructional designers, and educators, which guide and help incorporate AI technologies efficiently. For instance, the participants' perceptions reveal several essential benefits of integrating ChatGPT into programming instruction that can enhance students' learning and support the efficiency of their instructors. These perceptions recommend practitioners exploit and maximize such benefits by developing new teaching strategies, curriculum designs, in-class activities, and course outlines for programming curricula that incorporate ChatGPT efficiently. The potential drawbacks, limitations, and concerns of using ChatGPT in programming education that have been explored in this study also provide guidance for practitioners to take appropriate actions to mitigate their adverse effects. Indeed, practitioners are required to embrace such AI technologies rather than banning them. Additional effort is required from instructors to assign programming tasks that require applying programming knowledge and critical thinking instead of simple or trivial tasks that can be directly obtained. Instructors and students should improve their competencies and practices to meet the critical thinking and question-asking competencies required to satisfy the new demands of AI technology with appropriate support from their institutes. IT faculties need to adopt a teaching approach with a complementary role for ChatGPT that balances its potential benefits against its negative impacts to best enhance traditional programming teaching methods and maximize its benefits for students and instructors.

The implications of the participants' perceptions show that actual improvement in programming instruction can be attained through a cautious approach that appropriately balances potential benefits against negative impacts before integrating ChatGPT into learning. This way can significantly mitigate their adverse effects and achieve quality programming instruction. Integrating AI chatbots is essential, given that it enables students to improve their programming skills, critical thinking, and problem-solving skills. These perceptions are consistent with the current trend in AI-based technologies for education in different disciplines, which emphasizes the importance of incorporating such technology to improve students' 21st-century skills to succeed today.

The limitations encountered in this study may represent opportunities for future research. Thus, further research is required to investigate the efficacy of using ChatGPT on other topics in different environments. We recommend paying close attention to designing strategies and alternatives that suit ChatGPT to achieve better results. We also recommend examining the effect of ChatGPT on important attributes, such as motivation, engagement, and achievement of students. Controlling students' behavior during the in-class use of ChatGPT and using an appropriate design for tasks and assignments that best suit the subject and the students are additional challenges for consideration. Ultimately, this study recognizes sample size and subject area as limitations. Replicating this study on a larger scale, in various settings, and on other academic courses from other schools and universities is recommended.

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