Generative AI for Programing Education: Can ChatGPT Facilitate the Acquisition of Fundamental Programming Skills for Novices?

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| \*Correspondence  [akinul@aiub.edu](mailto:akinul@aiub.edu)  1 American International University-Bangladesh,  Dhaka, Bangladesh | **Abstract**  Modern generative AI systems like ChatGPT have sparked much interest in their potential to revolutionize programming education, especially for beginners. However, the existing empirical data regarding the effectiveness of technologies like ChatGPT as autonomous programming tutors is presently limited. The present study investigates the capacity of ChatGPT to facilitate the acquisition of fundamental programming skills for novice programmers without human assistance. In this study, we have put forth a conceptual framework (APEC - Adaptive Programming Education via ChatGPT) that integrates both bottom-up and top-down approaches, incorporating ChatGPT as the principal instructor for the study of programming. In order to evaluate the usefulness of ChatGPT in instructing beginner programmers on a new programming language, we conducted an empirical investigation. This investigation involved administering a survey to three programming experts subjected to the responses generated by ChatGPT. The survey findings indicate that ChatGPT is proficient in explaining core principles such as variables, data types, and control statements through conversational exchanges, adopting an intelligent and logical methodology. Nevertheless, certain constraints arise when dealing with increasingly complex topics.  **Keywords:** Generative AI, ChatGPT, Programming education, Educational Technology, Higher Education  **Introduction**  Artificial intelligence has reached a critical juncture with the advent of advanced generative AI systems such as ChatGPT. ChatGPT has undergone extensive training using a vast and varied corpus of textual data from various sources on the internet (Borji, 2023; Ray, 2023). By extracting patterns and structures from vast textual data, these models have developed a notable ability to generate coherent and contextually appropriate responses to prompts in natural language. Even so, it is important to recognize that despite their high level of intelligence, these systems do not possess actual |

cognition or intentionality. The responses provided by the model are mostly derived from the identification and extrapolation of statistical patterns within the data it has been trained on. The social effects surrounding the implementation of AI systems, which possess significant capabilities but are constrained in certain aspects, continue to be a subject of intense discussion and controversy (Wach et al., 2023). While accepting the limitations of a certain entity or concept, it is imperative to acknowledge its significant usefulness within appropriate boundaries equally. Domains such as customer service (Subagja et al., 2023), creative writing assistance (Shidiq, 2023), and programming education (Tian et al., 2023) exemplify areas in which these technologies can enhance human talents and increase productivity. However, the emergence of sophisticated generative artificial intelligence systems like ChatGPT has generated significant attention to their capacity to revolutionize educational methodologies in various fields (Lee, 2023; Lo, 2023; Rahman & Watanobe, 2023), including the teaching of computer programming (Biswas, 2023; Surameery & Shakor, 2023). Nevertheless, despite the considerable attention and speculations around these emerging technologies, significant academic studies still need to be investigated the effectiveness of tools such as ChatGPT in reliably teaching fundamental coding abilities without human assistance. This study focuses to fill the existing research gap by conducting a comprehensive examination of ChatGPT's effectiveness as a distinct programming teacher for beginner students who are learning the basics of Python.

This study aims to investigate the effectiveness of ChatGPT in facilitating independent learning of expertise in the Python programming language among students who need to gain prior knowledge and the need for human instruction. This study examines the accuracy and standard of ChatGPT's explanations regarding fundamental concepts and its ability to provide informative sample code. In addition, this study proposes the pedagogical strategy ChatGPT employs compared to traditional human tutoring methods, utilizing expert surveys as a way of evaluation. This study presents and assesses a well-defined conceptual framework that integrates bottom-up and top-down approaches to facilitate independent learning.

The key findings indicate that ChatGPT offers excellent assistance regarding fundamental Python concepts. However, it needs to improve in fostering the development of more advanced skills. Experts recommend integrating human tutoring with ChatGPT to maximize outcomes. This research generates novel insights into ChatGPT's promise and pitfalls as an independent programming tutor, establishing an empirical foundation to guide the thoughtful and strategic incorporation of generative AI in computer science education.

**Literature Review**

Learning computer programming languages has been extensively studied within education and cognitive science research. An enduring observation evident in a multitude of research is that learning and successful teaching of programming pose significant challenges (Medeiros et al., 2018; Seng & Yatim, 2014). Research findings also indicate that students have challenges in the areas of reading (McCracken et al., 2001), writing (Lister et al., 2004), and programming code design (Tenenberg & Fincher, 2005). This challenge arises from the diverse array of advanced skills required, including critical thinking and problem-solving abilities, proficiency in computer programming syntax and practical expertise in debugging and implementing solutions.

Several approaches have been suggested and assessed to facilitate the early phases of acquiring programming skills. Effective pedagogical tactics include the utilization of visual block-based languages as a precursor to shifting towards text-based coding (Lin & Weintrop, 2021), the implementation of problem-based learning using real-world illustrations (Martins et al., 2018), and the provision of scaffolding to facilitate the development of planning and tracing abilities (Whalley & Kasto, 2014). The research community emphasizes the significance of imparting theoretical foundations and practical coding skills (Ismail et al., 2010). Research has also demonstrated that pair programming and interactive instructors can effectively enhance engagement and foster skill development among those new to a particular domain (Isong, 2014).

The evolution of programming language learning has paralleled technical improvements, wherein generative AI tools such as ChatGPT have emerged as promising facilitators. Several studies have investigated the potential of utilizing ChatGPT in programming instruction within an experimental framework (Biswas, 2023). When utilizing AI-based tools and settings for programming learning, students possess the capacity to submit problems to the AI tool, thereby obtaining prompt feedback and solutions. This enables a customized educational experience per the student's unique learning pace (Yılmaz & Yılmaz, 2022). AI-powered tools have the potential to assist students with coding tasks through the provision of ideas, error detection, and the automation of code development. This approach can potentially enhance student's ability to produce both efficient and precise code, hence minimizing the time and effort needed to fulfill programming tasks. The utilization of AI-driven tools and environments has the potential to enhance student engagement and motivation through interactive interaction and individualized assistance and feedback in the process of acquiring programming skills (Yilmaz & Yilmaz, 2023).

So, investigating self-directed learning of programming fundamentals exclusively through AI tools such as ChatGPT, without human guidance, presents a promising domain for research exploration. This study targets to investigate the potential of ChatGPT in facilitating the independent acquisition of fundamental ideas in a specific programming language among novice students. The focus of this study revolves around basic research questions:

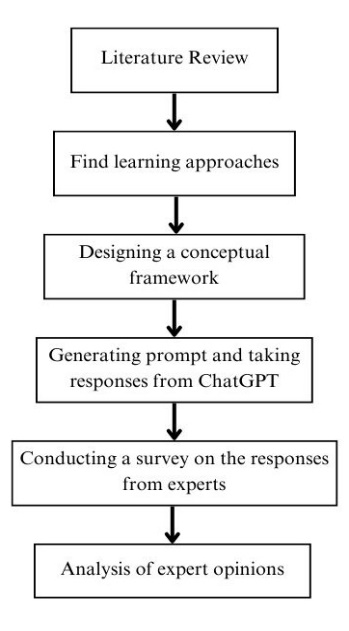
RQ 1: Can ChatGPT effectively teach beginners a programming language without human help?

RQ 2: How accurately can ChatGPT explain programming concepts and provide sample code to novice learners compared to human tutors?

RQ 3: How do experts view the quality of programming guidance provided by ChatGPT compared to traditional methods?

The primary emphasis of our study lies in the utilization of ChatGPT as a conversational agent, specifically in the context of providing programming education through text-based instruction. This study aims to analyze the sequential curriculum offered by ChatGPT, focusing on its suitability for novice learners seeking to acquire basic computer programming knowledge. The accuracy, thoroughness, and instructional design quality of each module and explanation provided by ChatGPT will be subject to rigorous evaluation. Upon further examination, our analysis thoroughly dissects the sequential phases of programming education outlined by ChatGPT. Next, we employ the litmus test by seeking the perspectives of proficient professionals who deeply understand the complexities of the specific programming language in question. The administration of a survey will accomplish this. These insights hold significant value as they contribute to understanding the effectiveness of ChatGPT's assistance.

**Methodology**



**Fig. 1** Methodology Diagram

Figure 1 depicts the sequential procedures utilized in the research. We initially conducted a comprehensive literature review to identify and analyze various programming learning approaches. Then, a conceptual framework that incorporates existing programming learning techniques was developed. We used ChatGPT to generate responses to specific questions designed to assess ChatGPT's potential for teaching programming to novices. Subsequently, a survey was conducted to obtain expert feedback on the teaching quality of ChatGPT. Finally, the opinions of experts were analyzed.

**Programming Language Learning Approaches**

There are two distinct methodologies for acquiring proficiency in a programming language: the bottom-up approach (BUA) and the top-down approach (TDA).

**Bottom-Up Approach (BUA)**

The bottom-up technique prioritizes acquiring foundational elements in a programming language, such as variables, data types, functions, and grammar. Through a comprehensive grasp of these fundamental principles, students can progressively integrate them to cultivate their abilities methodically, establishing a solid technical foundation. This approach is often utilized in educational institutions and programming books targeted at novices (Saito & Yamaura, 2013).

**Top-Down Approach (TDA)**

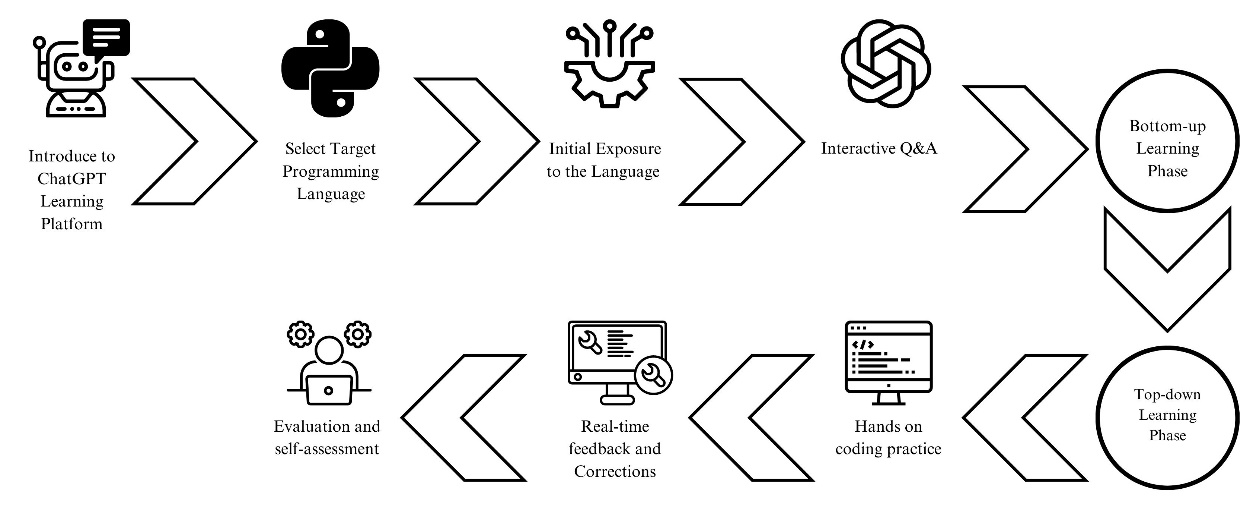
The top-down approach prioritizes an instructional approach in which learners are first exposed to sample programming to understand language functionality (Saito & Yamaura, 2014). The utilization of TDA facilitates the language acquisition process, requiring a shorter duration than BUA. This instructional approach enables learners to construct practical projects at an accelerated pace, resulting in heightened levels of engagement. Learners are provided with a structured curriculum or specific learning outcomes, emphasizing comprehension, manipulation, and code validation. TDA promotes a comprehensive understanding of programming blocks instead of individual code portions. Nevertheless, it is possible that the initial stages of learning may exhibit a deficiency in fundamental principles. Overall, the top-down method emphasizes comprehensive conceptualization and practical implementation while initially de-emphasizing technical complexities.

**Approach Used by ChatGPT**

ChatGPT effectively integrates bottom-up and top-down methodologies inside its instructional framework for teaching programming languages to novice learners. ChatGPT employs a bottom-up approach by providing fundamental explanations and details to establish a foundational understanding of programming concepts. Concurrently, it utilizes a top-down methodology by providing learners with concrete coding situations that allow them to comprehend the operation of the language inside the framework of real-life applications. The utilization of this dual approach provides learners with a complete learning experience. Through systematic explanations, learners get a strong foundation in programming principles. Simultaneously, they implement practical code, allowing for a hands-on learning experience. Combining bottom-up and top-down strategies guarantees that learners acquire a comprehensive understanding of syntax and structure and the capacity to create functional code. This approach finally cultivates a comprehensive expertise in programming languages.

**Framework for Learning Programming Using ChatGPT**

A conceptual framework called APEC (Adaptive Programming Education via ChatGPT) has been proposed to facilitate learning programming using ChatGPT. This framework primarily targets individuals new to programming but can also be adapted to accommodate those with varying levels of expertise. While initially designed for beginners, the framework has the potential to benefit learners at all proficiency levels who have a strong inclination toward programming. This framework enables dynamic and inclusive learning environments by utilizing ChatGPT as a guiding tool without human assistance. It proves valuable to anyone interested in programming, regardless of their existing knowledge in the field.



**Fig. 2** APEC (Adaptive Programming Education via ChatGPT) Framework

The following section provides a brief overview of the objectives included in the framework.

1. Introduction to ChatGPT Learning Platform:

Familiarize students with the ChatGPT platform as a self-learning resource for programming.

1. Selecting the Targeted Programming Language:

Students choose the specific programming language they want to learn.

1. Initial Exposure to the Language:

ChatGPT provides an overview of the selected programming language, introducing basic concepts and terminology.

1. Interactive Q&A Sessions:

Students engage in interactive sessions with ChatGPT, asking questions related to programming language fundamentals.

1. Bottom-Up Learning (BUA) Phase:

ChatGPT explains foundational concepts, syntax, and data structures, assisting students in building a strong base.

1. Top-Down Learning (TDA) Phase:

ChatGPT presents sample coding scenarios, allowing students to observe practical implementations of language concepts.

1. Hands-On Coding Practice:

Students apply their learning by actively writing code with ChatGPT's guidance.

1. Real-Time Feedback and Corrections:

ChatGPT provides instant feedback on code accuracy and helps correct errors, encouraging iterative learning.

1. Evaluation and Self-Assessment:

Students evaluate their understanding and coding skills by solving coding challenges independently.

The proposed framework integrates two instructional approaches commonly employed in programming education: a foundational approach, which prioritizes the comprehension of fundamental concepts, and a practical approach, which emphasizes applying these concepts in real-world contexts. Using ChatGPT as an instructional tool, our objective is to assist people new in programming. This technique addresses two significant questions: Can ChatGPT effectively deliver programming training to novice learners without any human intervention? Moreover, can ChatGPT's explanations and code examples attain a level of quality comparable to that offered by human tutors?

The initial query was established to assess the independent instructional capabilities of ChatGPT. Our study aimed to evaluate the usefulness of learning programming exclusively through interactions with ChatGPT without the presence of human teachers. In order to assess the viability of our approach, we employed ChatGPT as a tool to offer a comprehensive instructional resource for anyone interested in acquiring proficiency in Python programming. This resource encompasses introductory and foundational principles. The quality of the generated solutions was further assessed by incorporating expert comments and perspectives.

The following query examines the distinct instructional approaches utilized by ChatGPT and human educators. This study will evaluate the potential of ChatGPT in explaining programming ideas and offering informative code snippets. Subsequently, a comparison will be made between these strategies and those employed by human educators, facilitating an assessment of ChatGPT's instructional effectiveness concerning human capabilities.

**Using ChatGPT for Learning Python Programming Language**

In order to evaluate the ability of ChatGPT to offer concise and organized instructional assistance for individuals who are new to programming languages, we ask the following questions. Python was selected as the programming language for our research project. Using a syntactically simple programming language, such as Python, compared to a complex language like Java, has proven to enhance students' understanding and learning of programming principles (Koulouri et al., 2014). Initially, we ask ChatGPT's guidance in obtaining a systematic plan to pursue learning proficiency in Python programming as an individual with limited experience in the field. Subsequently, we request the system to instruct diverse Python modules encompassing topics such as variables and data types, data structures, as well as input and output mechanisms. By assessing the output created by ChatGPT, we can evaluate its efficacy in facilitating the understanding of foundational Python concepts. Furthermore, we ask ChatGPT to offer practical coding exercises in Python for novice learners in order to assess its efficacy as an instructor in facilitating programming education through active engagement in practice. Finally, we assess the suitability of ChatGPT for delivering real-time feedback and corrections while debugging a specific issue.

**Prompt:** Provide a roadmap to learn Python programming from beginner to basic

**ChatGPT Response:**

|  |  |
| --- | --- |
|  |  |
| Part-1 | Part-2 |

**Fig. 3** Beginner Python learning roadmap response from ChatGPT

**Prompt:** Teach me each part of the provided roadmap

**ChatGPT Response:**

|  |  |  |
| --- | --- | --- |
|  |  |  |
| (a) | (b) | (c) |
|  |  |  |

**Fig. 4** Samples of teaching each part of the ChatGPT. Here ChatGPT has been prompted to provide instruction on each component of its own roadmap that has been offered.

**Prompt:** Provide Hands-On Coding Practice in Python for beginners

|  |  |
| --- | --- |
|  |  |
| (a) | (b) |

**Fig. 5** Hands-on coding sample response from ChatGPT.

**Prompt:** Real-Time Feedback and Corrections

|  |  |  |
| --- | --- | --- |
|  |  |  |
| (a) | (b) | (c) |

**Fig. 6** Real-time coding corrections sample response from ChatGPT. We presented ChatGPT with a series of erroneous codes and requested assistance in identifying and rectifying the issues. The codes contained both theoretical and syntactical mistakes.

|  |  |
| --- | --- |
|  |  |
| (a) | (b) |

**Fig. 7** Real-time coding feedback sample response from ChatGPT. Multiple codes were sent to ChatGPT, which have the potential for additional improvement or simplification. The provided code snippets were written in an inefficient manner.

**Analysis and Discussions**

**Survey Questions**

A survey was conducted to accurately evaluate ChatGPT's quality in various tasks, such as interactive programming, providing structured roadmaps, and code debugging. The survey involved developing a customized collection of questions closely aligned with the framework's main objectives. These thoughtfully crafted questions corresponded with the research inquiries, effectively capturing the intended outcomes. Three individuals proficient in Python programming participated in this survey to provide their insightful viewpoints on the generated responses by ChatGPT. The primary objective was to shed light on the quality and efficacy of these responses.

The Likert Scale was employed as the measurement scale for the survey questions. The Likert Scale is widely recognized as a reliable and valid instrument for assessing individuals' subjective opinions and attitudes in an organized manner (Wu & Leung, 2017). The survey employs a scale that gives participants different response alternatives to indicate their degree of agreement or disagreement with a given topic. Participants in the study offer a numerical value to their responses, which spans from "Strongly Disagree" (1) to "Strongly Agree" (5) (Sullivan & Artino Jr., 2013). This scale is common in surveys and questionnaires to get a wide range of thoughts and perspectives from participants. Then, these data may be examined and interpreted to make well-informed decisions.

Table 1 Survey questionnaire

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No** | | **Question** | | **Strongly Agree**  (5) | | | | **Agree**  (4) | **Neither agree nor disagree**  (3) | | **Disagree**  (2) | | **Strongly disagree**  (1) | |
| 1 | Main | | ChatGPT can effectively teach beginners the following Python concepts – | |  | | | | | | | | | | |
| i | | Variables and data types | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |
| ii | | Control Statements | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |
| iii | | Functions and Modules | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |
| iv | | Data Structures | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |
| v | | Exception Handling | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |
| vi | | File Handling | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |
| 2 | | ChatGPT has the potential to teach beginners programming without teachers - | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |
| 3 | | ChatGPT can be used to personalize the learning experience for each beginner- | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |
| 4 | | ChatGPT can be used to provide feedback to beginners in a timely and constructive way- | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |
| 5 | | ChatGPT can effectively help beginners with Hands-On Coding Practice - | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |
| 6 | | ChatGPT can provide Real-Time Feedback and Corrections for beginners – | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |
| 7 | | ChatGPT can help promote deep conceptual understanding and real-life implementation capabilities of learners – | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |
| 8 | | ChatGPT maintains a Bottom-Up Approach while generating responses – | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |
| 9 | | ChatGPT maintains a Top-Down Approach while generating responses – | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |
| 10 | | The quality of programming guidance provided by ChatGPT is better compared to traditional methods – | | ☐ | | ☐ | | | ☐ | | ☐ | | ☐ | |

A brief description of each question is discussed in the following section.

1. ChatGPT's Effectiveness in Teaching Python Concepts:

The question aims to assess the efficacy of ChatGPT in instructing specific Python concepts, which is divided into six subparts (I through VI). We inquire with specialists regarding the ability of ChatGPT to instruct new learners on fundamental Python topics such as variables, input and output, and data structures.

1. ChatGPT's Potential for Independent Programming Learning:

This inquiry evaluates the confidence in ChatGPT's potential to facilitate programming education for novices without necessitating human instructors. The question explores the extent to which respondents agree or disagree that ChatGPT, an AI-powered tool, may autonomously facilitate the acquisition of programming skills for novices, hence eliminating the necessity for human instructors.

1. Personalizing Learning with ChatGPT:

This inquiry relates to the capacity of ChatGPT to customize the educational experience for novice learners individually. The participants in the study conveyed their opinions regarding the extent to which ChatGPT is capable of meeting the individual requirements of learners.

1. Timely and Constructive Feedback from ChatGPT:

This question evaluates the ability of ChatGPT to offer constructive and prompt feedback to novices throughout their participation in learning and coding activities.

1. Effectiveness of ChatGPT in Hands-On Coding Practice:

This question seeks to determine the perspectives of experts regarding the effectiveness of ChatGPT in assisting novice individuals in the practical application of coding by creating real code. This inquiry examines the potential of ChatGPT as a dependable companion for learners in facilitating their involvement with practical coding tasks by seeking respondents' agreement or disagreement.

1. Real-Time Feedback and Corrections from ChatGPT:

This inquiry examines whether ChatGPT has the potential to serve as a valuable mentor by assisting learners in real-time code refinement and debugging. The question aims to gather respondents' perspectives on this matter, seeking agreement or disagreement.

1. Enhancing Proficiency in Comprehension and Application Skills:

This survey question investigates the perspectives of experts regarding the impact of ChatGPT on improving learners' comprehension of programming principles and their practical utilization, with an emphasis on conceptual knowledge and real-world application.

1. Maintaining Bottom-Up Approach in Responses:

This inquiry seeks to determine whether the generated responses of ChatGPT follow the bottom-up methodology, which incorporates starting with fundamental concepts and advancing toward specific details.

1. Maintaining a Top-Down Approach in Responses:

Similarly, this query assesses whether ChatGPT's responses correspond to a top-down approach, where sample programming examples lead to extensive language components.

1. Comparison of Programming Guidance Quality:

The final question seeks to determine if respondents believe that the quality of programming guidance provided by ChatGPT is better compared to the traditional methods and invites respondents to indicate their level of agreement or disagreement.

**Expert Opinion Analysis**

After obtaining feedback from three Python programming language specialists, we analyzed and compared their responses to each survey question. The responses provided by the participants for each survey question were subjected to analysis and comparison in order to identify areas of agreement and disagreement. The combination of expert viewpoints unveils common trends and noteworthy specifics. This procedure ultimately facilitates a comprehensive exploration of expert opinions regarding the efficacy of ChatGPT in the domain of programming education, enabling an analysis of the experts' feedback.

**Fig. 6** Expert Responses to Question 1. Question 1 has 6 sub-questions, from i – vi.

Figure 6 illustrates expert responses to the first question of the survey, together with its sub-questions, which assess the ability of ChatGPT to teach foundational knowledge of Python programming to beginners. In questions labeled "i," "ii," "v," and "vi," all three experts have provided replies that are generally satisfactory, with ratings ranging from "Agree" (4) to "Strongly Agree" (5). According to the perspectives of these experts, it is evident that ChatGPT possesses the ability to effectively guide inexperienced individuals in learning fundamental Python principles, such as understanding variables and data types, control statements, exception handling, and file handling. In contrast, it is worth noting that two experts expressed a neutral stance, indicating "Neither agree nor disagree" (3), while expert 2 expressed "Agree" (4) in response to the question "iii," which pertained to the assessment of ChatGPT's effectiveness in teaching functions and modules. The prevailing viewpoint among experts suggests that there remains potential for enhancing the instructional capabilities of ChatGPT in its provision of teaching functions and modules to novice users. In response to question "iv," all three experts express a neutral stance "Neither agree nor disagree" (3) on ChatGPT's effectiveness in teaching data structures to novices. This suggests that ChatGPT has clear areas for improvement in this particular domain. In general, ChatGPT has a satisfactory capability to deliver efficient instruction in teaching the foundational principles of the Python programming language.

**Fig. 7** Expert Responses to Question 2-10.

Figure 7 depicts the responses provided by the experts in relation to survey questions "2" to "10". In general, all three experts provided mostly good responses to the majority of the questions. In questions 2, 3, and 4, the expert assigns ratings that span from "Agree" (4) to "Strongly Agree" (5). Based on the provided responses, the respondents express agreement or strong agreement regarding the potential of ChatGPT in facilitating programming education for novices in the absence of instructors. Furthermore, they acknowledge its ability to tailor the learning process to individual beginners and deliver timely and constructive feedback. In response to issue 5, all three experts express a strong agreement regarding the effectiveness of ChatGPT in facilitating hands-on coding practice for novices. In both questions 6 and 9, all respondents indicated agreement, with an average rate of 4. The observation suggests that ChatGPT possesses the capacity to offer real-time feedback and corrections to individuals who are new to programming. Additionally, it maintains a top-down approach while generating responses. In relation to questions "8" and "10", it is observed that expert 1 and expert 2 express agreement with a rating of "4", whilst expert 3 expresses a neutral stance with a rating of "3". Based on agreement among experts, ChatGPT follows a Bottom-Up Approach in its response generation. Furthermore, the programming guidance offered by ChatGPT exhibits superior quality when compared to conventional methodologies. In contrast, the majority of experts express a neutral stance, neither agreeing nor disagreeing (3), regarding question 7. This suggests that ChatGPT has limitations in fostering profound conceptual comprehension and practical application skills among learners, indicating the need for further improvement.

**Conclusion and Future Work**

The objective of this research is to investigate the effectiveness of ChatGPT as a self-sufficient instructor in teaching fundamental programming knowledge to novice students, specifically emphasizing the Python programming language. ChatGPT exhibits a notable level of efficacy in demonstrating fundamental programming principles coherently and organized during conversational exchanges. The suggested framework incorporates a combination of bottom-up and top-down methodologies in order to promote a full learning experience. The findings suggest that ChatGPT performs strongly in instructing fundamental concepts like variables, data types, and control statements within an introductory context. Nevertheless, certain constraints arise when dealing with complex subjects such as functions, modules, and data structures.

Although ChatGPT exhibits potential as an initial tool, it needs to improve its ability to progress to more advanced proficiency levels without human tutors' supervision. The application mentioned above functions as a captivating supplemental resource, yet, it is essential to acknowledge the continued significance of human tutoring, particularly when dealing with complex issues. This study offers significant contributions in examining the pedagogical approaches of ChatGPT in contrast to conventional instructional methods. In general, ChatGPT demonstrates evident potential as a programming instructor for beginners, while its effectiveness can be further enhanced with the incorporation of human mentoring. This research paper sets a standard or reference point for comprehending the cautious integration of generative artificial intelligence (AI) in computer science education.

Future investigations may prioritize the integration of ChatGPT with intelligent tutoring systems and adaptive learning platforms to augment its functionalities as a programming instructor. The examination of appropriate combinations of AI-powered technologies with human instruction is a subject that deserves more exploration. Further research endeavors could encompass broadening the scope of programming languages and concepts explored, extending beyond the fundamental realm of Python. Continuous evaluations can be conducted to evaluate the long-term learning results that ChatGPT promotes. As technological advancements persist, the programming pedagogical capabilities of ChatGPT are also expected to progress. Therefore, the ongoing empirical assessment of its developing skills will be significantly useful. This study establishes the groundwork for a promising new domain in harnessing artificial intelligence to revolutionize the field of computer science education.

**References**

Biswas, S. (2023). Role of ChatGPT in Computer Programming.: ChatGPT in Computer Programming. Mesopotamian Journal of Computer Science, 2023, 8-16.

<https://doi.org/10.58496/MJCSC/2023/002>

Borji, A. (2023). A categorical archive of chatgpt failures. arXiv preprint arXiv:.03494. <https://doi.org/10.21203/rs.3.rs-2895792/v1>

Ismail, M. N., Ngah, N. A., & Umar, I. N. (2010). Instructional strategy in the teaching of computer programming: a need assessment analyses. The Turkish Online Journal of Educational Technology, 9(2), 125-131.

Isong, B. (2014). A Methodology for Teaching Computer Programming: first year students' perspective. International journal of modern education and computer science, 6(9), 15. <https://doi.org/10.5815/ijmecs.2014.09.03>

Koulouri, T., Lauria, S., & Macredie, R. D. (2014). Teaching introductory programming: A quantitative evaluation of different approaches. ACM Transactions on Computing Education, 14(4), 1-28. <https://doi.org/10.1145/2662412>

Lee, H. (2023). The rise of ChatGPT: Exploring its potential in medical education. Anatomical Sciences Education. <https://doi.org/10.1002/ase.2270>

Lin, Y., & Weintrop, D. (2021). The landscape of Block-based programming: Characteristics of block-based environments and how they support the transition to text-based programming. Journal of Computer Languages, 67, 101075. <https://doi.org/10.1016/j.cola.2021.101075>

Lister, R., Adams, E. S., Fitzgerald, S., Fone, W., Hamer, J., Lindholm, M., . . . Seppälä, O. (2004). A multi-national study of reading and tracing skills in novice programmers. ACM SIGCSE Bulletin, 36(4), 119-150. [https://doi.org/10.1145/1041624.1041673](https://doi.org/10.1145/1041624.1041673%20)

Lo, C. K. (2023). What is the impact of ChatGPT on education? A rapid review of the literature. Education Sciences, 13(4), 410. [https://doi.org/10.3390/educsci13040410](https://doi.org/10.3390/educsci13040410%20)

Martins, V. F., de Almeida Souza Concilio, I., & de Paiva Guimarães, M. (2018). Problem based learning associated to the development of games for programming teaching. Computer Applications in Engineering Education, 26(5), 1577-1589. [https://doi.org/10.1002/cae.21968](https://doi.org/10.1002/cae.21968%20)

McCracken, M., Almstrum, V., Diaz, D., Guzdial, M., Hagan, D., Kolikant, Y. B.-D., . . . Wilusz, T. (2001). A multi-national, multi-institutional study of assessment of programming skills of first-year CS students. In Working group reports from ITiCSE on Innovation and technology in computer science education (pp. 125-180). [https://doi.org/10.1145/572133.572137](https://doi.org/10.1145/572133.572137%20%20)

Medeiros, R. P., Ramalho, G. L., & Falcão, T. P. (2018). A systematic literature review on teaching and learning introductory programming in higher education. IEEE Transactions on Education, 62(2), 77-90. [https://doi.org/10.1109/TE.2018.2864133](https://doi.org/10.1109/TE.2018.2864133%20)

Rahman, M. M., & Watanobe, Y. (2023). ChatGPT for education and research: Opportunities, threats, and strategies. Applied Sciences, 13(9), 5783. [https://doi.org/10.3390/app13095783](https://doi.org/10.3390/app13095783%20)

Ray, P. P. (2023). ChatGPT: A comprehensive review on background, applications, key challenges, bias, ethics, limitations and future scope. Internet of Things and Cyber-Physical Systems. [https://doi.org/10.1016/j.iotcps.2023.04.003](https://doi.org/10.1016/j.iotcps.2023.04.003%20)

Saito, D., & Yamaura, T. (2013). A new approach to programming language education for beginners with top-down learning. Paper presented at the Proceedings of 2013 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE). [https://doi.org/10.1109/TALE.2013.6654538](https://doi.org/10.1109/TALE.2013.6654538%20)

Saito, D., & Yamaura, T. (2014). Applying the top-down approach to beginners in programming language education. Paper presented at the 2014 International Conference on Interactive Collaborative Learning (ICL). <https://doi.org/10.1109/ICL.2014.7017791>

Seng, W. Y., & Yatim, M. H. M. (2014). Computer game as learning and teaching tool for object oriented programming in higher education institution. Procedia-Social and Behavioral Sciences, 123, 215-224. <https://doi.org/10.1016/j.sbspro.2014.01.1417>

Shidiq, M. (2023). The use of artificial intelligence-based chat-gpt and its challenges for the world of education; from the viewpoint of the development of creative writing skills. Paper presented at the Proceeding of International Conference on Education, Society and Humanity. <https://ejournal.unuja.ac.id/index.php/icesh/article/view/5614>

Subagja, A. D., Ausat, A. M. A., Sari, A. R., Wanof, M. I., & Suherlan, S. (2023). Improving Customer Service Quality in MSMEs through the Use of ChatGPT. Jurnal Minfo Polgan, 12(2), 380-386. <https://doi.org/10.33395/jmp.v12i1.12407>

Sullivan, G. M., & Artino Jr, A. R. (2013). Analyzing and interpreting data from Likert-type scales. Journal of graduate medical education, 5(4), 541-542. <https://doi.org/10.4300/JGME-5-4-18>

Surameery, N. M. S., & Shakor, M. Y. (2023). Use chat gpt to solve programming bugs. International Journal of Information Technology & Computer Engineering, 3(01), 17-22. <https://doi.org/10.55529/ijitc.31.17.22>

Tenenberg, J., & Fincher, S. (2005). Students designing software: a multi-national, multi-institutional study. Informatics in Education, 4(1), 143-162. <https://doi.org/10.15388/infedu.2005.09>

Tian, H., Lu, W., Li, T. O., Tang, X., Cheung, S.-C., Klein, J., & Bissyandé, T. F. (2023). Is ChatGPT the Ultimate Programming Assistant--How far is it? arXiv preprint arXiv:.11938. <https://doi.org/10.48550/arXiv.2304.11938>

Wach, K., Duong, C. D., Ejdys, J., Kazlauskaitė, R., Korzynski, P., Mazurek, G., . . . Ziemba, E. (2023). The dark side of generative artificial intelligence: A critical analysis of controversies and risks of ChatGPT. Entrepreneurial Business and Economics Review, 11(2), 7-24. <https://doi.org/10.15678/EBER.2023.110201>

Whalley, J., & Kasto, N. (2014). A qualitative think-aloud study of novice programmers' code writing strategies. Paper presented at the Proceedings of the 2014 conference on Innovation & technology in computer science education. <https://doi.org/10.1145/2591708.2591762>

Wu, H., & Leung, S.-O. (2017). Can Likert scales be treated as interval scales?-A Simulation study. Journal of social service research, 43(4), 527-532. <https://doi.org/10.1080/01488376.2017.1329775>

Yilmaz, R., & Yilmaz, F. G. K. (2023). The effect of generative artificial intelligence (AI)-based tool use on students' computational thinking skills, programming self-efficacy and motivation. Computers and Education: Artificial Intelligence, 4, 100147. <https://doi.org/10.1016/j.caeai.2023.100147>

Yılmaz, R., & Yılmaz, F. G. K. (2022). Investigation of students' self-regulation skills, motivation and disorientation in smart mooc. <http://hdl.handle.net/11772/6932>