The Good, the Bad and the Ugly of Usage of AI Tools in Programming Education (Short Paper)

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הטוב, הרע והמכוער של שימוש בכלים של בינה מלאכותית בחינוך לתכנות (מאמר קצר)

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Abstract

This study explores the intricate dynamics of integrating Artificial Intelligence (AI) and AI code tools in Programming education. Delving into the dual nature of these tools, it addresses questions surrounding their positive and negative aspects. This study aims to comprehensively understand the dynamics and patterns of AI tools usage in an Introduction to Programming course, analyzing data from students' reports and surveys over a 12-week period. The study involved 73 teams from the Faculty of Engineering at Ruppin Academic Center, providing valuable information on the multifaceted aspects of AI tool integration in programming education. Throughout the course, the familiarity with AI tools among teams increased from an initial 27% to 100%. Towards the end of the course, 95% of teams used AI tools, with a growing percentage reporting constant usage as assignments became more complex. The analysis identified that using English as a query language in AI tools yielded better results than other languages. The uncovered data revealed positive aspects that included AI assisting participants in learning, enhancing real-world relevance, and developing essential literacies. Challenges, such as cheating and over-reliance leading to automation, were observed, along with concerns about misuse, limited understanding of core principles in the 'ugly' perspective.

Keywords: Artificial Intelligence (AI), AI in education, introduction to programming, AI coding tools.

מילות מפתח: בינה מלאכותית, בינה מלאכותית בחינוך, מבוא לתכנות, כלים בבינה מלאכותית ליצירת הקוד.

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Introduction

The use of Artificial Intelligence (AI) and AI code tools in Programming education reveals the dual nature of these tools, rises interesting questions related to both positive and negative aspects of this usage and the potential risks and rewards of these tools (Cotton, Cotton, & Shipway, 2023; Tlili, et al., 2023). AI in Education is one of the currently emerging fields in educational technology and it is still unclear for educators how to make pedagogical advantage of it on a broader scale, and how it can impact meaningfully on teaching and learning in higher education (Zawacki-Richter, et al., 2019). The role of educators, especially in higher education, is to prepare and train future professionals by equipping them with a comprehensive skill set that encompasses both traditional and cutting-edge technologies, fostering critical thinking, ethical decision-making, and adaptability to meet the evolving demands of the workforce.

Teaching students how to use AI tools aligns with the current and future needs of high-tech industry and enhances their readiness for the workplace. Additionally, training students to leverage AI tools can improve their efficiency and productivity. These tools can automate routine tasks, allowing programmers to focus on more complex and creative aspects of software development. While incorporating AI tools, it's crucial to strike a balance by ensuring that students also engage in manual coding. This helps preserve a deep understanding of programming fundamentals and principles and encourages creative thinking. Excessive reliance on AI tools may lead to students relying on automated solutions without fully understanding the underlying concepts, which can hinder critical thinking and problem-solving skills.

If not properly used AI coding tools and chatbots may prioritize surface-level knowledge and fail to instill a deep understanding of fundamental programming principles. Therefore, finding the right balance between AI tools and manual programming is the main focus of the current study.

Methodology

The primary objective of this study is to understand the dynamics of AI tools usage, discover patterns of AI usage and explore students' sentiments about them. In this paper we analyse data from students' reports and surveys about usage of AI code tools and chatbots during Introduction to Programming course. This course spans a duration of 12 weeks and adopts an instructional paradigm comprising 2-hour lectures and 4-hour laboratory sessions per week. During specific assignments, students were tasked with using AI tools to generate or explain portions of code, as well as to explore or learn about specific modules, concepts, or functions. Furthermore, in some tasks students were asked to correct the code generated by AI tool.

Additionally, on a weekly basis, students worked on home assignments. A 5-point bonus question related to the usage of AI tools and students' feelings about them was added to some of the assignments. The response rate for this question was 98.5%. A total of 73 teams, each comprising two students from the Faculty of Engineering at Ruppin Academic Center, participated in this study.

The bonus question comprised several parts, ranging from basic familiarity with AI tools to describing some of the benefits of using AI tools in your studies. It also delved into feelings about AI usage, including feeling comfortable with the usage of AI tools, concerns about having enough time to complete assignments without AI assistance. Furthermore, the question extended to a detailed report on the usage of AI tools during the assignment, evaluating the quality of the responses, and assessing the usefulness of the AI tool answers.

Results

The analysis of survey responses indicated that, initially, only 27% of the teams reported feeling familiar with the usage of AI tools. However, by the end of the course, this familiarity had increased to 100%, which can easily be explained by students' engagement in tasks that required AI usage.

Towards the end of the course 95% of the teams used AI tools in their assignments, even if they were not explicitly asked to do so. Towards the end of the course, as assignments become longer and more complicated, increased percentage of students reported constant usage of AI tools.

The content analysis of surveys revealed that usage of English as a query language yielded better results than Hebrew or other languages. Further analysis of chat transcripts with AI assistants through screenshots highlighted the effectiveness of breaking down large tasks into smaller subtasks and gradually increasing complexity in the code generated by AI tools.

The data uncovered about AI usage during assignments revealed several main categories, including information seeking, bugs identification and correction, code comparisons, and the creation of comments and supplementary documents.

We conducted an analysis of surveys and reports, examining them from a 'good, bad, and ugly' perspective. The positive aspects can be summarized as follows: AI assisted participants in learning by aiding in information seeking, bug identification, and writing comments. Participants perceived that the usage of AI tools added real-world relevance to the course and developed essential literacies and skills for understanding the technology and preparing them for the future.

On the negative (the bad) side, challenges emerged, including instances of cheating, relying on AI tools to generate entire solutions under time constraints or when facing difficulties in understanding certain learning units. Due to the efficiency and productivity of AI tools, there was an observed automation of particular programming tasks, such as generation of comments (92% of the teams completely transferred this task to AI tool). Additionally, there were occasional issues with the quality of produced code, and instances of unsuccessful bug identification and error fixing.

The 'ugly' part revealed concerns such as excessive reliance on AI tools, the potential for misuse, the ease of accessibility and inclusivity of these tools. It also uncovered that excessive usage of code generation tools leads to limited understanding of core programming principles and concepts. There were also vulnerabilities to technical issues, and algorithmic errors, due to bad translation of the task or incorrect query. Moreover, it was observed that for numerous tasks, AI tools proposed solutions using functions, classes, or libraries not covered within the course curriculum.

Conclusion

We believe that despite many difficulties and challenges, integration of AI coding tools in programming courses will bring benefits to most of the students and increase the number of participants. Discovering patterns in AI tool usage of novel programmers can enhance students learning. Identifying trends can help in tailoring future educational strategies and interventions based on observed patterns of engagement.

In our forward-looking approach to programming education, we recognize the need to equip students with AI skills for their future careers. By striking a balance, addressing ethical considerations, and promoting adaptability, educators can play a vital role in preparing a workforce that is well-equipped to navigate the challenges and opportunities presented by AI in the programming domain.

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Appendix A

The bonus question structure:

1. I feel familiar with AI tools usage (Likert's Scale from 1 to 5) (beginning of the course and of the course)
2. I feel comfortable with usage of AI tools in this assignment (Likert's Scale from 1 to 5)
3. I used AI tools during this assignment even without being asked to use it (yes/no)
4. Query language: I used only English, only Hebrew, both English and Hebrew, other language
5. I was happy with the results provided by AI tools (Likert's Scale from 1 to 5)
6. I am concerned that I may not have enough time to complete the assignment without the help of AI tools (Likert's Scale from 1 to 5)
7. I used AI tools during this assignment for the following tasks _____ (please provide at least 2 screenshots of the question/task and produced answer)
8. Describe the benefits of AI tools in your studies, personally.