Analysis of Programming Students' Prompts to Identify Interactions Patterns with Generative AI

Rodrigo Prestes Machado[1][a], Carlos Alario Hoyos[2][b] and Carlos Delgado Kloos[2][c]
[1]*Department of Informatics, Federal Institute of Education, Science and Technology, Porto Alegre, Brazil*
[2]*Department Telematics Engineering, Carlos III University, Madrid, Spain*
rodrigo.prestes@poa.ifrs.edu.br, {calario,cdk}@it.uc3m.es

Keywords: Generative Artificial Intelligence, Programming Education, Chatbots

Abstract: The abstract should summarize the contents of the paper and should contain at least 70 and at most 200 words. The text must be set to 9-point font size.

1 INTRODUCTION

Recent advancements in Generative Artificial Intelligence (GenAI) have opened up new possibilities in education. In programming courses, students can utilize GenAI tools to improve their understanding, receiving assistance, feedback, and detailed explanations.

The study of Chan and Hu (2023) revealed that both undergraduate and postgraduate students exhibit positive attitudes toward the use of GenAI in teaching and learning, noting that it enhances the depth of their thinking and understanding. Additionally, a systematic review conducted by Lo et al. (2024) demonstrated that students could effectively learn from ChatGPT, leading to improved understanding and academic achievement. Besides of that, it was also observed that ChatGPT enables students to regulate their learning pace, promoting self-regulation (Ait Baha et al., 2023) (Cai et al., 2023).

In the other hand, researchers have concerns about the impact of these tools on students. The systematic review of Vargas-Murillo et al. (2023) indicated that ChatGPT use might lead to an overreliance on the tool. Chan and Hu (2023) also noted that this reliance could result in a decrease in critical thinking, as students might make decisions based solely on the information provided by ChatGPT.

The student's confidence is warranted, as shown by Puryear and Sprint (2022), who demonstrated that GitHub Copilot can generate solutions for student assignments with accuracy rates ranging from 68% to 95%. However, this raises concerns that students might rely too heavily on GenAI tools, potentially neglecting a deeper understanding of the underlying concepts. Cai et al. (2023) further identified overdependence and reduced intellectual engagement as significant drawbacks of using ChatGPT in learning.

Regardless of teachers' preferences or beliefs, preliminary surveys performed by Dickey et al. (2024) revealed that at least 54.5% of students are already using GenAI for homework. This highlights the need to understand how students are interacting with these tools and how they can be used to enhance learning. Furthermore, a review by Lo et al. (2024) emphasized the necessity for extended studies and objective measures to gather more robust evidence on the use of GenAI tools in education.

To deal with this issue, some researchers have proposed different pedagogical strategies Denny et al. (2024) introduced the concept of *Prompt Problems*, where students solve programming exercises by formulating natural language prompts. Prasad and Sane (2024) proposed a self-regulated learning framework using GenAI to solve programming problems. Lauren and Watta (2023) explored the integration of GenAI with evidence-based learning strategies in computer science and engineering courses.

The study of effective educational strategies in use of GenAI tools in education context are important for determining the best training for educators. However, as these tools gain popularity among students Dickey et al. (2024) the urgency to equip educators with best practices may lag behind their rapid adoption. Therefore, analyzing students' interaction pat-

[a] https://orcid.org/0000-0003-0428-6387
[b] https://orcid.org/0000-0002-3082-0814
[c] https://orcid.org/0000-0003-4093-3705

terns with GenAI tools is important for understanding how these tools are being used and how educators can leverage them to enhance learning. In addition, these interaction patterns can create new opportunities to redesign GenAI tools to better support pedagogical strategies without repressing the development of abstract, critical and creative thinking.

Nevertheless, it is important to consider how GenAI tools affect students across different demographic groups, knowledge areas, cultural backgrounds Catalán et al. (2021) Neo (2022) and students' prior experience. Thus, this works is limited to a specific group of students and a specific GenAI tool. The results may not be generalizable to other populations or tools.

This study aims to analyze the interactions between students and CharlieBot, an ChatGPT 3.5 based bot developed by UC3M that leverages Retrieval-Augmented Generation (RAG) to enhance its contextual understanding of Java programming.

2 RELATED WORK

The advancements in GenAI and its use in programming courses have raised possibilities and concerns among educators and researchers. The study of Yilmaz and Karaoglan Yilmaz (2023) found that the main benefit of using ChatGPT in programming learning is to provide providing fast and mostly correct answers to questions, improving thinking skills, facilitating debugging, and increasing self-confidence. In contrast, the study the same appoint limitations such ask laziness, being unable to answer some questions, or giving incomplete/incorrect answers, causing professional anxiety in students.

From a cognitive perspective, Lo et al. (2024) shown that students were able to learn from ChatGPT, which increased their understanding and achievement. However, concerns were raised that the growing use of AI tools might lead to a decline in critical thinking among students. Teachers and stakeholders should continue to investigate pedagogical approaches that leverage ChatGPT to enhance students' understanding and critical thinking. For example, teachers can instruct students to fact-check and validate information produced by ChatGPT.

Examined students from different demographic groups using AI tools like ChatGPT, comparing perceptions and impacts among these groups. The results showed that AI tools had a positive impact on academic performance, especially for students with less prior experience.

2.1 Critical Thinking

Critical thinking is a fundamental skill for students to develop, as it enables them to analyze, evaluate, and synthesize information. This skill is essential for problem-solving and decision-making, making it a crucial aspect of educational success, specifically in programming courses. However, the use of AI tools like ChatGPT has raised concerns about the potential impact on students' critical thinking abilities Vargas-Murillo et al. (2023) Cai et al. (2023) Chan and Hu (2023).

In the other hand, the study of Zhang and Tur (2024) suggested that incorporating ChatGPT could stimulate students' critical thinking, probably because they had to assess the correctness of ChatGPT's answers.

Regarding self-regulation, Cai et al. (2023) noted that ChatGPT allowed students to regulate their learning pace.

Wu et al. (2024) found that ChatGPT-supported learning not only promoted students' self-regulation but also increased their self-efficacy.

2.2 CharlieBot

CharlieBot is a ChatGPT 3.5 based bot that provides assistance to students in a Java programming courses at UC3M. The bot uses the content of UC3M Java programming course at EdX to supply a RAG(Retrieval-Augmented Generation) system and thus try to respond more accurately to students' questions Chen et al. (2024). The main goal of CharlieBot is support students in their learning process by providing personalized assistance and feedback.

3 METHOD

The study was conducted in two phases: categorization and analysis. The categorization phase involved classifying student messages into eight categories. The table 1 shows the categories of analysis and their description. The initial categories were based on the work of Ghimire and Edwards (2024), however, four new categories were added due to the need to give more detail to the classification. Beside of that, the categories were grouped to understand the impact on critical thinking.

The analysis phase involved to understand the way that the students interact with CharlieBot. The students messages were collected from the logs of the bot and categorized manually by the authors. A total of YYY messages, of the first semester of 2024, were

analyzed. The participants were students of the YYY semester of the Computer Science at UC3M where Java programming is taught.

4 Results and Discussion

The Figure 1 shows the distribution of the messages in the categories:

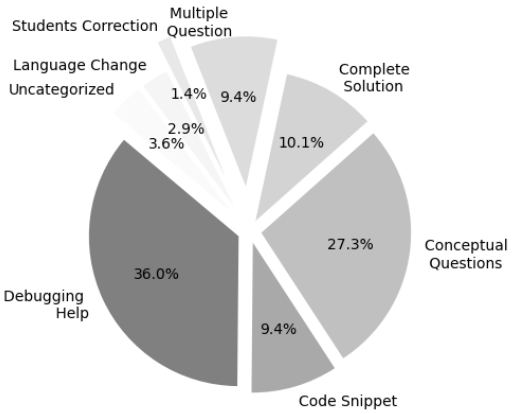

Figure 1: Classification of messages.

Approximately 64% of the messages pertain to categories associated with critical thinking, corroborating with the findings of Ghimire and Edwards (2024). In contrast, around 28% of the messages indicate a preference among students for ready-made answers.

5 Conclusion

The results of this study suggest that students interact with CharlieBot in a manner that promotes critical thinking. The majority of the messages analyzed were related to debugging help, conceptual questions, and student correction, indicating that students are actively engaging with the bot to understand concepts and solve problems. This is a positive outcome, as it suggests that CharlieBot is being used as a tool to enhance learning rather than a crutch for students to rely on.

ACKNOWLEDGEMENTS

The authors would like to thank the Federal Institute of Education, Science and Technology (IFRS) for the partial financial support provided for the execution of this research.

REFERENCES

Ait Baha, T., El Hajji, M., Es-Saady, Y., and Fadili, H. (2023). The impact of educational chatbot on student learning experience. *Education and Information Technologies*, 29(8):10153–10176.

Cai, Q., Lin, Y., and Yu, Z. (2023). Factors influencing learner attitudes towards chatgpt-assisted language learning in higher education. *International Journal of Human–Computer Interaction*, pages 1–15.

Catalán, A. C., González-Castro, N., Delgado, K. C., Alario-Hoyos, C., and Muñoz-Merino, P. J. (2021). Conversational agent for supporting learners on a mooc on programming with java. *Computer Science and Information Systems*, 18(4):1271–1286.

Chan, C. K. Y. and Hu, W. (2023). Students' voices on generative ai: Perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education*, 20(1):43.

Chen, J., Lin, H., Han, X., and Sun, L. (2024). Benchmarking large language models in retrieval-augmented generation. *Proceedings of the AAAI Conference on Artificial Intelligence*, 38(16):17754–17762.

Denny, P., Leinonen, J., Prather, J., Luxton-Reilly, A., Amarouche, T., Becker, B. A., and Reeves, B. N. (2024). Prompt problems: A new programming exercise for the generative ai era. In *Proceedings of the 55th ACM Technical Symposium on Computer Science Education V. 1*, SIGCSE 2024, page 296–302, New York, NY, USA. Association for Computing Machinery.

Dickey, E., Bejarano, A., and Garg, C. (2024). Ai-lab: A framework for introducing generative artificial intelligence tools in computer programming courses. *SN Comput. Sci.*, 5(6).

Ghimire, A. and Edwards, J. (2024). Coding with ai: How are tools like chatgpt being used by students in foundational programming courses. In Olney, A. M., Chounta, I.-A., Liu, Z., Santos, O. C., and Bittencourt, I. I., editors, *Artificial Intelligence in Education*, pages 259–267, Cham. Springer Nature Switzerland.

Lauren, P. and Watta, P. (2023). Work-in-progress: Integrating generative ai with evidence-based learning strategies in computer science and engineering education. In *2023 IEEE Frontiers in Education Conference (FIE)*, pages 1–5, Los Alamitos, CA, USA. IEEE Computer Society.

Lo, C. K., Hew, K. F., and yung Jong, M. S. (2024). The influence of chatgpt on student engagement: A systematic review and future research agenda. *Computers and Education*, 219:105100.

Neo, M. (2022). The merlin project: Malaysian students'acceptance of an ai chatbot in their learning process. *Turkish Online Journal of Distance Education*, 23(3):31–48.

Table 1: Categories of Analysis

Category	Description	Critical Thinking
Debugging Help	Prompts that seek help to identify, fix errors, or understand the provided code snippet.	Tends to promote.
Conceptual Questions	Prompts that are more about understanding concepts or algorithms rather than specific code.	
Student Correction	Prompts where the student corrects the bot.	
Code Snippet	Prompts that ask for a specific part of the code, like a function or a segment.	Tends not to promote.
Complete Solution	Prompts that request an entire solution or a complete code snippet.	
Multiple Question	Prompts where the user wants to solve a multiple-question exercise.	
Language Change	Prompts that request a change of idiom to convey a message more effectively.	Neutral.
Uncategorized	Prompts that do not fit into any of the above categories.	

Prasad, P. and Sane, A. (2024). A self-regulated learning framework using generative ai and its application in cs educational intervention design. In *Proceedings of the 55th ACM Technical Symposium on Computer Science Education V. 1*, SIGCSE 2024, page 1070–1076, New York, NY, USA. Association for Computing Machinery.

Puryear, B. and Sprint, G. (2022). Github copilot in the classroom: learning to code with ai assistance. *J. Comput. Sci. Coll.*, 38(1):37–47.

Vargas-Murillo, A. R., de la Asuncion Pari-Bedoya, I. N. M., and de Jesús Guevara-Soto, F. (2023). Challenges and opportunities of ai-assisted learning: A systematic literature review on the impact of chatgpt usage in higher education. *International Journal of Learning, Teaching and Educational Research*, 22(7):122–135.

Wu, T.-T., Lee, H.-Y., Li, P.-H., Huang, C.-N., and Huang, Y.-M. (2024). Promoting self-regulation progress and knowledge construction in blended learning via chatgpt-based learning aid. *Journal of Educational Computing Research*, 61(8):3–31.

Yilmaz, R. and Karaoglan Yilmaz, F. G. (2023). Augmented intelligence in programming learning: Examining student views on the use of chatgpt for programming learning. *Computers in Human Behavior: Artificial Humans*, 1(2):100005.

Zhang, P. and Tur, G. (2024). A systematic review of chatgpt use in k-12 education. *European Journal of Education*, 59(2):e12599.

APPENDIX

If any, the appendix should appear directly after the references without numbering, and not on a new page. To do so please use the following command: $\backslash section*\{APPENDIX\}$