Generative AI in Computer Science Education: A Study on Academic Performance

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ABSTRACT

This research investigates the impact of generative artificial intelligence (GenAI) on computer science students' academic performance. With a focus on coding capabilities, the study explores how GenAI tools influence student engagement, motivation, and the development of problem-solving skills. Data was collected through surveys targeting both students and teaching assistants at the University of Twente. The findings reveal a positive correlation between the use of GenAI tools and improved academic performance, particularly in understanding complex programming concepts. However, the research also highlights concerns about over-reliance on these tools and potential issues of academic integrity. This study underscores the necessity for a balanced integration of GenAI in educational frameworks to maximise benefits while mitigating risks.

Keywords: Generative AI, Computer Science Education, Academic performance, Artificial Intelligence

1 INTRODUCTION

The rapidly evolving sector of Artificial Intelligence has affected all of the layers of our society, one of the big sectors that got strongly influenced by AI is education[12]. The growing popularity of generative artificial intelligence (GenAI) among university students has led to a paradigm shift in the way knowledge is acquired and applied[5, 15]. In particular, the capability of Generative AI to write code and resolve coding tasks has revolutionised the approach of computer science students towards their assignments and projects[14]. For instance, students tend to ask GenAI to write code for them instead of trying to do it themselves.[2] This transformation is not merely confined to the realm of academia but has also extended its reach into the professional sphere, thereby altering the landscape of the software industry[3, 14]. For example, by boosting productivity in software engineering as a result of automising routine coding tasks, thus allowing professionals to focus on more complex problem-solving and innovation[11]. It is thereby crucial to investigate and find what impact the growing popularity of GenAI has on students.

The primary objective of this research was to focus on the coding capabilities of GenAI and its impact on computer science students, while deliberately excluding an examination of its other functionalities such as essay composition or image generation.

Prior to the widespread adoption of ChatGPT, students exhibited a greater tendency to seek help from teaching assistants[5]. However, the advent of GenAI has seemingly reduced the demand for human intervention. Therefore, it is of great importance to conduct an in-depth investigation to ascertain the effects of this novel approach on computer science students.

The Research Question of the study was:
"What impact does generative AI have on students' academic performance in computer science education?"

In this research context, academic performance refers to the extent to which students achieve educational goals. Typically, this is operationalised through measures such as grades or the highest level of educational attainment[9]. It's essential to consider not only intellectual capabilities but also other variables like emotional intelligence, personality traits, and the meaning of life when understanding academic performance[13]. Moreover, The impact was measured by assessing various aspects related to the growing popularity of generative AI among computer science students. All the factors were assessed through surveys, providing a comprehensive understanding of the impact of generative AI on students' academic performance. More on the methodology of the research can be found in section 3.

2 RELATED WORK

This section will highlight and go over existing research in the area of generative artificial intelligence and education.

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Generative AI has been a topic of interest in recent years, with several studies focusing on its impact on education, particularly in the context of computer science. Ghimire, Prather, and Edwards (2024) conducted a study on educators' awareness, sentiments, and influencing factors towards generative AI in education, providing insights into how educators perceive generative AI, which could be useful in understanding how these tools might be integrated into computer science education[4]. Zastudil et al. (2023) explored the perspectives of students and instructors on generative AI in computing education, helping to understand how students and instructors perceive and use generative AI tools in education[17]. Hou et al. (2024) investigated the effects of generative AI on computer science students' help-seeking preferences, providing insights into how students use generative AI tools for help-seeking[5]. Chan and Hu (2023) explored students' voices on generative AI, focusing on their perceptions, benefits, and challenges in higher education, providing insights into how students perceive and benefit from generative AI[1]. Yılmaz R. and Yılmaz F.G.K. (2023) examined the effect of generative AI-based tool use on students' computational thinking skills, programming self-efficacy, and motivation[16]. Lastly, Prather et al. (2023) navigated the generative AI revolution in computing education, discussing the challenges and opportunities these models present to computing educators[14].

While these studies provide valuable insights into the use of generative AI in education, there is a noticeable gap in the literature. Specifically, there is a lack of research investigating the direct impact of generative AI on students' academic performance in computer science education. Given the increasing integration of generative AI tools in education, it is crucial to understand how these tools affect students' academic outcomes.

3 METHODOLOGY

3.1 Research design and data collection

This research used two surveys targeting students and teaching assistants to understand GenAI's impact on academic performance.

Both surveys used Likert scale questions, allowing for the quantification of perceptions and experiences, making it easier to analyse and compare data[10]. This type of questions are particularly useful for measuring attitudes or feelings. Additionally, demographic questions were asked to ensure that the sample was representative of the population. This was important for the validity of the results and for drawing meaningful conclusions from the obtained data[6]. Demographic questions in the surveys included: age and gender of the participants, their followed study and educational level (e.g. Bachelor's, Master's, PhD) and lastly, the year of study the participants were in.

Upon receiving the responses, the data was exported from Google Forms into a CSV file format for analysis. The analysis focused on visualizing the relationships between variables described in subsection 3.3. Scatter plots were employed to graph variables against each other, providing insights into potential correlations and trends between different factors. Additionally, box plots were used to compare similar data from the two surveys, offering a clear comparison of distribution and variation within the responses. Python libraries such as 'matplotlib' and 'seaborn' were used to graph the data, providing a visual representation of the findings.

3.2 Sample descriptions

The following section will provide an overview of the participants from the two surveys included in the research.

3.2.1 Students survey

The student survey sample consisted of 17 respondents, providing a snapshot of the demographic distribution within the study. The ages of the participants ranged from 19 to 27 years old. The gender distribution included both male and female respondents, with no representation from non-binary or other gender identities. The fields of study were predominantly technical and business-related, mostly including Technical Computer Science and Business Information Technology (76.5% participants were either from Technical Computer Science or Business Information Technology). All respondents were at the Bachelor's level in their education, with varying years reported for their current studies. Notably, the sample did not include any first-year students, only second and third-year students.

The sample size of 17 respondents in this study provides valuable insights, but its limitations include lack of diversity in gender and field of study. Additionally, all respondents were at the Bachelor's level, which may limit generalisability to other educational contexts.

More on the potential limitations of the research can be found in the Discussion section of the paper.

3.2.2 Teaching assistants survey

The teaching assistant survey sample consisted of 9 respondents, mirroring the small sample size of the student survey. Similar to the student survey, all respondents were at the Bachelor's level in their education, and their current year of study was either 2 or 3. However, the teaching assistant survey presented a different demographic profile. The age of the participants ranged from 19 to 22 years old. Unlike the student survey, this sample only included 1 female respondent and did not include anyone who did not disclose their gender. All respondents were from the field of 'Business Information Technology'.

As with the student survey, the potential limitations and biases of this sample should be considered when interpreting the results. Once again, more on the potential limitations of the research can be found in the Discussion section of

the paper.

3.3 Framework

The framework has been built around multiple variables that represent concepts, which have an impact and can potentially influence the academic performance of students in computer science education, particularly in the context of Generative AI usage. The variables and their corresponding Likert-scale statements from the surveys can be found in table 1. The specific survey containing each statement is indicated in brackets within the table, "TAs" for the teaching assistants survey and "Students" for the students survey respectively.

Table 1: Variables and corresponding survey statements

Variable	**Likert-scale statement(s)**
Ease of use	*"I find generative AI tools easy to use."* (Students)
Confidence	*"I feel more confident in my abilities when I use generative AI tools."* (Students) *"Students seem more confident in their abilities since they started using generative AI tools."* (TAs)
Engagement	*"I am more engaged in my studies when I use generative AI tools."* (Students) *"I have noticed an increase in student engagement since the introduction of generative AI tools."* (TAs)
Grade improvements	*"I believe my grades have improved because of generative AI."* (Students) *"I have noticed an improvement in students' grades since the introduction of generative AI tools."* (TAs)
Learning	*"The generative AI tools help me understand complex programming concepts better."* (Students) *"Students seem to understand complex concepts better when they use generative AI."* (TAs)
Dependence	*"I rely on generative AI tools to complete my assignments."* (Students) *"I have noticed a decrease in students' dependence on teaching assistants after the emergence of generative AI."* (TAs)
Concerns	*"I am worried about plagiarism of my work more when I use generative AI tools."* (Students)
Help-seeking comfort	*"I feel more comfortable to seek help from generative AI than from a peer, teaching assistant/mentor or professor."* (Students)
Application	*"Generative AI tools help students apply their knowledge more effectively."* (TAs)
Grading efficiency	*"Generative AI tools have made grading assignments more efficient."* (TAs)

This study delved further into the relationships between these variables. Certain variables were combined and graphed against each other to better understand their interplay and impact on students' academic performance.

The Findings section shows the graphed variables and obtained insights.

4 FINDINGS

This section is divided into two subsections. The first subsection presents graphs that depict the correlations between variables from the same survey, providing insights into how these variables interact and influence each other. The second subsection provides a comprehensive comparison of variables across the two different surveys, specifically analysing and comparing the perceptions of students and teaching assistants.

4.1 Variable analysis of separate surveys

4.1.1 Students survey variables

In the context of the student survey, the first relationship examined relates to the correlation between engagement and grade improvements. Specifically, the association between the statements, "I am more engaged in my studies when I use generative AI tools" and "I believe my grades have improved because of generative AI."

Students who feel more engaged in their study with GenAI tools may gain a deeper understanding of the material, solve problems more efficiently, and see improvements in their grades[1]. Conversely, lack of engagement could limit these benefits. Therefore, studying the correlation between students' engagement with generative AI tools and their perceptions on grade improvement can provide insights into the impact of these tools on their education[7].

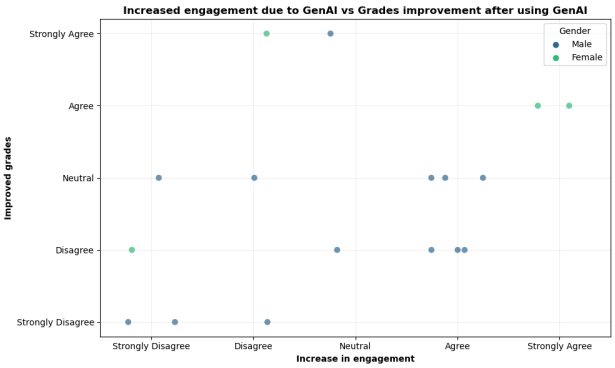

Figure 1: Engagement and grade improvements variables

The scatter plot in figure 1 shows a varied relationship between increased engagement due to generative AI and perceived improvement in grades among student participants. It can be seen that male students of the sample are more evenly distributed across different levels of agreement and perceived grade improvement, suggesting mixed experiences with GenAI. There is a notable cluster of male

students who agree that they are more engaged but feel neutral about their grade improvement. In contrast, female students mostly either strongly agree or agree that their grades have improved and 50% of the female respondents strongly agree that their engagement has increased. This indicates a generally positive perception among female students who participated in the survey regarding the impact of GenAI on both engagement and grades. Overall, while the data indicates a trend towards positive impact, the responses also reveal a diversity of experiences, highlighting the nuanced effects of GenAI in education.

The next variables analysed include learning and dependence, which are represented by the statements "The generative AI tools help me understand complex programming concepts better." and "I rely on generative AI tools to complete my assignments."

Generative AI tools can potentially aid students in understanding complex programming concepts, leading to increased reliance on these tools for assignments and problem-solving. Proper use of these tools can enhance understanding, efficiency, and academic performance by providing instant feedback, personalized learning pace, and exposure to diverse coding styles[8]. However, over-reliance without understanding the underlying concepts could hinder the development of independent problem-solving skills, crucial in computer science education[17]. By examining the relationship of the variables it can be seen whether students who believe that GenAI helps them understand complex concepts also rely on GenAI to complete their assignments.

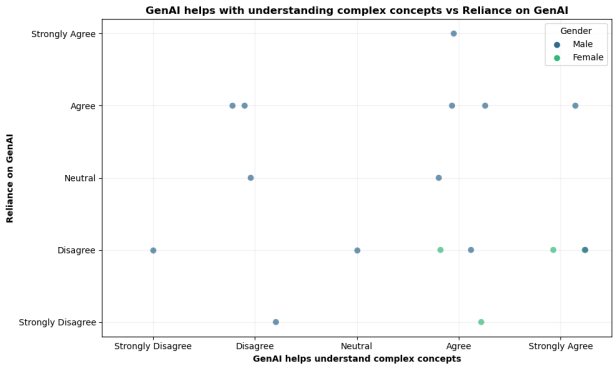

Figure 2: Learning and dependence variables

By looking at figure 2, it can be seen that the relationship between students' reliance on generative AI tools for completing assignments and their perception of these tools' effectiveness in understanding complex programming concepts is diverse too. Both male and female students show various opinions across the spectrum from "Strongly Disagree" to "Strongly Agree" on both axes. However, there seems to be a concentration of students, who agree that generative AI tools help in understanding complex concepts and also rely on these tools for completing assignments. This indicates that students who find generative AI tools helpful in grasping difficult programming concepts are also more likely to depend on these tools for their coursework. The scatter plot reveals another interesting finding. Most students believe that GenAI helps them understand complex concepts better. This is evident from the larger concentration of points on the right side of the graph, this may depict the positive impact that generative AI can have on students. The gender distribution, however, does not show a significant difference in responses, suggesting similar perceptions across genders.

Following the previous theme of reliance on generative AI, the next relationship analysis includes variables dependence and concerns. The correlating statements are "I rely on generative AI tools to complete my assignments." and "I am worried about plagiarism of my work more when I use generative AI tools."

The correlation between students' fear of plagiarism when using generative AI tools and their reliance on these tools for assignments reflects the perceived risk and dependence on these tools. If students use these tools responsibly, viewing the generated code as a guide rather than the final solution, they can reap the benefits of improved efficiency, potentially leading to better grades[1]. However, the fear of plagiarism can lead to stress and anxiety, which could negatively impact their academic performance. Furthermore, if this fear culminates in actual cases of plagiarism, it could have serious repercussions on their learning experience and academic career.

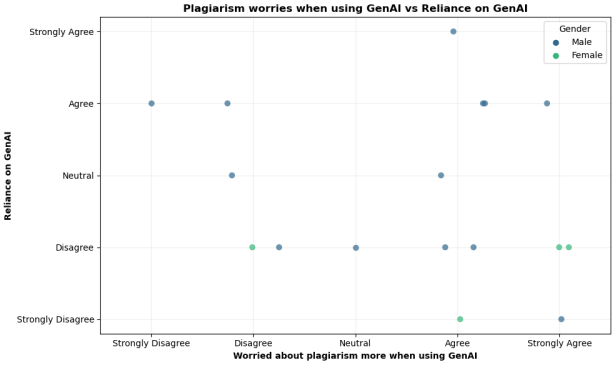

Figure 3: Dependence and concerns variables

Students' reliance on GenAI tools varies significantly across different levels of concern about plagiarism. In figure 3, it can be seen that students generally exhibit a wide range of reliance on GenAI irrespective of their plagiarism worries. Interestingly, those who agree (or strongly agree) with the concern about plagiarism appear to rely on GenAI tools at varying degrees, suggesting no direct correlation between high plagiarism concern and reduced reliance on GenAI. This indicates that while some students worry about plagiarism, it does not necessarily deter them from using GenAI tools extensively.

The final relationship of the two variables of the student survey part includes help-seeking comfort and engagement. The statements are "I feel more comfortable to seek help from generative AI than from a peer, teaching assis-

tant/mentor or professor." and "I am more engaged in my studies when I use generative AI tools."

If students are more engaged in their studies when using generative AI tools, it suggests that these tools are effectively stimulating their interest and involvement in learning[17]. On the other hand, if students feel more comfortable seeking help from generative AI tools than from humans, it indicates a preference for the anonymity, non-judgmental nature, and possibly the instant feedback these tools provide[5]. The connection between these two variables lies in the enhanced learning experience that generative AI tools can provide. If a student is more engaged with their studies when using these tools and feels comfortable seeking help from them, it creates a positive learning environment that encourages continuous independent learning and exploration.

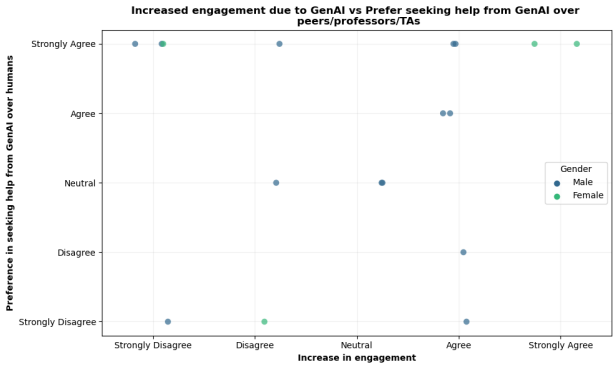

Figure 4: Help-seeking comfort and engagement variables

Figure 4 shows the relationship drawn in a scatter plot. The data points are scattered across the graph, indicating varied opinions among the students. However, it is worth mentioning that many students from the sample would prefer to seek help from generative AI, rather than from human educators or peers, this can be observed from the large number of points at "Strongly agree" tick of the y-axis. Such a result may indeed prove that the immediate feedback, anonymity and non-judgmental nature of the technology are crucial benefits of GenAI tools when compared to human assistants. Additionally, a big cluster of points can be seen in the top-right corner of the plot, which suggests that a major amount of participants agree or strongly agree with both statements. This may indicate the positive impact that GenAI can bring to the learning experience of students.

4.1.2 Teaching assistants survey variables

Moving on to the teaching assistants survey, the first variables that were analysed are dependence and confidence. Moreover, the statements that correspond to those variables are "I have noticed a decrease in students' dependence on teaching assistants after the emergence of generative AI" and "Students seem more confident in their abilities since they started using generative AI tools."

By plotting those variables against each other it will be possible to identify whether the decreased dependence of students on teaching assistants due to GenAI correlates with a growth of confidence in students' abilities. The independence from human educators' support may indeed lead to a greater confidence of students in their abilities, since they can solve complex problems on their own by asking GenAI for assistance, instead of seeking help from the teaching assistants[1].

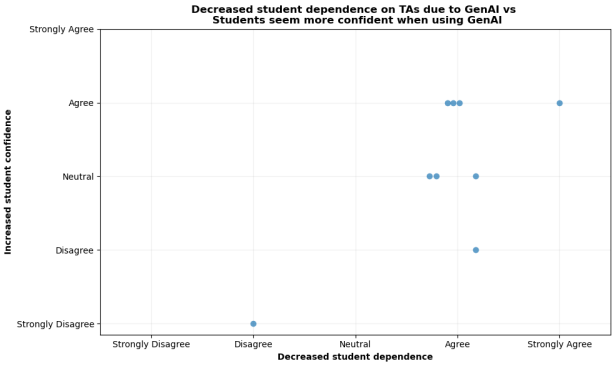

Figure 5: Dependence and confidence variables

The first scatter plot of the teaching assistants survey analysis is shown in figure 5. The positive correlation between decreased dependence on teaching assistants due to GenAI and an increase in student confidence can be noticed from the plot. Almost all of the points are on the right side of the graph, which suggests that the teaching assistants, who participated in the survey indeed noticed a decrease in students' dependence on their help. Moreover, a major part of the points are located in the top-right corner, this indicates that participants who have noticed a decrease in students' dependence have also noticed an increase in student confidence in their abilities due to GenAI. Hence, it can be concluded from the plot, that as students become less dependent on teaching assistants, their confidence in their own abilities increases. This suggests that GenAI is not only reducing the workload of teaching assistants but also fostering a more self-reliant and confident learning environment for students and thus may positively influence their academic performance.

The statements "Students seem to understand complex concepts better when they use generative AI" and "Generative AI tools help students apply their knowledge more effectively" correspond to the learning and application variables. If there is a positive correlation between these two variables, it suggests that students who understand complex concepts better when they use GenAI also apply their knowledge more effectively.

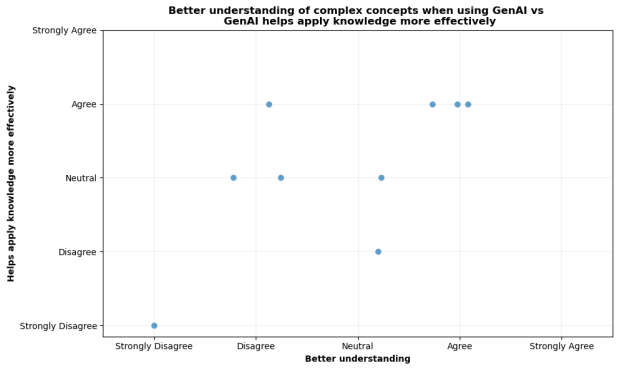

Figure 6: Learning and application variables

As can be seen from figure 6, 33% of the respondents have agreed on both statements, and there is a point that strongly disagreed with both statements, as well as a point that responded neutrally to both statements. This suggests, there might be a positive correlation between the variables. Nevertheless, it is difficult to call this correlation strong, since there are not enough data points. Despite the limited data, teaching assistants' responses and perceptions of those statements prove the potential of generative AI tools to have a positive impact on students in computer science education.

The final teaching assistants variable analysis includes such variables as grading efficiency and grade improvements. The statements are "Generative AI tools have made grading assignments more efficient" and "I have noticed an improvement in students' grades since the introduction of generative AI tools." If a positive correlation exists, it suggests that as GenAI tools enhance grading efficiency, students' grades also improve. This improvement could be due to quicker and more detailed feedback from teaching assistants using GenAI tools, enabling students to learn from their mistakes and enhance their performance by getting timely feedback from teaching assistants.

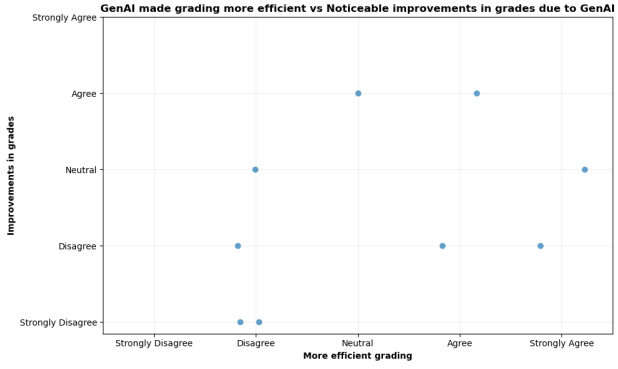

Figure 7: Grading efficiency and grade improvements variables

The plot in figure 7 reveals a varied distribution of responses. In the figure, it can be seen that there are responses spread across different levels of agreement and disagreement for both statements. Some teaching assistants strongly agree that generative AI has made grading more efficient and have noticed improvements in grades, while others disagree or remain neutral on both counts. This spread indicates a mixed perception among teaching assistants, with no strong consensus on the effectiveness of generative AI tools in enhancing grading efficiency and improving grades. Overall, the data suggests that while some teaching assistants perceive benefits, opinions are divided, reflecting the complexity of GenAI's impact.

4.2 Students vs Teaching assistants perceptions

This subsection of the findings, unlike the previous subsection, will compare matched statements from students and teaching assistants surveys to identify similarities and differences in their perception of generative AI and its impact on students.

The first overarching theme from both surveys is "Confidence". The students survey statement is: "I feel more confident in my abilities when I use generative AI tools." While the teaching assistants survey statement is: "Students seem more confident in their abilities since they started using generative AI tools."

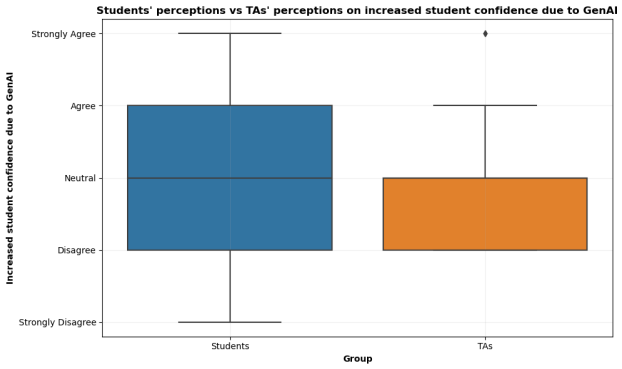

Figure 8: Confidence variable in both surveys

From the box plot in figure 8, it is noticeable that both students and teaching assistants (TAs) have a median response in the "Neutral" category, suggesting that the median perception for both groups is neutral regarding whether GenAI increases student confidence. However, the distribution of responses indicates that students have a wider range of perceptions compared to TAs. The interquartile range (IQR) for students spans from "Disagree" to "Agree," while for TAs, it is narrower, spanning from "Disagree" to "Neutral." This suggests that students' opinions on GenAI's impact on their confidence are more varied, and on average, students might feel slightly more confident due to GenAI compared to what TAs perceive or notice.

The next variable which is associated with statements from both surveys is "Grade improvements". The statements are "I believe my grades have improved because of generative AI tools" (Students) and "I have noticed an improvement in students' grades since the introduction of generative AI

tools" (TAs).

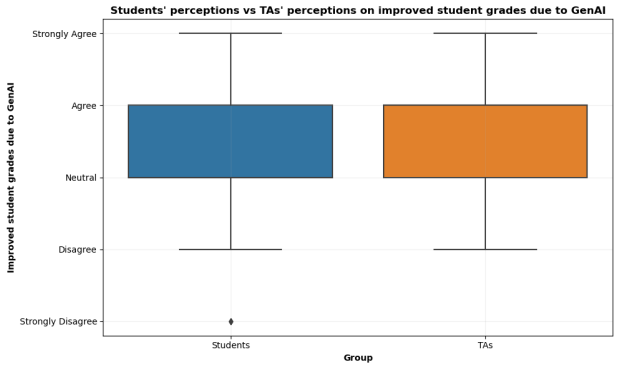

Figure 9: Grades improvements variable in both surveys

From figure 9, it can be inferred that the median response for both students and teaching assistants is 'Agree'. This suggests that the majority of both groups believe that generative AI has improved student grades. While there is a general consensus among students and TAs that generative AI has positively impacted student grades, the students' responses exhibit a wider range of opinions. The outlier in the students' responses indicates that there may be some students who strongly disagree with the majority opinion. This divergence could be an interesting area for further investigation.

Shifting the focus to the "Learning" variable, which also included similar statements in both surveys. The statements representing this variable are "The generative AI tools help me understand complex programming concepts better" (Students) and "Students seem to understand complex concepts better when they use generative AI" (TAs).

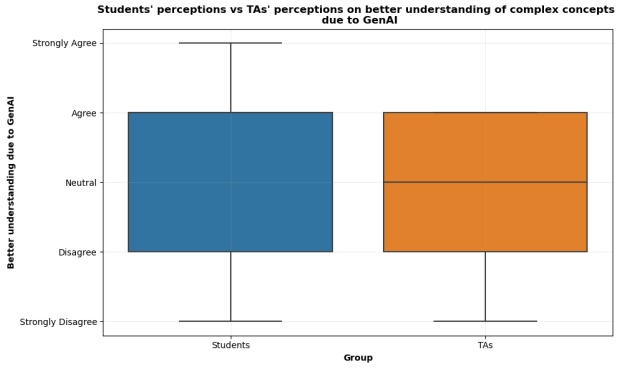

Figure 10: Learning variable in both surveys

Figure 10 shows that the students' box has a range of responses spanning from "Strongly Disagree" to "Strongly Agree", while the TAs' one ranges from "Strongly Disagree" to "Agree", indicating a variety of opinions on the effectiveness of generative AI in understanding complex programming concepts. The median response for both groups falls within the "Neutral" category, suggesting a more balanced view on the impact of generative AI tools. The interquartile range (IQR) for both groups spans from "Disagree" to "Agree," indicating that the central 50% of responses show moderate disagreement to agreement on the statements.

The final box plot in figure 11, shows the responses for statements "I feel more comfortable to seek help from generative AI than from a peer, teaching assistant/mentor or professor." and "I have noticed a decrease in students' dependence on teaching assistants after the emergence of generative AI". The box plot indicates that students are increasingly comfortable seeking help from generative AI, with responses ranging from Neutral to Strongly Agree. Concurrently, teaching assistants have noticed a decline in students' dependence on them, with almost all responses being "Agree". This suggests a shift in educational reliance from human tutors to AI, potentially due to factors such as students' comfort with AI, its efficiency, or its growing prevalence in education [17].

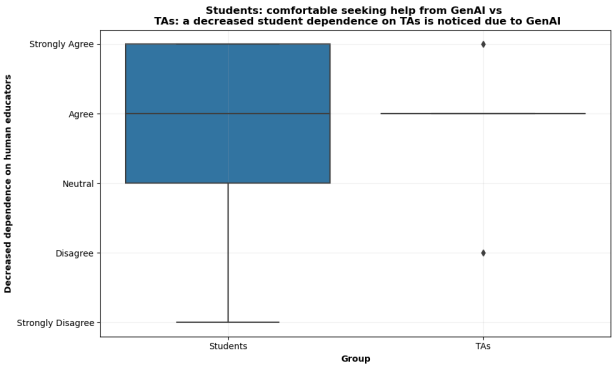

Figure 11: Help-seeking preference and dependence on TAs

5 DISCUSSION

The primary goal of this research was to investigate the impact of generative AI on students' academic performance in computer science education. This discussion section will summarize and interpret the findings from the student and teaching assistant surveys, connect them with the research objectives, and explore their broader implications. Additionally, it will address the study's limitations and propose directions for future research.

5.1 Summary and interpretation of the findings

The survey analysis revealed that students' engagement and perceived grade improvements correlate with the use of generative AI tools. However, experiences vary among students. The study also found a significant number of students using these tools for understanding complex programming concepts and completing assignments, indicating a dual role of generative AI as a learning aid and a potential risk of over-reliance.

Despite concerns about plagiarism, it does not deter extensive use of AI tools, calling for strategies to maintain academic integrity. Many students prefer AI assistance over peers or instructors due to its anonymity and non-

judgmental nature, which is linked with increased engagement and promotes independent learning and problem-solving.

From the teaching assistant perspective, the survey revealed a perceived decrease in student dependence on teaching assistants accompanied by an increase in student confidence. This was reflected in the positive correlation between these variables, indicating that generative AI tools can foster a more self-reliant and confident student learning process. Additionally, teaching assistants observed that students who used generative AI tools tended to understand complex concepts better and apply their knowledge more effectively, although with some variance in perceptions.

The comparison of perceptions between students and teaching assistants showed that, overall, both groups had similar views on the impact of generative AI. For instance, both students and teaching assistants generally agreed that generative AI tools improve grades and help in understanding complex concepts. However, students exhibited a wider range of opinions, reflecting more varied individual experiences. Teaching assistants, on the other hand, were more consistent in their perceptions, particularly noting an increase in student confidence and a decrease in reliance on their help. The only difference was observed in the confidence levels of students due to GenAI. The median perception for both groups is neutral regarding whether GenAI increases student confidence. However, students' opinions are more varied compared to teaching assistants, indicating that while students may feel slightly more confident using GenAI, this perception is not universally held.

5.2 Implications of the findings

The positive correlation between engagement and grade improvements suggests that generative AI tools can enhance academic performance by making learning more interactive and engaging. This can be particularly beneficial in a field like computer science, where understanding complex concepts is crucial.

However, the reliance on generative AI tools for completing assignments raises concerns about the development of independent problem-solving skills. While these tools can significantly aid learning, it is essential to encourage students to use them as supplementary aids rather than primary sources of solutions. This balance is critical to ensuring that students develop the necessary skills to succeed independently.

The varied perceptions of plagiarism concerns highlight the complexity of integrating generative AI in education. Institutions must develop clear guidelines and educational programs to help students use AI tools responsibly, mitigating the risks of academic dishonesty.

The shift towards seeking help from AI rather than human educators points to the need for integrating AI seamlessly into the educational framework. While AI can provide immediate and non-judgmental support, human educators play an irreplaceable role in providing personalized guidance and mentorship. A blended approach that leverages the strengths of both AI and human support can create an optimal learning environment.

The overall impact of generative AI on students' academic performance in computer science education is multifaceted. Generative AI tools enhance the learning experience by making complex concepts more accessible and providing personalized support, which can lead to better academic outcomes. Students benefit from increased engagement and confidence, which contribute positively to their performance. However, the integration of these tools also necessitates addressing challenges such as over-reliance and academic integrity. To maximize the benefits of generative AI, educational institutions should develop strategies that incorporate these tools as supplements to traditional learning methods, ensuring that students build strong foundational skills while leveraging the advantages of advanced AI technologies.

5.3 Limitations and future directions

This study has several limitations that should be considered when interpreting the findings. The rapid development of generative AI technology means that the landscape is continually evolving, which may affect the applicability of the findings over time. Additionally, the time constraints of this research limited the depth of analysis and the ability to explore long-term impacts.

Additionally, the sample size was relatively small and not representative of the entire student population. However, it provided valuable insights into individual opinions, which are crucial in understanding the nuanced impacts of new technology in education. Future research should aim to include a larger and more diverse sample to enhance the generalisability of the findings.

Measuring the impact of generative AI on academic performance is inherently complex due to the multifaceted nature of education and learning. Future studies could benefit from a mixed-methods approach, combining quantitative data with qualitative insights to provide a more comprehensive understanding, as well as include professors' perceptions of GenAI in computer science education.

6 CONCLUSION

In conclusion, this research has demonstrated that generative AI tools can significantly enhance computer science education by improving student engagement and academic performance. The data indicates that while GenAI tools aid in understanding complex programming concepts, there is a risk of students becoming overly reliant on these tools, potentially undermining the development of independent problem-solving skills. The varied perceptions of plagiarism underscore the need for clear guidelines and educational programs to ensure responsible use of AI

tools. Future research should address limitations by incorporating larger and more diverse samples and employing a mixed-methods approach to provide a comprehensive understanding of the impact of generative AI on education. Ultimately, a balanced integration of AI tools and human educators can create an optimal learning environment that leverages the strengths of both to support student success in computer science education.

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A APPENDIX - AI TOOLS USED

During the preparation of this work the author used the following tools for the following reasons:

- Grammarly
  - Used for an overall grammar check of the paper.
  - Helped with writing and checking the grammar structure of the texts.
- ChatGPT and Microsoft CoPilot
  - Used for general questions on paper structure, such as:
    - "What should be included in the abstract?"
    - "What should the discussion section of an academic paper consist of?"
  - Used to help working with LaTeX, the prompts

included:

  - ∗ ”How to add bibliography to LaTeX?”
  - ∗ ”How to adjust/remove spaces between paragraphs?”
  - ∗ ”How to create a table in LaTeX?”

– Used to help shorten the paper to the permitted maximum of 8 pages. The prompt used was including the pdf of my first version (9 pages) and ”This pdf version of my thesis paper is 9 pages long, when the allowed maximum is 8 pages. Where and how would you recommend to shorten it down?”

After using those AI tools, the author reviewed and edited the content as needed and takes full responsibility for the content of the work.