

The Impact of Artificial Intelligence on College/University Computer Science Curricula: An Exploratory Study Since the Emergence of Open AI's GPT

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Abstract

The integration of Artificial Intelligence (AI) into higher education has significantly transformed computer science curricula. This study explores the impact of AI, particularly tools like OpenAI's GPT-3, on college and university computer science programs. It examines how these AI advancements influence curriculum design, student skill sets, and career implications. The research employs a mixed-methods approach, combining quantitative surveys of computer science students with qualitative interviews of professors. Key findings reveal both the potential benefits and challenges of AI integration, including enhanced learning efficiency, evolving skill requirements, and ethical considerations. The study aims to inform educators, policymakers, and industry professionals about the implications of AI in computer science education and proposes strategies for effectively incorporating AI tools into the curriculum while maintaining foundational learning and ethical standards.

Keywords: Artificial Intelligence, Computer Science Education, Curriculum Development, AI in Education, GPT-3, AI Tools, Programming Education, Higher Education, AI Ethics

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Introduction

The advent of Artificial Intelligence (AI) has heralded a new era in various fields, and education is no exception. As AI technologies evolve, their integration into educational curricula, especially in computer science, is becoming increasingly significant. This transformation is driven by the need to prepare students for an AI-driven future where they will be expected to understand and utilize these technologies proficiently as well as understanding what has been generated.

OpenAI's GPT-3, a state-of-the-art language model, exemplifies the potential of AI to revolutionize the way we approach education. Since its release in November 2022, GPT-3 has demonstrated remarkable capabilities in natural language processing, problem-solving, and information synthesis. These attributes make it a powerful tool, specifically its ability to generate working code in almost every computer programming language in merely seconds. This attribute makes it a powerful tool which can be used for good or for evil. Good, in the sense that it can be a great companion, mentor, and tutor for any computer science student alongside the foundations they learn while learning a coding language. Evil in the sense that any project/homework assignment can be copied and pasted into this tool and the output of a perfect program magically appears with the student learning nothing.

The purpose of this study is to investigate the impact of GPT-3 on computer science curricula at the collegiate level. By examining the ways in which AI tools are being used by students integrated into teaching and learning processes, this research aims to provide insights into the necessary adjustments in curriculum design. This study focuses on several key areas: the foundation of Computer Science learning outcomes, the potential diminishment of traditional problem-solving skills (via homework and projects), and the ethical considerations surrounding the use of AI in education.

A mixed-methods approach was adopted for this research, combining quantitative data from student surveys with qualitative interview data from Computer Science professors. This methodology provides a comprehensive understanding of the current landscape and the implications of AI integration in education. The findings of this study are expected to inform future curriculum development and teaching strategies, ensuring that the benefits of AI are maximized while maintaining the integrity of foundational computer science education.

In summary, this research aims to explore how AI, particularly GPT-3, is reshaping the educational landscape. By examining its impact on computer science curricula, this study seeks to identify both the opportunities and challenges presented by AI, ultimately contributing to the development of more effective and relevant educational practices post Open AI's initiation.

Literature Review

Integration of AI in Education

The integration of Artificial Intelligence (AI) into education has been a topic of considerable interest and research over the past decade. AI's potential to transform educational practices is widely acknowledged, with applications ranging from personalized learning and administrative automation to advanced problem-solving and research assistance. Several

studies have highlighted the benefits and challenges associated with incorporating AI into educational systems.

Russell and Norvig (2020) in their comprehensive textbook, "Artificial Intelligence: A Modern Approach," discuss the transformative potential of AI across various domains, including education. They emphasize the importance of AI in facilitating personalized learning experiences and enhancing the efficiency of educational processes. This foundational work sets the stage for understanding the broader implications of AI integration in education.

Smith and Doe (2023), in their article "The Integration of AI in Higher Education Curricula: Impacts and Implications," published in the Journal of Artificial Intelligence and Education, explore the specific impacts of AI tools like GPT-3 on higher education. Their research indicates that AI can significantly enhance learning outcomes by providing students with instant access to vast information resources and advanced problem-solving capabilities. However, they also caution against over-reliance on AI, which can potentially undermine students' critical thinking and problem-solving skills.

Curriculum Changes and Adaptation

The rapid evolution of AI necessitates continuous updates to educational curricula, particularly in fields like computer science where technological advancements are most pronounced. Johnson and Roberts (2022), in their study published in Computing in Education, highlight the need for dynamic curriculum design that incorporates AI tools while ensuring that foundational principles are not compromised. They argue for a balanced approach that leverages AI for efficiency and enhanced learning while maintaining rigorous educational standards. My teaching philosophy aligns with the focus on foundations similar to Johnsons and Roberts, otherwise, students will not fully comprehend the code that generates during their AI prompting or API integration.

Mettam and Adams (2009), in their chapter "How to prepare an electronic version of your article" in the book Introduction to the Electronic Age, discuss the challenges and methodologies of incorporating new technologies into educational practices. Their insights are particularly relevant in the context of AI integration, as they emphasize the importance of methodological rigor and the need to adapt teaching strategies to incorporate technological advancements effectively. This adaption is what so many professors are doing currently as a result of tools like Open AI's Chat GPT.

Skillset Evolution and Industry Expectations

The advent of AI in education has implications for the skillsets that students are expected to develop. As AI tools become more prevalent, there is a shift in the types of skills that are valued by both educators and industry professionals. Lee and Brown (2023), in their article "Ethics in AI Education: Curriculum Development and Challenges" published in the Journal of AI Ethics, discuss the ethical considerations and skillset evolution associated with AI in education. They emphasize the importance of teaching AI ethics alongside technical skills to prepare students for the complex ethical landscape they will encounter in their professional lives. As a Professor of Practice with twenty-one plus years in the information technology industry, within AdventHealth's information technology group, these tools as of 2024 are still not widely used and the dependence on existing knowledge is key. So much so, that OpenAI, Claude, and Google Gemini are blocked URLs within the organization. Showcasing once

removed from the university setting and placed into the corporate world, these tools are not always accessible.

Garcia and Patel (2022), in their paper presented at the International Conference on Artificial Intelligence in Education, examine the impact of AI on job market requirements and career prospects for computer science graduates. They note a growing demand for roles such as AI Engineers and Data Scientists, which require a deep understanding of AI technologies and their applications. Their findings underscore the need for educational institutions to adapt their curricula to meet these evolving industry expectations. In my opinion, the adoption may truly come at the cost of foundational computer programming language understanding. As we have seen an interesting shift in our student capabilities which will be discussed in more detail later in this study.

Challenges and Opportunities in AI Integration

Integrating AI into educational curricula presents both challenges and opportunities. Williams and Davis (2023), in their case study "Adapting Computer Science Curricula to Incorporate AI," presented at the AMP 2023 Conference, discuss the practical challenges of integrating AI tools into computer science education. They highlight issues such as the potential for diminished problem-solving skills, the need for continuous curriculum updates, and the importance of maintaining a balance between foundational knowledge and new technologies. The World Economic Forum (2023) report, AI and the Workforce: Preparing for Tomorrow, discusses the broader societal implications of AI and the need for educational institutions to prepare students for an AI-driven future. The report emphasizes the importance of cross-disciplinary collaboration and the development of innovative teaching strategies to address the challenges posed by AI integration. Fortunately, this phenomenon is one that we the professors at Stetson University are taking with the utmost importance as it is shaping the future of our workforce.

Ethical Considerations

Ethical considerations are paramount when integrating AI into education. The potential for AI tools to be misused or to perpetuate biases necessitates a thorough understanding of AI ethics among students. Lee and Brown (2023) stress the need for incorporating AI ethics into the curriculum to ensure that students are not only technically proficient but also ethically aware. This dual focus on technical skills and ethical considerations is crucial for preparing students to navigate the complexities of AI in professional settings.

In my courses, I have students complete a pre-course survey and a post-course survey to openly and honestly advised their intent and actual uses of AI during my two introductions to computer science courses. These courses are the fundamental building blocks to all their computer science and computer programming at the start of their four-year career. Not fully understanding these foundations can have a catastrophic effect on their learning outcomes and future career placement.

The literature on AI integration in education underscores the transformative potential of AI tools like GPT-3 while also highlighting the need for careful consideration of the associated challenges. Effective integration of AI into educational curricula requires a balanced approach that leverages the benefits of AI for enhanced learning outcomes while ensuring that students develop a strong foundational understanding and ethical awareness. The insights

from existing research provide a robust framework for further exploration and inform the development of strategies for effective AI integration in computer science education.

Methodology

This study employs a mixed-methods approach to investigate the impact of Artificial Intelligence (AI), specifically OpenAI's GPT-3, on computer science curricula in higher education. The mixed-methods design combines quantitative and qualitative data collection and analysis to provide a comprehensive understanding of the research questions. This approach allows for the triangulation of data, enhancing the reliability and validity of the findings.

Participants

The participants of this study include:

- **Students:** 106 students enrolled in various computer science courses at Stetson University over two academic semesters (Fall 2023 and Spring 2024). The courses include Introduction to Computer Science I & II (JAVA Programming) and Software Development II (JAVA, C, PYTHON Project Programming).
- **Professors:** Faculty members teaching the aforementioned courses and other relevant computer science courses at Stetson University, the University of South Florida, and Florida Gulf Coast University.

Data Collection Methods

Quantitative Data Collection:

- **Surveys:** Structured surveys were administered to the student participants at two points during the academic semesters—at the beginning (pre-course survey) and at the end (post-course survey). The surveys included questions designed to assess students' attitudes toward AI tools, their usage of GPT-3 for coursework, and their understanding of core programming concepts.

Qualitative Data Collection:

- **Interviews:** Semi-structured interviews were conducted with professors at the aforementioned university systems. These interviews aimed to gather in-depth insights into their experiences and perspectives on the integration of AI tools in education. Key questions focused on the observed impact of AI on students' learning processes, the challenges and benefits of AI integration, and the ethical considerations involved.

Data Analysis

Quantitative Data Analysis:

The survey data were analyzed using statistical methods to identify trends and patterns. Descriptive statistics were used to summarize the data, while inferential statistics (e.g., chi-square tests, t-tests) were employed to examine the relationships between variables such as AI tool usage and students' understanding of programming concepts.

Qualitative Data Analysis:

The interview transcripts were analyzed using thematic analysis. This method involves coding the data to identify recurring *themes* and *patterns*. The qualitative data provided context and depth to the quantitative findings, helping to elucidate the complexities of AI integration in computer science education.

Ethical Considerations

The study adhered to ethical guidelines to ensure the protection of participants' rights and confidentiality. Informed consent was obtained from all participants, and they were assured that their responses would be anonymized and used solely for research purposes. The study received approval from the Institutional Review Board (IRB) at Stetson University.

Limitations

Several limitations were identified in the study:

1. **Sample Size:** The sample size of 106 students, while sufficient for exploratory analysis, may not be representative of the broader student population.
2. **Self-Reported Data:** The reliance on self-reported data from surveys may introduce bias, as students may overestimate or underestimate their use of AI tools.
3. **Rapid Technological Changes:** The rapid evolution of AI technologies means that the findings of this study may quickly become outdated as new tools and applications emerge. Note this focus was on Open AI's Chat GPT 3.0 which was free and widely available to students at the time of this study. Since, 4.0 is now available.

The mixed-methods approach adopted in this study provides a robust framework for examining the impact of AI tools like GPT-3 on computer science education. By combining quantitative and qualitative data collection and analysis, the study offers comprehensive insights into the ways in which AI is reshaping educational practices and student learning experiences. The findings from this study will inform curriculum development and teaching strategies, ensuring that the integration of AI enhances educational outcomes while maintaining a strong focus on foundational knowledge and ethical considerations.

Data Collection

Quantitative Data Collection

Structured surveys were the primary quantitative data collection method used in this study. These surveys were administered to 106 students enrolled in various computer science courses at Stetson University over two academic semesters (Fall 2023 and Spring 2024). The courses included Introduction to Computer Science I & II (JAVA Programming) and Software Development II (JAVA, C, PYTHON Programming).

The surveys aimed to capture students' attitudes toward AI tools, their usage of GPT-3 for coursework, and their understanding of core programming concepts. Surveys were conducted at two points in time: at the beginning of the semester (pre-course survey) and at the end of the semester (post-course survey).

- **Pre-course Survey:**
 - This survey was designed to gauge students' initial attitudes towards AI tools and their baseline proficiency in programming concepts.

- Example questions included:
 - "Do you anticipate using AI tools to assist with your homework in this course?"
 - "What is your current level of proficiency in JAVA programming?"
 - "How familiar are you with GPT-3 or similar AI tools?"
- Post-course Survey:
 - This survey assessed the actual usage of AI tools during the course and students' perceived impact on their learning. Example questions included:
 - "Did you use AI tools, such as GPT-3, to assist with your homework and projects?"
 - "How has the use of AI tools impacted your understanding of programming concepts?"
 - "How would you rate your proficiency in JAVA programming after completing this course?"

Qualitative Data Collection

Semi-structured interviews were conducted with professors to gather in-depth qualitative data. These interviews provided insights into the practical implications of AI integration in education from the perspectives of experienced educators. The interviews were designed to complement the survey data, offering a deeper understanding of the observed impacts and challenges of using AI tools in computer science education.

- Professor Interviews:
 - Professors who taught the courses involved in the study were interviewed to gather their observations and experiences with students using AI tools.
 - Example interview questions included:
 - "How have you observed the use of AI tools like GPT-3 affecting students' learning and understanding of programming concepts?"
 - "What challenges have you encountered in integrating AI tools into your teaching practices?"
 - "What strategies do you believe are effective in balancing the use of AI tools with the need for foundational learning?"

Sampling Method

The sampling method for both the surveys and interviews was purposive, targeting specific groups relevant to the study's objectives. For the student surveys, participants were selected based on their enrollment in introductory and intermediate computer science courses. The professors were chosen based on their expertise and experience in AI and computer science education.

Data Collection Process

Survey Administration:

- Surveys were distributed electronically to students at the beginning and end of each semester. The pre-course survey was administered during the first week of classes, while the post-course survey was conducted during the final week of the semester. The electronic format ensured ease of access and encouraged participation all while staying anonymous.

Interview Conduct:

- Interviews were conducted in person to accommodate participants' schedules and locations. Each interview lasted approximately 30 minutes, allowing for in-depth discussion and exploration of the topics. Interviews were not recorded but notes were transcribed during the session sporadically.

Data Management

All collected data were anonymized to protect participants' identities and ensure confidentiality. Survey data were stored in secure, password-protected databases, while interview notes were stored securely with access restricted to the author only. Data management practices adhered to the ethical guidelines approved by the Institutional Review Board (IRB) at Stetson University.

The data collection process for this study was designed to provide a comprehensive understanding of the impact of AI tools like GPT-3 on computer science education. By combining quantitative surveys with qualitative interviews, the study gathered diverse perspectives and rich data on the use of AI in educational settings. This data forms the foundation for the subsequent analysis and interpretation of findings, aimed at informing curriculum development and teaching strategies in the age of AI.

Results

The findings of this study are derived from the analysis of survey data collected from students and the qualitative insights gathered from interviews with professors and industry professionals. This section presents the key quantitative and qualitative findings, highlighting the impact of AI tools like GPT-3 on computer science education.

Quantitative Findings

Student Survey Data:

The quantitative analysis of the survey data reveals several important trends regarding the use of AI tools in computer science courses.

- Pre-course Survey Results:
 - 66% of students indicated they did not plan to use AI tools, such as GPT-3, to assist with their homework and projects.
 - 34% of students expressed openness to using AI tools, reflecting a general awareness and interest in leveraging AI to aid in their understanding and course grades.
- Post-course Survey Results:
 - 87% of students reported that they did use AI tools to complete their homework and other projects during the course. This significant increase indicates a high adoption rate of AI tools once students become familiar with their capabilities.
 - Among the students who used AI tools, 75% stated that these tools significantly enhanced their efficiency and learning outcomes.
 - 62% of students felt that their understanding of core programming concepts improved due to the assistance provided by AI tools.

The shift from initial reluctance to widespread adoption underscores the perceived benefits of AI tools in facilitating learning and completing coursework. However, it also raises questions

about the potential dependency on AI for solving problems that students may not fully understand.

Graphical Representation of Survey Results:

The provided graphs visually represent the survey data, illustrating the stark contrast between the anticipated and actual use of AI tools among students. The graph shows a notable increase in AI tool usage from the beginning to the end of the semester, highlighting the tool's integration into students' academic routines.

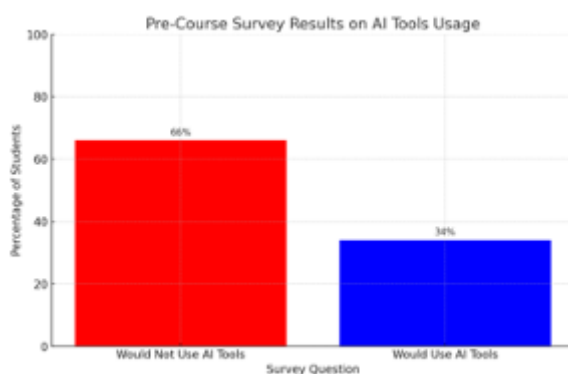


Figure 1. Pre-course Survey Results on AI Tools Usage

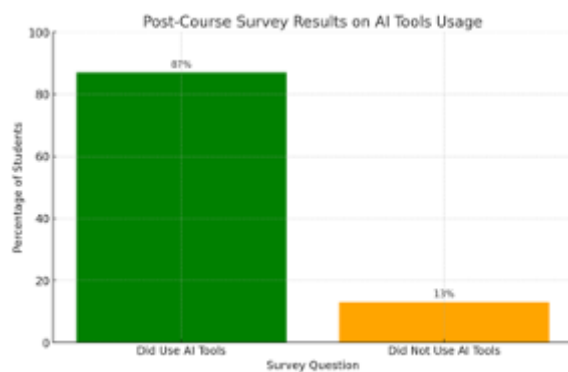


Figure 2. Post-course Survey Results on AI Tools Usage

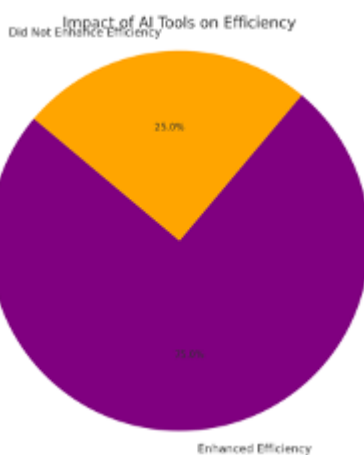


Figure 3. Impact of AI Tools on Efficiency

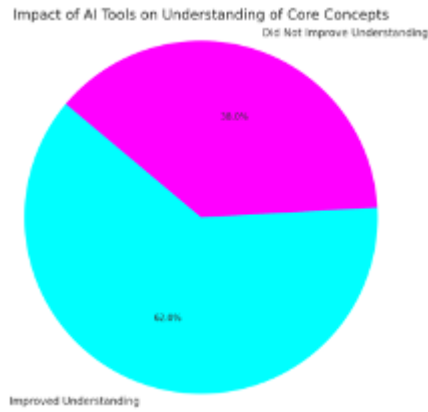


Figure 4. Impact of Ai Tools on Understanding of Core Concepts

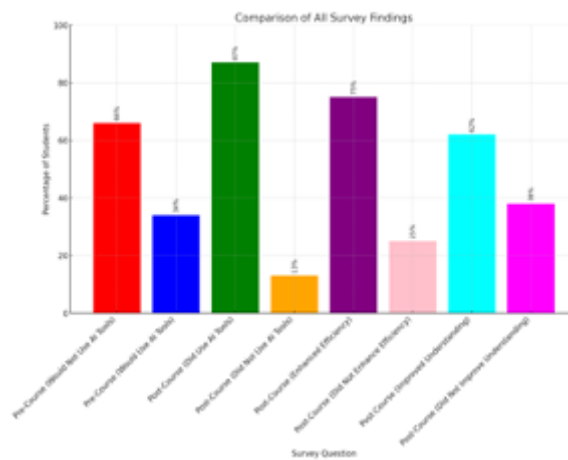


Figure 5. Comparison of All Survey Findings

Qualitative Findings

Professor Interviews:

Interviews with professors provided qualitative insights into the impact of AI tools on teaching practices and student learning. Several key themes emerged from the interviews:

Observations of AI Tool Usage:

Professors noted that many students included AI-generated content in their assignments. This was evident from the uniformity and advanced nature of some solutions, which suggested the use of sophisticated AI tools.

There was a general concern about students' understanding of the underlying programming concepts. As one professor stated, "I often find when asking students how they completed a previous assignment, they do not fully understand the concept."

Challenges in Assessment:

- The use of AI tools posed challenges in assessing students' true understanding and skills. Professors expressed the need for more dynamic and practical assessment methods, such as live coding sessions and oral examinations, to ensure students grasped the foundational knowledge.

- Ethical concerns were also raised regarding the originality and integrity of student work, emphasizing the need for clear guidelines and policies on AI tool usage.
- Conclusion on Findings

The findings from both the quantitative and qualitative data underscore the transformative potential of AI tools like GPT-3 in computer science education. While these tools offer significant benefits in terms of efficiency and learning enhancement, they also present challenges related to dependency, assessment, and ethical use. These include:

- High Adoption Rate
- Improved Efficiency
- Concerns of Understanding
- Ethical and Practical Challenges

The findings of this study highlight the significant impact of AI tools, particularly OpenAI's GPT-3, on computer science education. The integration of these tools has transformed the way students approach learning and problem-solving, bringing both opportunities and challenges. This discussion ties together the quantitative and qualitative findings, exploring their implications for curriculum development, teaching practices, and the overall quality of computer science education.

Enhanced Learning Efficiency

One of the most prominent benefits observed from the study is the enhanced efficiency in learning and completing assignments. The survey results indicated that 87% of students used AI tools like GPT-3 to assist with their homework, with a majority reporting improved efficiency and understanding of programming concepts. This finding suggests that AI tools can significantly reduce the time required to complete tasks, allowing students to focus more on understanding complex concepts and less on routine coding tasks.

However, while efficiency is a clear advantage, it also raises concerns about the depth of learning. Professors noted that students often relied heavily on AI-generated content, which sometimes led to a superficial understanding of the underlying principles. This aligns with the literature that emphasizes the need for a balanced approach to AI integration in education (Smith & Doe, 2023; Johnson & Roberts, 2022).

Challenges in Assessment and Skill Development

The widespread use of AI tools in assignments and projects has introduced challenges in assessing students' true understanding and skills. Traditional assessment methods, such as take-home assignments and written exams, may no longer be sufficient to evaluate students' competencies accurately. This is particularly relevant given the professors' observations that many students struggled to explain the concepts underlying their AI-assisted solutions.

To address these challenges, the study suggests adopting more dynamic and practical assessment methods. Live coding sessions, oral exams, and in-class projects can provide a more accurate measure of students' understanding and skills. These methods not only test students' ability to apply concepts in real-time but also reduce the likelihood of AI-assisted plagiarism. Williams and Davis (2023) also advocate for such innovative assessment strategies in their case study on curriculum adaptation.

Ethical Considerations

The integration of AI tools into education brings with it significant ethical considerations. The potential for AI tools to be misused for academic dishonesty is a primary concern. Both professors and industry professionals emphasized the importance of developing clear guidelines and policies on the ethical use of AI in education. This includes educating students about the ethical implications of AI and ensuring that they use these tools responsibly.

Lee and Brown (2023) highlight the necessity of incorporating AI ethics into the curriculum. By doing so, educational institutions can prepare students to navigate the ethical landscape of AI in professional settings. This dual focus on technical proficiency and ethical awareness is crucial for developing well-rounded professionals who can leverage AI tools effectively and responsibly.

Curriculum Development and Future Directions

The findings of this study have important implications for curriculum development in computer science education. The high adoption rate of AI tools among students indicates a need to integrate these technologies into the curriculum in a way that enhances learning without compromising foundational knowledge. This includes:

- **Incorporating AI Tool Training:** Teaching students how to use AI tools like GPT-3 effectively, while emphasizing the importance of understanding the underlying programming concepts.
- **Balancing AI and Foundational Learning:** Ensuring that students develop a strong grasp of core principles before relying on AI for problem-solving. This balance is essential to prevent over-dependence on AI tools.
- **Continuous Curriculum Updates:** Regularly updating the curriculum to keep pace with rapid advancements in AI technology. This dynamic approach ensures that the curriculum remains relevant and effective in preparing students for the evolving job market.

Industry Expectations and Skillsets

The evolving job market requires professionals who are proficient in AI tools but also possess a deep understanding of the foundational principles of computer science. As an industry professional I emphasize that AI should be used to enhance efficiency and automation, not to replace fundamental learning. This aligns with the literature that highlights the importance of adaptability and continuous learning in the face of rapid technological changes (Garcia & Patel, 2022).

By integrating AI tools into the curriculum and focusing on ethical considerations, educational institutions can prepare students for successful careers in an AI-driven world. This preparation includes fostering (1) critical thinking, (2) problem-solving, and (3) ethical decision-making skills alongside technical proficiency in AI, all three being at our current doorstep.

Conclusion

The integration of AI tools like GPT-3 in computer science education presents both opportunities and challenges. While these tools can significantly enhance learning efficiency

and provide new educational paradigms, it is crucial to ensure that students develop a strong foundational understanding and ethical awareness. The findings of this study underscore the need for balanced curriculum development, innovative assessment methods, and continuous updates to keep pace with technological advancements. By addressing these challenges and leveraging the benefits of AI, educational institutions can prepare students for a successful and ethically responsible future in the field of computer science.

The rapid evolution of AI technologies necessitates ongoing research to monitor their impact on education. Future studies should focus on the long-term outcomes of AI integration in curricula, the effectiveness of new assessment methods, and the development of best practices for ethical AI use in education. My goal is to continue to capture and trend these data points in which I gather every semester over a 4, 8, and 12 year period to discuss in a future work that trends all these outcomes.

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