ISSN: 2976-7466

Journal of Biosensors and Bioelectronics Research

SCIENTIFIC Research and Community

Review Article

Open Access

Perceptions and Aspirations of Undergraduate Computer Science Students Towards Generative AI: A Qualitative Inquiry

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ABSTRACT

This article presents a comprehensive study conducted during the spring semester of 2024, aimed at exploring undergraduate computer science students' perceptions, awareness, and understanding of generative artificial intelligence (GAI) tools within the context of their Artificial Intelligence (AI) courses. The research methodology employed qualitative techniques, including human-subject research and focus groups, to delve into students' insights on the evolution of AI as delineated in the seminal textbook by Russell and Norvig. The study-initiated discussions on the historical development of AI, prompting students to reflect on the aspects that intrigued them the most, and to identify which historical concepts and methodologies, perhaps even those not directly covered in their curriculum, piqued their interest. Furthermore, the dialogue encompassed the learning methodologies highlighted in the textbook, seeking students' feedback on the strategies that have been most effective for mastering complex AI theories and their practical applications. Interdisciplinary applications of AI were also discussed, encouraging students to contemplate AI's role beyond the realm of computer science and its potential to foster innovative solutions across various fields. Finally, the conversation shifted towards students' personal goals and aspirations in AI, urging them to consider how their perspectives have evolved in light of technological advancements, societal needs, and ethical considerations. The findings underscore a notable gap in students' awareness of AI's history and its current capabilities, indicating a need for educational strategies that not only deepen understanding but also foster a broader appreciation of AI's potential. This study contributes valuable insights into enhancing AI education and encouraging interdisciplinary innovation among the next generation of computer scientists.

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Received: June 01, 2024; **Accepted:** June 05, 2024; **Published:** July 01, 2024

Keywords: Generative AI, Computer Science Education, Interdisciplinary Applications, AI Learning Methodologies, Evolution of AI Perceptions

Introduction

The advent of artificial intelligence (AI) has transformed not only the technological landscape but also the curricula of Computer Science departments across global higher education institutions. This journey into the realm of AI began with foundational theories and experiments that sought to imbue machines with the capacity for human-like reasoning and learning. As highlighted by Russell and Norvig, the field's origins can be traced back to the mid-20th century, when pioneers such as Alan Turing (1912-1954) questioned the possibility of machines thinking, laying the groundwork for what would become the Turing Test as a measure of machine intelligence (ML) [1, 2]. This historical context is crucial in understanding the evolution of AI and is commonly introduced to students in the initial chapters of AI courses, providing a lens through which the rapid advancements and ethical implications of the field can be examined.

The progression of AI from theoretical constructs to practical applications has been a core component of Computer Science curricula, emphasizing not only the technological milestones but also the shifting paradigms in how AI is conceptualized and utilized [3]. The introduction of generative AI (GAI) tools represents a significant leap forward, heralding a new era of AI capabilities that extend beyond traditional methodologies [4]. These tools, powered by sophisticated algorithms and vast datasets, have the potential to revolutionize various sectors, from healthcare to entertainment, by generating content and solutions that were previously inconceivable.

However, a review of educational practices reveals a gap in the comprehensive integration of GAI tools into the AI education framework [5]. Despite their growing importance, there is a lack of emphasis on these tools within the conventional curriculum, which predominantly focuses on established AI methodologies as outlined in foundational texts like that of Russell and Norvig [1]. This discrepancy raises questions about the preparedness of students to engage with the forefront of AI technology and its applications.

In response to this educational challenge, the current study seeks to explore undergraduate Computer Science students' perceptions and awareness of GAI tools within their AI coursework. By employing qualitative research methods, including focus groups and interviews, this investigation aims to shed light on how students perceive the historical development of AI, as taught in their courses, and their understanding of GAI tools in comparison

to traditional AI methodologies. Furthermore, it examines the effectiveness of current learning methodologies in equipping students with the knowledge and skills necessary to contribute to the field's future development. This exploration into the pedagogical approaches to AI education is essential for identifying areas where curricula can be enhanced to better prepare students for the evolving landscape of AI technologies.

Literature Review

The integration of artificial intelligence (AI) into the Computer Science curriculum has evolved significantly over the years, reflecting broader technological advancements and changing educational paradigms. This literature review chronologically examines the progression of teaching methodologies for AI in higher education, from early pedagogical approaches to contemporary strategies that leverage generative AI tools. Each study contributes to understanding the best practices in AI education, addressing various challenges from fostering foundational knowledge to embracing interdisciplinary applications.

In the mid-1980s, Good et al. highlighted the potential of AI to enhance science education, identifying early challenges in teaching and learning with a fuzzy knowledge base and the nascent technologies of natural language processing and machine learning. This period marked the beginning of integrating AI concepts into educational settings, emphasizing the need for innovative teaching methods to address the complexities of AI [6]. As educational technologies evolved, Pantic et al. presented a novel agent framework for teaching introductory AI, combining objectivist and constructivist approaches [7]. This method engaged students in personal learning while maintaining intellectual rigor, signifying a shift towards more interactive and student-centered learning environments in AI education.

The mid-2000s to early 2010s saw further diversification in teaching methodologies. Li et al. explored five aspects of teaching AI, including textbooks and assistant teaching measures, emphasizing the need for quality improvement in AI education [8]. This period also witnessed innovative approaches like those proposed by Uke et al., focusing on heuristic teaching, systematic experiment training, and utilizing games and puzzles to enhance the understanding and retention of AI concepts [9]. These approaches marked a significant move towards practical and engaging learning experiences.

The advent of more sophisticated AI technologies in the 2010s and 2020s brought about a paradigm shift in teaching AI. Gong et al. discussed the use of AI and Unity3D technology in computer teaching software, which effectively improved student interest and accommodated individual learning differences [10]. Meanwhile, Mishra et al. proposed an interdisciplinary approach to teaching AI, incorporating various disciplines to provide students with a holistic understanding of the science of thinking [11]. This approach underscored the importance of interdisciplinary education in preparing students for the complex, multifaceted challenges in AI. In recent developments, Allen et al. identified best practices in teaching AI and machine learning in higher education, addressing confidence, mathematics anxiety, and diverse educational backgrounds [12]. This study reflects the ongoing challenges in AI education and the need for inclusive, supportive teaching methodologies that accommodate the varied needs of students. There is thus a clear trajectory from foundational frameworks to interactive, interdisciplinary, and technologically enhanced methodologies in AI education. Each phase of this evolution has contributed to addressing the unique challenges of teaching AI, emphasizing the need for innovative, flexible, and student-centered approaches. As AI continues to evolve, so too will the pedagogical strategies employed to educate the next generation of computer scientists, ensuring they are well-equipped to contribute to the field's advancement.

Despite the significant advancements and varied approaches to teaching artificial intelligence in higher education, a noticeable gap exists in the literature concerning the advent and integration of generative AI (GAI) tools, which became widely accessible in 2023. This recent development marks a pivotal moment in the evolution of AI technologies and their potential applications in educational settings. The rapid emergence of GAI tools offers unprecedented opportunities for enhancing teaching methodologies, fostering innovative learning experiences, and addressing longstanding challenges in AI education. However, the extent to which these tools have been adopted and their impact on student learning and perceptions remains largely unexplored. This scarcity of research underscores the need for a timely investigation into the current state of AI education, particularly in relation to the awareness, understanding, and application of GAI tools among undergraduate computer science students. The present study aims to fill this gap by examining the perceptions of these students enrolled in artificial intelligence classes, thereby providing insights into how the introduction of GAI tools has influenced their learning experiences and future aspirations in the field of AI. Through this exploration, the study seeks to identify areas where AI curricula may be enhanced to better prepare students for the evolving landscape of AI technologies and their interdisciplinary applications.

Methodology

This study adopts a qualitative research design, utilizing human-subject research and focus groups to gain in-depth insights into undergraduate Computer Science students' perceptions, awareness, and understanding of generative artificial intelligence (GAI) tools. The qualitative approach allows for a rich, detailed exploration of students' experiences and views, facilitating a comprehensive understanding of their engagement with AI concepts and methodologies, both traditional and generative.

The participants of this study consisted of undergraduate students enrolled in Artificial Intelligence classes during the spring semester of 2024. A purposive sampling strategy was employed to select participants who could provide diverse perspectives on the integration and impact of GAI tools in AI education. The sample size aimed to achieve saturation, with a total of 28 (n=28) students participating in the focus groups.

Data collection was conducted through focus group discussions, supplemented by individual semi-structured interviews to delve deeper into specific themes that emerged during the groups. Each focus group consisted of 6 to 8 participants, ensuring a conducive environment for active engagement and interaction among students. The discussions initiated with reflections on the historical development of AI, as outlined in Russell and Norvig's textbook, progressing to explore students' perceptions of GAI tools compared to traditional AI methodologies.

A structured discussion guide was developed to facilitate the focus groups and interviews. The guide included prompts on the following themes:

1. Historical development of AI and surprising aspects

discovered through coursework.
2. Concepts beyond the current curriculum that sparked interest and why.
3. Effectiveness of learning methodologies in mastering AI concepts.
4. Interdisciplinary applications of AI and their potential impact.
5. Evolution of personal goals and aspirations in using AI, considering technological advancements and ethical considerations.

Data from focus groups and interviews were transcribed verbatim and analyzed using thematic analysis. This involved a rigorous process of coding and categorizing the data into themes and sub-themes, allowing for the identification of patterns and insights into students' perceptions and experiences. The analysis focused on understanding students' awareness and understanding of GAI tools, their perceived effectiveness of learning methodologies, and the implications for AI education.

The study was conducted in accordance with ethical standards for human-subject research, including obtaining informed consent from all participants and ensuring confidentiality and anonymity in the presentation of findings. Ethical approval was secured from the institutional review board prior to commencing the study.

This methodology provides a comprehensive framework for exploring the perceptions of undergraduate computer science students regarding GAI tools and their integration into AI education. By focusing on qualitative insights, the study aims to contribute valuable knowledge to the field of AI pedagogy, informing future educational strategies and curriculum development.

Results

The analysis of data collected from focus group discussions and individual interviews with undergraduate Computer Science students provided valuable insights into their perceptions, awareness, and understanding of generative artificial intelligence (GAI) tools. The results are organized according to the main themes derived from the discussion guide. In the collected qualitative feedback from undergraduate computer science students who participated in discussions on AI, an array of sentiments and insights emerge, providing a vivid depiction of student engagement, curiosity, and the educational impact of AI. Through careful analysis, this narrative synthesis presents a comprehensive view, supported by select quotes, of key takeaways, discoveries, and constructive feedback aimed at enhancing AI education and student awareness [13].

Historical Development of AI and Surprising Aspects

Participants expressed a general sense of awe and curiosity about the historical development of AI, particularly the milestones highlighted in Russell and Norvig's textbook. Many students were surprised by the rapid progression of AI technologies and their philosophical underpinnings, noting that the ethical considerations and theoretical debates from the early days of AI have become increasingly relevant. However, a recurring theme was the lack of awareness about the historical context of GAI tools. Students acknowledged that their courses had primarily focused on traditional AI methodologies, leaving a gap in understanding the evolution of generative models.

Concepts Beyond the Current Curriculum

When discussing concepts beyond their current curriculum, students showed a keen interest in deep learning and neural networks, areas they perceived as closely related to GAI tools. The discussion revealed a desire for more comprehensive coverage of these topics within their courses, with many students suggesting that an in-depth understanding of these areas would better prepare them for the evolving AI landscape. The enthusiasm for exploring the technical foundations of GAI tools highlighted a gap in the curriculum that students felt needed to be addressed to stay abreast of recent advancements.

Effectiveness of Learning Methodologies

The effectiveness of learning methodologies in mastering AI concepts elicited mixed responses. While traditional lectures and textbook-based learning were valued for providing foundational knowledge, students expressed a strong preference for hands-on experience with AI technologies, including GAI tools. Interactive learning experiences, such as projects and labs that incorporate GAI applications, were highlighted as instrumental in understanding complex AI theories and their practical implications. This feedback underscores the need for curriculum development that integrates practical experiences with theoretical learning.

Interdisciplinary Applications of AI

The conversation on interdisciplinary applications of AI sparked considerable interest among participants. Students shared their excitement about the potential of AI to revolutionize fields such as healthcare, finance, and environmental science. The discussions reflected a broad understanding of AI's implications beyond computer science, with many students expressing a desire to apply AI solutions to real-world problems in their areas of interest. However, there was a consensus that more opportunities for interdisciplinary collaboration and project-based learning would enhance their ability to innovate and apply AI technologies effectively.

Evolution of Personal Goals and Aspirations

Reflecting on their personal goals and aspirations, students noted that their perspectives on using AI had evolved significantly. Many cited the emergence of GAI tools as a pivotal factor influencing their aspirations, with a strong inclination towards pursuing careers that leverage AI for societal benefit. Ethical considerations, technological advancements, and societal needs were identified as critical factors shaping their visions for employing AI. Despite this enthusiasm, there was a sense of unpreparedness among students, attributed to a perceived gap in their education regarding the latest GAI tools and their capabilities.

Discoveries and Learning Experiences

The next section involves a sentiment analysis of student written feedback submitted as seen in Table 1. Students articulated a profound sense of discovery about the vast capabilities and specific applications of AI technologies. One student highlighted an expanded understanding, saying, "I learned more about copilot and how there are different AI's depending on what you need," showcasing a positive sentiment towards the diversity within the AI field. Another student reflected on learning about AI's social implications, stating, "I learned that Diversity, Equity, and Inclusion is a prominent focus when it comes to chat AI like ChatGPT for some reason," indicating a positive realization of the ethical dimensions integrated within AI technologies. Additionally, the awareness of specialized AI development for security purposes, as one student mentioned, "We discovered that special teams such as the CIA, etc. are developing their own platforms/system to avoid any leaking information," underscores the critical role of AI in safeguarding sensitive information, echoing a very positive

sentiment towards AI's applicability in high-stakes environments.

Key Takeaways

The discussions spurred students to delve deeper into the AI landscape. The intention to explore conversational AI tools further was captured by a student's enthusiasm, "After this presentation, I would like to learn more about all the different types of AI chats," reflecting a positive drive for self-directed learning. The aspiration to personally benefit from AI technologies was echoed by another participant, "When he showed different types of artificial intelligence platforms that can perform different things. I want to try them out and possibly use them for my own benefit," illustrating a proactive stance towards leveraging AI for personal advancement. Curiosity about AI's integration into familiar technologies was also noted, with a student expressing interest in "using the new AI in Windows," showing a neutral yet inquisitive attitude towards the practical applications of AI in daily tech experiences.

Discussion Effectiveness and Suggestions for Improvement

The format and interactive nature of the discussions were frequently commended. For instance, the use of relatable topics to demonstrate AI applications was appreciated, "Bringing up the super bowl, since it was super present and then demonstrating. Also having the class talk and have a discussion with him helped as well," highlighting the positive impact of integrating current events to make AI relatable. The facilitation style that encouraged participation was seen as beneficial, "I felt like the way that he conducted the discussion was very effective, he gave time for the audience to add or question," showing approval for the inclusive and engaging discussion atmosphere. Despite the overall positive feedback, there was an expressed desire for deeper engagement with AI applications and more interactive elements, suggesting room for enhancement in engaging students more thoroughly in AI discussions.

Table 1: Summary of Sentiment Analysis Results

Theme	Sentiment	Select Quotes
Discoveries and Learning Experiences	Positive	"I learned more about copilot and how there are different AI's depending on what you need."
	Positive	"I learned that Diversity, Equity, and Inclusion is a prominent focus when it comes to chat AI like ChatGPT for some reason."
	Very Positive	"We discovered that special teams such as the CIA, etc. are developing their own platforms/ system to avoid any leaking information."
Key Takeaways	Positive	"After this presentation, I would like to learn more about all the different types of AI chats."
	Positive	"When he showed different types of artificial intelligence platforms that can perform different things. I want to try them out and possibly use them for my own benefit."
	Neutral	"I guess using the new AI in Windows would be interesting to play around with."
Discussion Effectiveness	Positive	"Bringing up the super bowl, since it was super present and then demonstrating. Also having the class talk and have a discussion with him helped as well."
	Positive	"I felt like the way that he conducted the discussion was very effective, he gave time for the audience to add or question."
Suggestions for Improvement	Neutral	Despite the overall positive feedback, there was an expressed desire for deeper engagement with AI applications and more interactive elements.

Analyzing student feedback reveals an overwhelmingly positive reception towards the discussions on AI, characterized by eagerness for deeper exploration, appreciation for the comprehensive insights offered, and a call for more practical engagement with AI technologies. The feedback underscores the need for educational strategies in AI to evolve continually, ensuring they align with student interests and the dynamic nature of AI advancements. This constructive outlook suggests a pathway for educators to enrich AI discussions, integrating more hands-on demonstrations, ethical deliberations, and interactive learning opportunities to better equip students for the future of artificial intelligence.

Recommendations

The insightful feedback provided by undergraduate computer science students regarding their experiences with discussions on AI yields several actionable recommendations for educators and curriculum developers aiming to enhance AI education. These recommendations are designed to address the expressed desires for deeper engagement, broader exploration of AI applications, and a more interactive learning environment. For instance, students expressed a keen interest in exploring a wide range of AI technologies, highlighting the value of practical exposure to diverse AI tools. Educators should strive to incorporate a variety of AI platforms, including generative AI tools, conversational agents, and specialized AI applications, into the curriculum. This can be achieved through laboratory exercises, project-based learning, and demonstrations, ensuring that students gain hands-on experience with the latest advancements in AI technology.

The feedback underscored the importance of understanding AI's interdisciplinary applications and its potential to revolutionize various sectors. Integrating case studies, guest lectures, and collaborative projects from diverse fields such as healthcare, finance, environmental science, and social justice can enrich an understanding of the broad impact of the technology. This approach will encourage students to think creatively about how AI can be leveraged to address complex real-world problems. Also, the positive reception of the open and engaging discussion format highlights the effectiveness of fostering a dynamic classroom environment. Educators are encouraged to maintain an inclusive atmosphere that invites student participation, questions, and debate. Utilizing current events, ethical dilemmas, and real-world AI applications as discussion starters can stimulate interest and engagement. Additionally, incorporating student-led presentations or discussion sessions can further enhance peer learning and critical thinking skills.

The interest in the ethical implications of AI, including diversity, equity, and inclusion, suggests a need for a more comprehensive exploration of AI ethics within the curriculum. Incorporating modules or discussions focused on ethical considerations, societal impacts, and the responsibilities of AI developers can prepare students to navigate the complex moral landscape of AI technology. Engaging with ethical dilemmas through case studies, role-playing, and debates can provide practical insights into addressing ethical challenges in AI development and application.

Given the rapid pace of AI advancements, continuous learning opportunities outside the traditional curriculum can support ongoing student engagement and development. Recommending online courses, webinars, workshops, and conferences focused on AI can help students stay abreast of new technologies and methodologies. Creating a community of practice or a student-led AI club can foster a culture of collaborative learning and innovation. Implementing these recommendations can significantly enhance the educational experience for students studying AI, ensuring they are well-equipped with the knowledge, skills, and ethical awareness necessary to contribute meaningfully to the field.

Conclusion

The integration of artificial intelligence (AI) into various sectors has underscored the importance of comprehensive AI education for preparing the next generation of computer scientists and engineers. This study sought to explore undergraduate Computer Science students' perceptions, awareness, and understanding of generative AI (GAI) tools through qualitative research methods, including focus groups and individual interviews. The significance of this inquiry lies not only in its contribution to the evolving dialogue around AI education but also in its potential to inform curriculum development to better align with the rapidly advancing technological landscape.

The results from the discussions reveal a high level of student engagement and curiosity about AI, particularly regarding the applications of GAI tools, ethical considerations, and the interdisciplinary potential of AI technologies. Students expressed a desire for more hands-on experiences with diverse AI tools and a deeper exploration of AI's societal impacts. The positive sentiment towards the interactive discussion format suggests that engaging, inclusive educational approaches are effective in enhancing students' learning experiences. Moreover, the feedback highlights a gap in current curricula regarding the breadth of AI applications and ethical dimensions, indicating an opportunity for educational institutions to expand their offerings to include a wider range of AI topics and practical experiences.

In light of these findings, several recommendations have been put forward to address the identified needs. These include integrating diverse AI tools into the curriculum, emphasizing interdisciplinary applications, fostering an inclusive and interactive discussion environment, expanding coverage of ethical considerations, and providing continuous learning opportunities. These actions aim to equip students with a comprehensive understanding of AI, its applications, and its implications, thereby enabling them to contribute meaningfully to the field.

The next steps for research should focus on evaluating the implementation of these recommendations within AI curricula across educational institutions. Longitudinal studies could assess the impact of curriculum changes on student outcomes, including knowledge retention, skill development, and ethical awareness. Additionally, comparative studies between institutions that have adopted these recommendations and those that have not could provide further insights into the effectiveness of different educational strategies. Finally, expanding the scope of research to include the perspectives of educators, industry professionals, and other stakeholders in AI education could offer a more holistic view of the educational needs and challenges in preparing students for the future of AI.

This study serves as a foundation for ongoing exploration into the best practices for AI education, emphasizing the importance of adaptability, inclusivity, and forward-thinking in curriculum development. By aligning educational strategies with the dynamic nature of AI technology, educators can ensure that students are not only knowledgeable about current AI tools and methodologies but also prepared to lead the next wave of innovations in artificial intelligence.

Data Availability

Data available upon request.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Funding Statement

NA

Authors' Contributions

Conceptualization, J Hutson; Methodology, J Hutson; Validation, T Jeevanjee; Investigation, T Jeevanjee - Original Draft Preparation, J. Hutson; Writing - Review & Editing, J Hutson; Visualization, J Hutson.

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