Generative AI on Computer Science Education: From the Computer Science Faculty Perspective

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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INTRODUCTION

On November 22nd, 2022, OpenAI released ChatGPT, a large language model that people were able to engage in conversation with through their front-facing website. Large language models are an outcome of machine learning, which trains on data input to predict the desired output for a user. The data can range from text, audio, images, and even video depending on the model of your choice. Users would type out a prompt to ChatGPT, in which the model would reply back with an answer. Considered to have been trained on the internet itself, ChatGPT is capable of answering a multitude of questions the users has, crafting storylines for the user, and expands upon it even more (OpenAI 2022). While there exists some limitations on whether or not ChatGPT would give correct answers reliably, it became a major technology used in schools for its ease of use and quick responses.

This did not go on far without retaliation by some schools. In a New York Times article, some professors were hesitant to accept the newfound language model, restricting students to locked browsers to ensure that the work was their own (Huang 2023). The once pronounced open-ended, take-home assignments students would receive during the pandemic has become more feared for plagiarism. ChatGPT has even led to the development of adversarial technology to determine whether or not a student used ChatGPT to write an essay. Despite these worries, many others also see it as another obstacle to improve how we perceive and improve education, given that the internet has already existed for decades as a resource to find answers. How educators approach the nuances of generative AI will determine the future education of many students.

This STS thesis will examine the influence of generative AI on education for computer science faculty and how classes have changed. First, the use of generative AI will be examined from a

literature review. Afterwards, a series of interviews will be analyzed as case studies and will be conducted through qualitative analysis. Through these interviews, similar and differing trends between the professors will be selected.

LITERATURE REVIEW

The intersection of education and computers has only existed for a couple of decades, but has rapidly iterated over the years with newfound technological advancements like the World Wide Web and smartphones, requiring educators to pivot how to teach students with the vast amount of information we can consume today. The most recent surge has been generative artificial intelligence, which allows users to provide some input like text and receive an output from the AI model. With the given state of education, the perspective of educational researchers and educators throughout varies on how to use the new-found generative AI models.

The development of artificial intelligence in education has existed since the 1990s, from personalized learning chatbots to virtual learning environments developed to enhance the learning experience of students (Zhang et. al 2021). The benefits of some of these technologies have been considered useful by the authors, such as using AI for analyzing the behavior trends of students in a learning environment. The variety of use-cases of AI and how it's been integrated into education today gives the author's a more positive viewpoint on the matter. Moreso, it is the job of the educator to determine how to best fit the technological tools into the learning experiences of the students to accelerate and amplify their learning.

The development of generative AI models such as ChatGPT can be seen as a double-edged sword. Researchers used paradox theory and critical analysis to see that generative AI models are paradoxical in their nature (Lim et. al 2023). The dependence of the model on the flowing information of the internet to generate the responses relies on people around the world to

provide. This has led to questions on whether the models could be reliable for providing correct information, given that there are no clear-cut measures on verifying whether a claim it makes is true without verification from a professional. The paradox shows that a model can answer many prompts of the user, even though it does not even understand the actual reasoning besides for mathematical formulas. Another common trend is the negative view on generative AI usage in education, while the tools provide an even farther, easier outreach to information for students to use.

How the model provides information is another important perspective when seeing its reliability. ChatGPT's performance on various subjects was highly volatile, ranging from proficient in economics to unsatisfactory in mathematics (Lo 2023). While the generative AI model is able to provide quick and easy information to the user, the reliability of the information is not a guarantee. Since the proficiency of the generative AI model varied in topic, the author's viewed it cautiously as a reliable assistant for education. The viewpoint of ChatGPT being reliable can be a negative for how the public uses the tool, since it can provide false information that can negatively affect the learning experience of a student.

While the topics have demonstrated on a general overview the implications of generative AI on education, there is a disconnect between why the model has difficulties in particular subjects. The use case for an education subject is also widely different: writing argumentative papers on historical events will have a different use for generative AI than proving theorems in mathematics. This is because of the data that is used to train the generative AI bot: using previous historical papers to create a generative AI bot for writing papers on historical events is more important than using that data for a generative AI bot designed for proving theorems. Some papers have visited the specifics of the educational topics and technology, but given the recent

growth in generative AI, there have not been significant resources on how the models have been used for current curriculums.

In terms of computer science education, many tools have also been deployed that cater towards simplifying the coding process. One major example of that is GitHub Copilot, which integrates with an IDE, a development environment for coding, to allow in-code prompts to be made by the programmer. Once the programmer writes a prompt, Copilot is able to generate code that is close to what the programmer desires. Although there may exist some bugs, Copilot is known to be a great tool for creating boilerplate code and templates that are simple to make but take lots of time to create.

METHODS

The bulk of the research questions involved interacting with computer science professors at the University of Virginia. Two computer science professors were interviewed, and given questions that will probe them of major components in the STS research question: their ruleset on how generative AI is used in the classroom, how generative AI is being used outside of the classroom and for research purposes, and how education will change based on their perspectives with the introduction of generative AI into computer science courses. The specific set of questions are listed below:

- How has generative AI been handled in courses you have taught recently?

- How do you feel that generative AI has changed the student's learning experience from your own experience?

- How does the future of generative AI play into how your courses are constructed in the future?

- From your perspective, what are the benefits and downsides of introducing generative AI into computer science education?

All of these interviews were conducted in-person and transcribed for ease of reference. Once the interviews have been completed and transcribed into writing, a case study analysis was applied, where each interview was analyzed in their perspectives and views on how the landscape of computer science education will change. Each interview was taken into account in the scope of their credentials, such as the size of the courses they taught, their field of expertise, and the amount of research and teaching the professor must do. These cases were generalized to give a more global overview of generative AI in computer science education.

RESULTS

From the professors that have reached out for an interview, two obliged to the interview participation. The professor's identity has been anonymized and content has been restricted to ensure the privacy of each professor. The content of each professor will be shown below, with subsections designated for each question that was provided above. While the contents of the interview have been transcribed, for the sake of the length of the paper, the opinions stated by each professor have been paraphrased. To note each professor, they will be called by "Professor X", where X is the number assigned to them. So in this case, there will be Professor 1 and Professor 2.

While there is only a set of two professors for the entirety of the paper, the perspectives of the two professors are distinctively different: the number of courses they have taught, the content of the courses, and the amount of students taught are vastly different. A lot can be learned from only two professors, since after a certain threshold a lot of the professors share lots of

similarities. The two professors selected differ a lot as stated above, and will be able to provide a lot of in-depth information on the interviews presented below.

How has generative AI been handled in courses you have taught recently?

For Professor 1, they generally allow the use of generative AI at all for any of the homeworks or assignments that they have declared unless otherwise noted. The main reason that Professor 1 does not allow for the use of generative AI is due to the lack of experience with using the tools so far; without knowing how the intricacies of tools like ChatGPT and GitHub Copilot work, they are unsure whether or not to allow it. Therefore, to eliminate unnecessary variables in their courses, they simply do not allow it. Professor 1 would think that if they had more time to experiment with generative AI, then it could give them a better understanding of whether or not to allow its usage.

Professor 2's opinion on the question depends heavily on the course that is being taught. For example, teaching more introductory level computer science courses would lead to Professor 2 not allowing generative AI usage. The reason being is that during these introductory courses, a lot of core fundamentals of computer science are being learned at that moment. To enforce the idea of no generative AI, rather than trying to restrict the assignments further, the grading system is shifted more towards in-class assignments and exams where generative AI cannot be used as easily.

However, when it comes to classes that are more high-level electives, Professor 2 has a more lenient approach on generative AI. When using generative AI tools like GitHub Copilot to generate boilerplate code and assisting in development, Professor 2 does not have any problems with it and allows it in their course. Given that students have already learned a lot of the core fundamentals in computer science, logic such as boolean, for loops, data structures, and many

more are not as critical to skip when generating the code since the students are already expected to know it.

One more thing that Professor 2 notes is that since students understand that core knowledge, they can also sniff out incorrect information that generative AI can produce when they are given a prompt. An important skill to keep track of in the future when using generative AI tools is to see whether or not the information that it is giving to you is truthful or not.

How do you feel that generative AI has changed the student's learning experience from your own experience?

Professor 1 notes that it has affected student learning, but the major effects will happen more in the long run with generative AI. While they haven't noticed anything significant as of late, it has led them to reconsider how assignments are created in relation to generative AI. Professor 1 also considers that a student's learning also depends on the computer science topic that is being taught. For courses that are heavier in theory, it does not affect the course as much since the students will need to work hard to understand the theory to be successful in the course. On the other hand, courses that are more programming heavy may suffer more from generative AI in terms of learning.

Professor 2 finds it more difficult to answer this question, given that there isn't a great way to review courses that have been taught and how much generative AI has really affected the problem. They emphasize that there are many factors that can contribute to how student learning has been affected. For example, a course taught in 2022 vs. 2023 showed a significant drop in student ability to take exams and write code. However, the pandemic was happening during this moment at the same time that generative AI took off, which does not exactly mean correlation to

causation in this case. There is a lot of noise to tell whether or not it has had a significant impact on student learning.

How does the future of generative AI change how you will create your classes in the future?

Professor 1 does not have too much worry about generative AI given the nature of the content they teach at the moment. The courses that they currently teach focus more on exams and creative assignments, one of which cannot use generative AI while the other generative AI has had more struggle with aiding students on.

Professor 1 does acknowledge that there is a split between how graduate and undergraduate courses are taught and how that affects the usage of generative AI. To Professor 1's knowledge, undergraduate courses are more structured for continuous assignments and learning more fundamentals, which weigh heavily on creating assignments and exams. Because of generative AI's growth in solving coding problems, Professor 1 also sees a shift towards more exam-heavy grading to test the student's knowledge.

On the other hand, graduate courses are more creative thinking and reading. Lots of the graduate courses focus on teaching the students via readings that explore the student's thought process and creativity, rather than creating exams and assignments to test core knowledge. Because of that, generative AI does not have as much of an impact due to the struggles it has on creating novel solutions on its own.

For Professor 2, they recognize that it is a problem but that it is a difficult problem to fix. They are unsure how they are going to approach the problem since future thinking for such a new technology is near impossible for humanity. The acute technosocial opacity connects directly to this problem: humanity cannot predict the future, and thus it should not develop a reliance on predicting the future consequences, but rather focus on flexibility and wisdom from past

experiences to adapt to situations (Huff). Professor 2 acknowledges that there is no turning back from this, but at the same time where we are on the technological curve for Generative AI is unknown.

Professor 2's bigger worries are whether or not students are making the right decisions in investing their education into computer science. The long-term commitment of 4 years to one degree can be daunting due to the amount of rapid change that has happened in the tech industry, thus more concerned about the perspective of whether the commitment of the computer science degree is worthwhile.

What are the benefits and downsides that you see from generative AI in computer science education?

Professor 1 believes that there will be a lot of pros from generative AI in computer science education. A lot of more minor things, such as bugs from syntax and logic errors, could be easily corrected by the technology, allowing for both students and professors to focus more on creating novel ideas rather than debugging code.

The downsides that Professor 1 can see are that students could be learning too high-level skills with generative AI, rendering a lot of the computer science fundamentals not as necessary for the education. Given that generative AI can take in a prompt for a coding problem and create an output program, how the programmer views that code depends on whether or not they actually understand what is going on with the code. If generative AI can create such code that it always works every time, it will still be important for the programmer to know and understand how it works, otherwise it renders the programmer useless.

Professor 2 is skeptical of the current promises that generative AI promoters are saying, such as replacing the entire software engineering industry with AI software engineers. However,

Professor 2 believes that a lot of the grunt work that comes from software engineering and computer science could be phased out with the help of generative AI, allowing for those to work on more critical problems without having to worry about debugging.

For education, Professor 2 thinks that while the technology can help reduce the grunt work later on in higher-level electives, it is important that students focus on the core fundamentals of computer science in class. Generative AI can lead the students astray by giving students answers without really understanding why it works. This is why a shift towards more in-person assignments and exams may be the future to ensure students are taking the time to understand the theory.

QUALITATIVE ANALYSIS

Given the perspectives of each of the professors, an analysis will now be performed to see the general trends that the professors share and also differ in opinions on. This will be structured into general trends on computer science education and summarizes the experience of the professors in the Results section.

The Shift in Grading Schemas

Both the professors have expressed that the fundamentals in computer science are essential for students to learn at the moment, otherwise the content that they absorb in future electives will be more challenging to overcome. While students can be encouraged to avoid the use of generative AI tools on their assignments, there is no easy way to guarantee that students are not using the tools, especially for computer science assignments.

To combat this, professors have shifted more towards in-class assignments and exams. This strategy combats generative AI to help focus students on assignments that do not allow the

supplemental tools. This is highly dependent on the content the professor teaches however, which will be discussed in the next subsection.

Generative AI Usage in Class

Both professors acknowledge the idea that generative AI tools are highly dependent on what type of class is being taught. Given the limitations of generative AI, higher-level electives and graduate-level computer science courses are not as much of a worry for professors since they focus on the student's creativity and out-of-the-box thinking, rather than following the steps to complete an assignment. Again, professors want the students to learn computer science fundamentals, so undergraduate courses that focus on such knowledge are more restricted to generative AI usage.

Uncertainty in Generative AI on Education

While steps are being taken to see whether or not generative AI tools will be used in a classroom environment, there is still lots of uncertainty that cannot be known except for those who are more experienced in the generative AI field. Some of the professors are hesitant to make drastic changes to their curriculum, given that the technology is fairly new and where humanity is on the technological curve is unknown. On the other hand, the tools are praised by professors to be an enhancement to learning by avoiding all the minute tasks that aren't as necessary for programming, rather focusing on creativity. Regardless of the position, professors are cautious in how students are using generative AI.

CONCLUSION

From the perspectives of computer science professors, there is a lot of uncertainty that is going on with regards to how generative AI will integrate into computer science education in the near and far future. Steps are being taken to be cautious about the developments of AI, but are also welcomed as it continues progressing further. Professors are skeptical of whether or not student learning will be affected with generative AI, and are taking some measures to ensure that students are taking the time to learn and understand computer science fundamentals and theory. The future of generative AI usage is still a mystery to humanity, but that comes with any new technology that has come forth to us, from electricity to automotives to the World Wide Web. By taking the perspectives of computer science professors, it gives new insight into how education will be carefully viewed over the next few years and trends to look for as generative AI continues to evolve further. Perspectives from outside of the computer science faculty could be an interesting area to explore to understand how generative AI is impacting other fields across academia.

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