Final Research Report

The Impact of ChatGPT on Learning Programming: Benefits and Limitations

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1. Abstract

With the release of ChatGPT, news and discussion around AI technology flooded the internet. Some are optimistic about the advancement of technology and its impact on education; however, some are voicing concerns about a range of problems that could arise from such a rapid growth of AI usage. Its impact on those learning programming has also been a central topic in the tech space. Using a combination of netnography and focus group, we found that if utilized in the right way, ChatGPT can be particularly beneficial in increasing the efficiency of learning programming. However, there is still much skepticism surrounding using AI technology in a learning environment. Beyond education, participants also shared their outlook on using ChatGPT in an industry context.

2. Motivation and Background

We've seen increased use of ChatGPT in many people's daily lives. More questions have arisen regarding the use of these AI technologies in education for essay writing, standardized tests, language learning, coding, and many more purposes. Many have praised ChatGPT for its effective use towards personalized learning[1], while some are skeptical of the new technology's potential impact on the education system.[2] Either way, this technology isn't going away anytime soon, so students and educators alike are adjusting to adapt to the new way of learning.[3]

Besides writing essays and answering math questions, ChatGPT's capability to generate code quickly using the most common languages has impressed many students and programmers in the technology industry. It has become increasingly popular among students and those entering the field of software engineering to use ChatGPT to assist with coding and learning new programming languages.[4] In addition, some programmers are concerned that their job, unlike journalism or nursing, which largely involves human factors and interest, will become redundant in the face of the new technology.[5] The purpose of this study is to understand the impact of ChatGPT on students' learning processes for programming languages and the sentiments of those who will be entering or just entering the field of software engineering because they are the ones shaping the future of the field.

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[1]Chincholi
[2]Douglas
[3]Roose
[4]Stieg
[5]Marr

We conducted two phases of research, netnography and focus group, which will be described in the following sections.

3. Research Question

How does ChatGPT impact students' learning of programming?

3.1 Sub-Research Questions

- How do students trust the information from ChatGPT?
- How do students use ChatGPT to get the most optimal answer?
- What are students' sentiments toward using ChatGPT for learning programming?

4. Sample Population

Our netnographic research targeted discussions around ChatGPT and AI's impact on education and learning, which means our data consists mostly of opinions from educators, industry professionals, students, and current learners.

In the second phase of research, we focused our research on ChatGPT's impact on software engineering (SWE) education, so the sample population shifted towards current students or recent graduates who previously have taken at least two programming classes and have used ChatGPT during their learning experience.

5. Method

5.1 Netnography (Online observations)

5.1.1 Data collection

In our phase one research, we used netnography as our method because we wanted to get a broad sense of students' perspectives and experiences about using ChatGPT for learning. We chose three online sites (YouTube, LinkedIn, and Reddit) because there are more active and rich discussions on these three sites. We collected 20 text posts, which had to meet the following criteria, from each site (60 posts in total).

Criteria of these posts:
- Content: the impact of ChatGPT on students' learning process and their engagement in learning environments

- Keywords: #LearnAI #LearnChatGPT #ChatGPTStudentLearning #AIStudentLearning #ChatbotsInEducation #AIAssistedLearning #AIEducation
- Engagement metrics: at least 5-10 comments or 50 views

Data was collected and stored in Google sheets. For each post, we documented its content, such as experience with using ChatGPT for learning, opinions, and concerns toward the impact of ChatGPT on learning and critical thinking.

5.1.2 Data analysis

We used affinity modeling to analyze the data in FigJam (see Appendix). Firstly, three of us went through the posts on YouTube, LinkedIn, and Reddit respectively, and created codes to summarize the key aspects of 60 posts. Then we grouped together to create sticky notes for the 60 posts and categorized them according to the relevant codes. The most common themes we identified were "efficiency", "personalization", "critical thinking", "trust/accuracy", "accessible" and "replacement", which we will further illustrate in the next section.

5.1.3 Ethical consideration

Although these posts were published content, re-publication or citation in an academic publication may have unexpected consequences for the individual. Therefore, we would only indicate the source of the posts instead of the publishers' names to protect their real or pseudonymous identities.

5.1.4 Limitations

One of the limitations we want to address is the potential bias influenced by the demographic and usage purpose of each platform. Generally, Youtube and Linkedin comments were more positive and supportive while Reddit discussions were more casual and varied in sentiment.
- Youtube comments were mostly subscribers responding and interacting with creators that they are interested in, so we found that the discussions were mainly supportive.
- Due to Linkedin's emphasis on professional identity, most commenters were respectful, positive, and formal. Sentiment on the use of ChatGPT in education, whether that's through posts or comments, geared towards optimism and promotion of the tool.

- Reddit, on the other hand, strives for anonymous discussion where users can more freely share their thoughts without attached consequences or impact on identity, so the discussions were more casual and argumentative.

5.2 Focus Group

5.2.1 Data collection

We conducted one focus group session. Focus groups allow us to get more insight into participants' thinking compared to individual interviews. Since ChatGPT is still a disputed topic for many, we hope that participants could have a discussion and build off of each other's thoughts through the focus group. The 3 participants in the focus group are college students or recent graduates (both undergraduate and graduate) who previously have taken at least two programming classes and have used ChatGPT during their learning experience in programming.

Participant criteria:
- Individuals who are college students or recent graduates
- Individuals who have used ChatGPT to learn programming
- Individuals who have taken at least two programming courses
- Individuals who are willing to participate in an online discussion during May

To recruit participants for the focus group, we used the following recruitment procedures:
- We posted a recruitment message on educational Slack channels such as university slack or forums.
- We created a screening survey to ensure that participants meet the inclusion criteria.
- We provided participants with an information sheet and a consent form before they began the study.

The data for this study were collected through a focus group discussion with the 3 selected participants within our network.
- The focus group took place online via Zoom in mid-May.
- The focus group was moderated by a moderator and two notetakers. We used a semi-structured interview guide to elicit responses from the participants.
- Prior to the focus group, participants were provided with an information sheet and a consent form (see Appendix) outlining the purpose of the study and their rights as

participants. The focus group was audio recorded for later transcription and analysis.

5.2.2 Data Analysis

The data collected from the focus group discussion was transcribed and analyzed using a thematic analysis approach.

- This involved identifying key themes and patterns in the participants' responses and grouping them into categories. The data were coded and used to group similar ideas and concepts together. We split the data up by platform and distributed it amongst our team members. These codes were used to develop themes that are overarching.
- We transcribed the audio recording of the focus group to ensure accuracy. Quotes from the participants were used to illustrate the themes and provide context for the findings.

5.2.3 Ethical Considerations

We provided participants with an information sheet and a consent form before participating in the study.

- Participation in the study is voluntary, and participants have the right to withdraw from the study at any time.
- All data collected during the study is kept confidential, and participants are assigned pseudonyms to protect their identities.
- The data collected is used only for the purposes of this study. Any presentations resulting from this study will not disclose any identifying information about the participants.

5.2.4 Limitations

During the research, we identified several limitations when conducting focus group discussion. The limitations include the potential for bias in participant perspectives, constraints on time and depth of discussions, and contextual limitations. These limitations should be taken into consideration when interpreting the findings and applying them to a broader population.

- There can be potential bias in participants' perspectives. The participants in the focus group discussions may not fully represent the broader population for the learning of software engineers. They may have unique perspectives or experiences

that could introduce bias into the findings. It is important to consider the limitations of relying solely on the viewpoints of a small group.

- The constrained time can affect the depth of discussions. The time allocated for the focus group discussion is limited to 45-60 minutes, which could have constrained the depth of the conversations. Some topics or viewpoints may not have been fully explored due to time constraints, potentially leaving gaps in the understanding of participants' perspectives.
- There are contextual limitations. The focus group discussions were conducted within a specific context. The findings should be interpreted within the context of the research design and the specific characteristics of the focus group participants.

6. Key Themes

6.1 ChatGPT Usage and Benefits

Finding: Participants have different levels of trust when using ChatGPT. They trust it for productivity and simple tasks but do not rely on using ChatGPT for complex problems and creativity.

During the discussion, the participants demonstrate a high level of confidence and trust when it comes to summarizing articles or writing simple content. But express a lack of trust in the system when it comes to actual coding, design work, and more complex tasks.

> *"I'd probably give it a 4 for debugging and productivity during development. I think there's a lot of aspects where it can be alleviated in the office. But as for actual coding, I'd give it a slightly lower score, like a 3." - P1*

> *"I've used it on design stuff. So it was a project. When I was asked to design a simple cloud-based data pipeline on the AWS environment and instead of reading up on all the documentations and exploring all the different AWS services. I just kind of told ChatGPT the spec that asks it which services I should use, and how I should integrate them, and that gave me a pretty workable solution." - P2*

> *"Not using it for system design, I wouldn't trust that much with that. Maybe only using it for general understanding." - P2*

Finding: One of ChatGPT's biggest advantages in education is personalized learning and problem-solving.

We discovered the biggest advantage that people enjoyed most about using ChatGPT as a learning tool is its personalized problem-solving. Specifically, those who are learning programming often use the tool to help with tedious tasks such as debugging and coding syntax. In the focus group discussion, while participants talked about ChatGPT's usefulness in learning new languages and solving problems, they also pointed out that it is important to provide enough context and specific cues in order to obtain more relevant answers or resources.

> *"I'm not super familiar with how to prompt directly. Many people are really passionate about it and play around with writing the prompts. But I never really invest time in that. So I feel like the stuff I type in and the stuff I get out, in terms of code quality, isn't what I need or expect. So I think that's why it doesn't help me that much." - P1*

> *"I started learning python like 3 weeks ago and recently tried out ChatGPT for fun but then realized how good it actually is. I often give it my codes and it points out the flaws and ways I could improve my codes. It literally is like a tutor." - YouTube*

> *"I find myself curating code more than writing it myself. Copilot is a real timesaver for many trivial tasks." - LinkedIn*

> *"If you keep it specific enough or direct it to the problem, that's a good thing as ChatGPT works." - P3*

> *"I feel like there's a pretty steep learning curve of getting comfortable in looking for the information you need. And you might not be sure whether these answers are correct or not. But with ChatGPT, you can tune it to explain things in simple terms. And it's very tailored to the specific problems you face if you provide it with another context." - P1*

Finding: Most participants praised ChatGPT for its efficiency in high-level work such as documentation and summarization.

When sharing how they used ChatGPT in their programming workflow, participants said it was particularly useful for summarizing the content and writing documentation. Participants still preferred writing their own code, however, for school projects, It is useful for handling more manual work such as writing and reading.

"In the past semester, I've been doing some research work and I feel like what ChatGPT is really good at doing is summarizing the content and presenting a lot of interesting insights." - P1

"I still remember in one of our projects meetings when I just type that into ChatGPT and it just cut half the meeting time down because they didn't have to mindlessly scroll. I thought I was pretty helpful." - P1

"It's sometimes a pain in the ass to go to stack overflow and try and solve your problem. If you have Chat GPT, it can not only help you solve your problem for your case. It can also give you a generalized answer and help you learn in a process. What did you miss? And how can you apply that to future work, I think that's the valuable gap it can bridge as opposed to the workflow of today, just searching on the web and then looking for other people's experience with regard to your buck, that may not be exactly the same as yours." - P3

6.2 Limitations and Concerns

Finding: Participants expressed worries regarding potential leaks of corporate information and copyright issues. These concerns underscore the need for clear guidelines and safeguards to protect sensitive data and intellectual property when utilizing ChatGPT in professional contexts.

The participants expressed concerns related to ownership when utilizing ChatGPT in professional contexts. They do not rely solely on the generated content for their work, highlighting potential biases associated with content originating from a Chatbot. Additionally, participants emphasized the need to protect proprietary information, by raising concerns about ChatGPT logging conversations and the potential use of that data for training purposes.

"I don't trust it yet as much as to base my work off of what it generates. And on a subtle level I also don't want to bias whatever comes out of me to come from a Chatbot." - P3

"I can't use it for proprietary reasons, because ChatGPT is explicitly known for the ChatGPT logs, so whatever conversation you have, and it can be used for its own training purposes. And, as far as code knowledge, and the further it goes, we

wouldn't want that happening for a company, especially when the model itself is not in-house. Plus, I think it's also a mixture of mistrust" - P3

Finding: Sentiment towards ChatGPT is generally positive with some concerns about limits on critical thinking. Although ChatGPT is useful when learning new languages, heavy reliance on producing code hinders the learning process.
ChatGPT could be a double-edged sword at times. Participants shared that ChatGPT would be useful for a beginner learning a new language, where the process involves a lot of Googling and understanding dense material. This helps with efficiency and lowers the learning curve at the start. However, one of the participants mentions that heavy reliance on ChatGPT could be a downfall for students who are starting to produce their own code. Commenters on Youtube and Reddit echoed the same concerns. The tensions in learning and being productive are what help students learn. Taking out the challenge, could hinder the process of taking in and fully understanding the code for the students.

"I think, whenever we're learning a new language. There's always a phase where you'll be Googling everything to figure out. ChatGPT is good for that." - P2

"I know lots of people, like freshmen and sophomores specifically, using it for learning. A lot of times when they ask me for help, I do tell them to use ChatGPT. Just because a lot of times I think ChatGPT does a pretty good job at explaining stuff. Not for the purpose of getting answers, but to explain why certain things are like this." - P1

"Students, even college students miss the point of education, education is not about knowing stuff, that's a side effect, your brain needs to be exposed to the process of thinking in order to develop, just like how neuroplasticity works, if you don't use that part of the brain you lose it." - Reddit

"Making a daily effort to review what I've previously read has given me a rich long-term memory, which I can compare all newly acquired knowledge with. This has enriched every experience I've ever had. Relying on technologies to spoon-feed us knowledge when we need it to solve a problem will probably encourage people to become dumber." - YouTube

"Relying on ChatGPT sometimes could kill a lot of the learning aspect. We're in a more of a school setting, so that takes a lot away, and I think Chat GPT has its brilliant movements in which it could be pretty powerful, but I don't want to over rely on it too much as well." - P1

6.3 Impacts on Education and Industry

Finding: ChatGPT makes learning more accessible by reducing learning curves and being more available than traditional education.

Through the lens of education, many praised ChatGPT for being a beginner-friendly learning tool since it uses more casual language and is easier to understand. It acts as a widely accessible learning tool for those who don't have the resources to receive traditional education since the basic tier is free for most people to access.

"I'm someone from a totally different career path who just decided to learn to code to help improve my own work. I've made this decision because AI is giving me the sense that coding is something more achievable for me now (it feels less cryptic when I have someone/something to guide me step by step)." - Reddit

"I've been using it for 1 week. It's so good. It could replace 99% of our teachers. It answers exactly what you want. and gives simple and good explanations. It's 1000 times better than our uni teachers. Our teachers literally read powerpoints without even explaining anything." - YouTube

"When I first tested ChatGPT, it blew my mind with awesome results. As an ed-tech consultant, I am always interested in how technology can improve and make education accessible to all. If AI is used correctly, it can significantly improve quality and accessibility to education." - LinkedIn

Finding: Although many were worried about SWE getting replaced by ChatGPT, most people were confident that software engineers will continue to play a vital role in driving innovation.

Most online discussion talks about ChatGPT's effectiveness in assisting with learning how to code, which prompted lots of concerns about job replacement by AI in the field of software. However, we discovered while general discussions were heavily geared towards

the replacement of SWE in the future, the general sentiment was mostly optimistic. Many people have confidence in engineers' drive for innovation and their problem-solving skills.

> *"There is, and always will be, infinite demand for software engineering resources, as projects inevitably become infinitely more complex. AI will, however, replace the need for most entry and mid-level programmers." - Reddit*

> *"I think of AI and programmers as Wordpress and Web developers. They both have needs and purposes for different uses but both are needed! We can definitely benefit from AI, but it's definitely not going to take over!" - YouTube*

> *"I believe LLMs are better thought of as virtual assistants, rather than human replacement. In the particular field of education, it is to aid teachers and students to improve learning, hence it shouldn't be blocked." - LinkedIn*

6.3 Insights Summary

Through our studies, we found that the online communities and our focus group participants shared some similar sentiments. The biggest advantage that ChatGPT provides is its efficiency and customized answers, which expedites the learning process and tailors the material and feedback to the student's needs which is hard to achieve in traditional education. Specifically, many are using it to help summarize design documents and assist with coding as a co-pilot. It saves time and effort for both the students and educators when it comes to learning new materials.

With the increased automation of learning and access to knowledge, people are concerned about ChatGPT becoming a shortcut that hinders proper learning and critical thinking. Sharing similar concerns, one of our focus group participants shared their ideal workflow which is only relying on AI technology when it comes to tedious tasks such as summarizing and documentation but relying on oneself to tackle the challenging and more complex problems.

With ChatGPT, the reduced cost and learning curve for students could make programming education more accessible for the underprivileged. The increased efficiency and customization can improve students' learning journey. There are many foreseeable problems, however, starting by putting guardrails into practice, such as usage guidelines

and workshops, could help solve the preliminary concerns and help skeptics be more accepting of this new technology being used in education.

7. Implications

In this study, we have discovered that the use of ChatGPT in learning and schoolwork becomes more prevalent. Although some raise concerns about negative impacts on student learning, the use of ChatGPT seems to be an inevitable trend. Therefore, we hope that this study can provide some insights for **educators and students**. First of all, we have noticed that one concern people raised is that utilizing ChatGPT to write assignments is likely to rob students of the motivation to learn and hinder their critical thinking process. Regarding this point, educators could consider changing the way assignments are given so as to minimize the use of ChatGPT to do assignments and further assess students' learning and performance. For example, instructors could design assignments that require students to demonstrate their problem-solving, critical thinking, and communication skills by asking them to participate in group discussions, presentations, or other interactive activities.

In addition, although ChatGPT is a powerful learning tool, it is worth noting that overreliance on ChatGPT tends to pose a threat to students' learning and creativity. Since it is difficult to ban students from using ChatGPT, schools could consider developing policies and procedures for students' use of ChatGPT and providing training and support for students in order to ensure that students make use of ChatGPT reasonably, responsibly, and ethically.

8. Future Work & Reflection

8.1 Learning Reflection

In this study, we realized there were lots of things to be mindful of to conduct an effective and unbiased research focus group. Moderating takes practice and it is useful to take into account the participants' personalities and talking styles. Here are our learnings from the focus group discussion:

- Emphasize open discussion - Participants expressed that they felt restricted by the questions and that they were afraid that starting a discussion would hold back the focus group. For example, one participant shared that they wanted to probe deeper into an opinion another participant shared, however, they knew that the focus group time was almost up, so they refrained from asking the question.

- Consider not having participants share their background - Participants reflected that they were afraid their opinions weren't as valuable since they were less experienced compared to the other participants.
- Be prepared for changes - A participant was late to the focus group and the other had to wait for him. We still finished our focus group in the allotted time, but it would be better if we had prepared something for the other participants while they were waiting.

8.2 Future Work

There are several avenues for future work that can contribute to the advancement of ChatGPT technology. These potential research directions can benefit not only researchers but also designers, policymakers, and the broader community.

Future research can focus on understanding the specific needs and preferences of users, including designers and other stakeholders when utilizing ChatGPT. Conducting user studies and gathering feedback on different ChatGPT use cases and workflow can help tailor guidelines and features to meet the unique requirements of various users. By involving designers in the development, ChatGPT can be refined to better support their creative processes and overall usability.

Research is needed to inform policy-making and governance frameworks surrounding the use of ChatGPT in various domains. This includes addressing legal and ethical considerations, and accountability. Establishing regulations and guidelines for the usage. Collaboration between researchers, policymakers, and industry experts can help shape policies that promote responsible and ethical use of ChatGPT, while also considering potential impacts and implications.

9. Appendix

- Reference
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- Screening Survey
- Script for Recruitment
- Information Sheet
- Consent Form
- Codebook

10.   Personal Reflection

Throughout this research project, I have had the opportunity to delve into the complexities of studying the impact of ChatGPT technology on software engineers. It has been a valuable experience that has allowed me to reflect on my methodological skills and consider their application in future endeavors.

One of the key methodological skills that I have honed during this project is conducting focus group discussions. I have learned how to effectively facilitate conversations, probe for deeper insights, and manage group dynamics. These skills have been crucial in eliciting rich qualitative data from participants and uncovering their perspectives on the use of ChatGPT in software engineering contexts.

In the future, I intend to apply my methodological skills by conducting more comprehensive and diverse studies. I aim to expand my research scope to include a wider

range of participants, such as software engineers from different experience levels and backgrounds, as well as industry professionals and stakeholders. By doing so, I can capture a more comprehensive understanding of the impact of ChatGPT and its implications in various professional contexts.

Furthermore, I will continue to refine my skills in data analysis and interpretation. This involves employing rigorous qualitative analysis techniques to derive meaningful insights from the data collected. I will also explore the integration of quantitative methods to complement the qualitative findings and provide a more comprehensive understanding of the research topic.

Additionally, I recognize the importance of ethical considerations in conducting research. In the future, I will be more vigilant in ensuring participant confidentiality, informed consent, and adherence to ethical guidelines. I will continue to prioritize the well-being and rights of the participants while maintaining the integrity and validity of the research process.

Overall, this research project has allowed me to strengthen my methodological skills and gain valuable insights into the impact of ChatGPT technology on software engineers. I am excited to apply these skills in future research endeavors, contributing to the advancement of knowledge in the field and addressing the emerging challenges and opportunities in the realm of artificial intelligence and human-computer interaction.