Investigating Computing Science Students' and Educators' Initial Perceptions of ChatGPT in Higher Education

by

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Abstract

The rise of Generative Artificial Intelligence (GenAI), particularly Chat Generative Pre-trained Transformer (ChatGPT), highlights the pressing need to understand its impact within academia. This thesis investigates ChatGPT's role in post-secondary education, focusing on its usage, benefits and drawbacks as perceived by students and faculty. We present findings from two studies at a Canadian university: 1) A focus group with 40 computer science and engineering individuals discussed plagiarism and assessment concerns, advocated for ChatGPT usage guidelines, classroom assessments, and its mandatory disclosure. 2) An online survey with 39 participants assessed ChatGPT's educational implications. The chatbot is perceived as a valuable learning tool, providing access to additional resources and time savings. However, inaccuracies, academic dishonesty, and ethical issues such as bias and privacy emerged. These studies contribute to the understanding of GenAI's role in academia and provide insights for educators on the potential opportunities and challenges of using ChatGPT in academic settings.

Keywords: ChatGPT; Perception; Generative Artificial Intelligence; Artificial Intelligence in education; Post-secondary

Dedication

To the explorers among us who seek discomfort.

> Do not go where the path may lead, go instead where there is no path and leave a trail.
>
> Ralph Waldo Emerson

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Chapter 1

Introduction

1.1 Motivation

In recent months, the field of natural language processing (NLP) has witnessed a sharp rise in the use of advanced conversational AI models. While previous chatbots like ELIZA [99], PARRY [5, 21], A.L.I.C.E. [15] and Cleverbot [8, 103] existed, they lacked attributes such as scale, training data, and generative capabilities [56, 41, 7]. The latest advancement in this field is OpenAI's Chat Generative Pre-trained Transformer (ChatGPT) [60]. The AI chatbot was first released to the general public in November 2022 and has since become one of the fastest-growing consumer applications to date [60]. Within two months of its release, ChatGPT had already surpassed 100 million users [54]. This advanced language model is trained on a massive amount of data which, in return, allows it to understand the context of user prompts and provide human-like responses [79, 92, 88]. With capabilities such as answering questions, summarizing text and even writing essays, ChatGPT has the potential to revolutionize how we live and work [34, 51, 79, 93, 32]. As a result, this technology has ignited the interest of researchers to explore its implications in education and for professionals to seek various usages within their businesses.

ChatGPT is an extremely versatile chatbot with a wide range of capabilities. It can produce and debug computer code, compose music, write student essays, and even answer exam questions, depending on the context that it is used in [79, 93, 32]. This chatbot is based on a GPT-3 deep learning model that is comprised of 175 billion parameters and trained a large dataset [92, 85]. ChatGPT's pre-existing knowledge enables it to generate text in a variety of languages, including English, Spanish and French, as well as computer programming languages like Python, JavaScript, Java, and more [46]. It can also produce responses in different styles, ranging from formal to informal to humorous, depending on the user's preferences [46, 14, 24].

These advanced conversational AI models have far reaching applications in various industries, including education, healthcare and customer service [11]. The technology can be a pivoting point for higher education, particularly in the realm of student assignments and

assessments [102]. ChatGPT's ability to generate human-like responses can offer an unprecedented level of support for students. For example students can iterate on new ideas in real-time or even have their assignments completed by the chatbot [63].

A literature reviewed published in 2018 by Winker and Söllner highlighted that chatbots could have a "significant positive impact on learning success and student satisfaction" [102]. Additionally in February 2023, after ChatGPT had been released for four months to the public, an exploratory study on GPT-3 by Haluza and Jungwirth supported ChatGPT usage in academia as it can connect students from all around the world to learn together [34]. As part of this exploratory study, the authors prompted OpenAI's "*text-davinci-003*" AI model with various questions and analyze its responses. The findings from both the literature review and the exploratory study indicate that ChatGPT has a significant role in personalizing learning based on students' needs [34, 102]. Furthermore, a study conducted in January of 2023 on ChatGPT's on ChatGPT and traditional assessment in higher education by Rudolph et al., suggests that ChatGPT has the "potential to serve as a means of generating different scenarios for students to work together to solve problems and achieve goals" [79]. Moreover, a March 2023 qualitative study, on how ChatGPT impacts learning English by Ali et al. suggests that using the chatbot "generally motivates learners to develop reading and writing skills" and ChatGPT-based teaching is motivational [10]. These findings all support the overarching idea that ChatGPT's role in higher education could have a positive impact.

Nonetheless, according to study done by Sullivan et al., this unprecedented level of support also raises concerns about academic integrity and the role of course instructors [91]. After using content analysis of news articles (*N=100*), Sullivan et al. discovered that ChatGPT's release has prompted public discussions surrounding "academic integrity concerns and opportunities for innovative assessment design" [91]. Furthermore, a similar finding was reported by Qadir after conducting an exploratory study through prompting ChatGPT with specifc questions. According to Qadir, as students increasingly turn to ChatGPT for support in completing their assignments, instructors face uncertainty regarding how to approach this new technology [71]. This result was also in line with a systematic literature review (N=146) conducted by Zawacki-Richter et al. on artificial intelligence applications in higher education [107]. Based on these results, Zawacki-Richter et al. indicate that while the use of such chatbots can increase efficiency and improve the quality of work, it also presents significant challenges to minimizing plagiarism [107].

Despite the benefits that ChatGPT offers, the chatbot comes with limitations and drawbacks. As some early 2023 studies conducted by researchers in various universities around the world (e.g. Khalifa (UAE), Rangsit (Thailand), Kaplan (Singapore)) indicate, ChatGPT's limited data-set may provide inaccurate responses, thus make it unreliable [79, 88, 45]. These studies also point out that the chatbot could provide biased answers based on its training data [79, 88, 45]. Furthermore, a study of "AI language processing and its implications" by

Mattasa stresses the ethical and social considerations such as privacy that users must take into account while using the AI chatbot [51]. Although using ChatGPT in a programming course is not the focus of this thesis, the idea of using such tools in a computer science education context is the core idea to be investigated. The studies outline above provide relevant and applicable information in this context.

In spite of the preliminary research on ChatGPT (within 12 months of its public release) in higher education, there are minimal number of mixed-method (qualitative and quantitative) studies on this topic. The studies included in this thesis stands out as it echoes the voices of students and instructors on a topic which has become controversial in academia. At the core of this thesis is the following thesis:

> *Educators regularly lack the time and resources to explore, learn, and integrate teaching and learning tools for their classrooms. Providing them with in-context access to student and colleague recommended examples of how the latest's generative AI tools (specifically, ChatGPT) can impact their courses could provide a useful and usable means to overcome these common challenges.*

1.2 Research overview

As part of The Teaching Talks (TTT) and with pre-approval from the university's ethics office, I developed and co-facilitated (with TTT host and an undergraduate representative from Computer Science Student Society) a focus group session with a follow-up survey to explore the perception of ChatGPT (specifically GPT-3.5) within post-secondary education among undergraduate, graduate students and faculty members of Simon Fraser University's Faculty of Applied Science. Through this process, I provided a platform for participants to engage in an informal dialogue in a respectful, inclusive, and safe environment.

Overall, this thesis takes a mixed-method inquiry approach to provide answers to a number of research questions about students' and educators' perception of how ChatGPT (precisely GPT-3.5) would impact the educational space:

1. How do students/faculty believe ChatGPT should be incorporated into future courses and assignments?
2. How does ChatGPT impact in-class and take home assignments?
3. How should professors assess students and make sure the ChatGPT usage is adequate?
4. How would ChatGPT affect students' learning and/or job preparedness?
5. How is ChatGPT regarded as an educational tool?
6. How is ChatGPT used by post-secondary students and instructors?

7. What are the potential benefits and drawbacks associated with using ChatGPT in post-secondary education?

This investigation began in early March 2023, with an in-depth focus group session with 40 students and faculty members to explore the immediate and direct impact of ChatGPT on course elements such as assignments, assessment and students' learning. This session was conducted and advertised through the The Teaching Talks (TTT) series; a medium which provides an informal space for students and faculty to voice their opinions on the latest trends that impact the teaching and learning domain. Although participants did not receive any incentive to participate (aside from light snacks and refreshments, which are usual for these sessions), there were a significant number of individuals in the room considering the usual number of participants from previous TTT sessions. In addition to uncovering a surprising number of ChatGPT-users, the study also revealed how course instructors can adapt their teaching practices to better support students' learning. This study further highlighted that ChatGPT has a direct impact on student assessments such as take-home assignments which would require course instructors to develop clear guidelines to ensure responsible usage.

In a second study, focusing on the perception, usage, benefits and drawbacks of ChatGPT, I analyzed the responses of 39 anonymous participants who took part in a survey. With approval from the university's ethics office, the survey was distributed to participants of the TTT focus group session and all members of the Faculty of Applied (FAS) Sciences community through mailing lists and word of mouth. An incentive, respondents were entered into a draw and had a chance of winning one of ten $20 gift cards funded by the FAS Dean's office and FAS faculty teaching fellow (host of TTT series). This study uncovered various unique insights into the use of ChatGPT, demonstrating a strong inclination and motivation for students and faculty members to leverage this generative AI tool within their teaching and learning. This is in part due to ChatGPT's ability to provide quick, easy and personalized responses to users' query. However, concerns regarding ChatGPT's response accuracy, its potential to pave the way for academic dishonesty and the risk of reducing critical thinking skills among students who use the chatbot were raised.

Taking insights gained from these two studies into account, I implemented a set of AI-usage guidelines [73] for a second-year computer science class (CMPT 276: Introduction to Software Engineering [95]) at Simon Fraser University in Fall 2023 semester, about 10 months after the release of ChatGPT. As an instructor for this course, I provided the option for students to use any generative AI tool they'd like to complete their course assignments, labs, and project components, however, using any AI tools for exams such as midterms and quizzes were strictly prohibited. As part of this process, students had to submit a detailed AI-usage disclosure form [74] for every assignment, lab and project milestone submission. This process provided a transparent and proactive approach for using generative AI tools such as ChatGPT in an educational space. With approval of university ethics office, I will

be analysing the impact of ChatGPT's usage on students' learning and performance by correlating their reported usage of these tools (through the AI-usage disclosure form) and their grades.

1.3 Contributions and thesis structure

The main contributions presented in this thesis are:

1. Empirical insights into immediate and direct impact of ChatGPT (particularly GPT-3.5) on course elements such as assignments, assessment and students' learning from students and faculty members (**Chapter 3**).

2. Understanding students' and faculty members' perception, usage, benefits and drawbacks of ChatGPT (specifically GPT-3.5) in education through an empirical approach **(Chapter 5)**.

Although both studies were focused on ChatGPT's role in an educational context, different research methodologies were used to get a wide range of data (e.g. qualitative and quantitative) and gain more detailed insight. **Chapter 4** bridges the two studies together and highlights how they are connected.

The structure of this thesis is as follows:

Chapter 2 provides an outline of relevant research literature and other works in domain of generative AI tools within education. In particular, it contextualizes this work among research into existing use of AI tools before the release of ChatGPT, the use of chatbots in education and ethical application of ChatGPT in an educational context.

Chapter 6 reflects upon the broader takeaways for using ChatGPT in an educational context and includes specific limitations of this work which can help drive future research in this domain. This chapter also touches on the importance of computer science education as a research area and indicates how this could drive future research on this topic.

Parts of this thesis have previously been included in peer-reviewed publications (or are being reviewed for publication). Specifically, the content of **chapter 3 and 5** contain the conference (Western Canadian Conference on Computing Education [98]) and journal (Education and Information Technologies [90]) papers which I was the first author of, as part of my degree and the heading of these chapters reflect the original publications. The research on ChatGPT's application in a second-year Software Engineering course, while not included in this thesis but inspired by it, is currently being authored for future conference and journal publications.

Chapter 7 wraps up the thesis, summarizing key findings from the focus group and survey. It provides an overview of ChatGPT's implications in post-secondary education. The chapter also discusses the limitations and potential future research directions based on these studies.

Appendix A and B contain the original questions provided to participants in the focus group and survey respectively.

Chapter 2

Background and related works

In this chapter, I contextualize my research within the wider research literature surrounding how large language models (LLMs) such as conversational agents (e.g. ChatGPT) are used within computer science education and what their implications are. This overview of existing work is applicable to both studies in chapters 3 and 5 respectively. Due to the novelty of ChatGPT, there is a growing body of literature that is published on a rapid pace [36, 17, 27, 84, 86, 87, 14, 11]. As a result, this literature review is only up-to-date as of early November 2023 and includes publications within the domain of computer science and education in post-secondary context. Any published work outside this domain or released after early November is excluded from this thesis.

2.1 Early explorations and evolving perspectives of chatbots in education

A 2018 systematic literature review by Winkler and Söllner, two university researchers in Switzerland and Germany, explored the potential of chatbots in education, finding that "chatbots are in the very beginning of entering education" [102]. This review also suggests that chatbots "promise to have a significant positive impact on learning success and student satisfaction" due to their ability to react to individual intent as they provide real-time feedback [102]. Furthermore, Winker and Söllner report that chatbots can be used to increase student motivation in learning by giving them more control of their learning process [102]. The authors also note that chatbots have a major advantage compared to asynchronous ways of communication as students can engage in a conversation with them at any time [102]. On the other hand, this review also stresses that students do not interact with chatbots the same way they do with human teaching staff and students often "apply simpler sentences" with poor vocabulary which as a result, makes it difficult for chabots to understand students' intentions [102]. Although this may have been valid in 2018, with the release of ChatGPT in 2022, this no longer is an area of concern. ChatGPT's extensive training data allows it to easily recognize user prompts, even when simple sentences and poor vo-

cabulary is used. Lastly, Winker and Söllner advocate for future research to be conducted on understanding at what point in the learning process humans or chatbot assistants leads to better learning outcomes [102].

A research study was conducted in January of 2023 on "How May AI and GPT Impact Academia and Libraries" by Lund and Wang, highlights that "ChatGPT has considerable power to advance academia and librarianship in both anxiety-provoking and exciting new ways" [48]. The authors of this study used a novel methodology of conducting an interview with ChatGPT. The researchers asked ChatGPT specific questions regarding it's role in academia while also including queries surrounding the ethical and privacy implications of itself [48]. The results of this AI-interview study indicate that elements such as ethical considerations, privacy, and bias play a major role in how this technology could affect the field of academia [48]. In a literature review study published in February of 2023 on AI language processing and its implications, Mattas warns of ChatGPT's potential to "revolutionize the way we interact with technology" and stresses that it could change "the way we communicate and access information" [51]. Both studies suggest that a careful approach is needed before ChatGPT is integrated in an academic setting. Despite the timely release of these publications, they do not provide much insight into how stakeholders can manage the ethical considerations of ChatGPT such as privacy and bias. Furthermore, the studies lack specific applications of ChatGPT within an educational domain, an area that is need of investigation due to the rapid growth in ChatGPT's popularity among students. While both Lund and Wang, and Mattas acknowledge the disruptive potential of ChatGPT in academia, their research does not delve deeply into the chatbot's practical benefits and drawbacks in an educational settings. Specifically, the study led by Lund and Wang did not lacked human participants and the literature review by Mattas was conducted only a few months after the release of ChatGPT. This gap highlights the need for further and more up-to-date investigation of ChatGPT in an academic domain, which this thesis aims to fill.

2.2 ChatGPT within computer science education

The growing use of ChatGPT among students and educators in the computer science community has sparked a new wave of in-depth research within the domain (e.g. Generative AI in Computing Education Working Research Group [30]). In particular, within a few months of ChatGPT's release, researchers in 2023 have been busy examining its role within the computer science education discipline [23, 84, 86], identifying its opportunities [39, 12, 72, 36], threats [24, 55] and perception among students [89, 88, 89] and educators [45, 97]. Furthermore, the idea of using generative AI tools such as ChatGPT and GitHub Copilot [31] to teach and assess students in programming courses has also been explored [100, 81, 69, 27, 40]. Almost all the literature on this topic have been published within 2022 and 2023.

Notably, Porter and Zingaro have recently (September 2023) published a book, "Learn AI-Assistant Python Programming", which leverages GitHub's Copilot, an AI-based assistant, to teach basic programming concepts using Python [68]. The authors propose that this level of integration of ChatGPT within computer science education allows new students to learn programming skills while also mastering AI tools to use within their learning experience [68]. Porter and Zingaro walk students through the basics of writing how to read Python code, to introducing them to their very own AI assistant, Copilot [31]. The authors define AI assistant as "an Artificial Intelligence (AI) agent that helps you get work done" [68]. Through this approach, the authors also expand on how Copilot has changed the way we program and also discuss various risks, challenges and societal concerns associated with using such AI code generators [68]. This book offers a wealth of knowledge on how students with minimal background on computer science can use Copilot AI coding assistant [31] to create a wide range Python programs from basic "Hello World" to games similar to Wordle [94]. Nonetheless, this approach of teaching and learning programming is novel and yet to be tested with real students. Future research on this exciting approach could shed light on its effectiveness to teach students who possess no computer science background how to write and understand programming.

A trending and comprehensive (51 pages) research was recently published in early October 2023 by 15 leading domain experts from 8 different countries including Prather, Denny, Leinonen, Becker, et al. which aim to explore the role of large language models (LLMs) within computer science education [70]. All 15 authors of this paper are part of a working group called "Generative AI in Computing Education" [30] which was developed as part of ITiCSE's 2023 conference: Innovation and Technology in Computer Science Education [38], as a response to the growing use of ChatGPT within computer science education. This working group report presents findings from an exhaustive literature review on LLMs in computer science education and discusses the results of a survey from computing science students and instructors which includes 20 different countries [70].

The literature review conducted by the Prather et al. suggest that "LLMs will have substantial impact on computing education and programming more generally" [70]. Additionally, the review results indicate that there is no agreement on the benefits or risks of using LLMs in a computer science course, however stakeholders are aware of issues surrounding academic integrity due to LLMs being misused by students [70]. Moreover, some specific benefits of LLMs in education were also mentioned such as: reduction in instructor workload [25, 49, 81], automating grading [104], providing personalized help for students [64, 16, 9], help students understand programming errors [43, 19, 50], and rethinking assessment practices within computer science courses [13, 26, 67, 82, 77, 80, 83]. In addition, various risks were also identified from the literature, these include: inaccurate responses to explain code [100, 81, 62], excessive time spent on prompt engineering than making process to solutions [100], hallucination of LLMs [35], unauthorized usage for assignments (e.g.

plagiarism) [65, 55, 33], over-reliance of students on generative AI tools to solve problems [42, 12, 78, 44, 28] and assist in debugging code [43, 108, 66].

The results from the survey conducted by the Prather et al. point to a similarity in perception of generative AI tools by both students and instructors [70]. Specifically, students and instructors were aligned on their: 1) experience of using generative AI tools, 2) belief that some restrictions should be placed on the usage and 3) expectations of the tools [70]. Interestingly, the specific area that the two parties did not agree on were usage policies of generative AI tools [70]. In particular, the majority of students agreed to the following statement "the policies at my university are clear regarding what is allowed and what is not allowed in terms of using GenAI tools", while the majority of instructors disagreed [70]. This misalignment occurred in the same sequence for the following statement: "the policies in the courses I [took/taught] last semester were clear regarding what is allowed and what is not allowed" [70].

This report by Prather et al. also includes findings from in-depth interviews of computing educators who have adapted their courses to LLMs [70]. The findings associated with these interviews include that most instructors were not using generative AI tools within their courses, however, a large majority of them plan to incorporate some generative AI tools [70]. The interview results also suggest that instructors leaned towards using ChatGPT to develop educational materials such as assessment questions, however, it was suggested that the quality of AI-generated content requires improvement [70].

The research presented by Prather et al. also touches on ethical implications of using AI tools through the lens on Association for Computing Machinery's (ACM) Code of Ethics [29, 70]. ACM is an academic-based society that hosts a digital library of publications which focus on advancing "computing as a science and a profession" [29]. The ethical considerations presented in the report were aligned to ACM's Code of Ethics: 1) Avoid harm, 2) Be honest and trustworthy, 3) Be fair and take action not discriminate, 4) Respect the work required to produce new ideas, inventions, creative works and computing artefacts, 5) Respect privacy, and 6) Honor confidentiality [29, 70]. The authors argue that these ethical principles provide a framework of thinking and acting on information provided by generative AI tools such as ChatGPT and other LLM models [70].

Lastly, the findings of this report also highlight the performance of LLMs on various computing education data sets. The results presented on this regard suggest that new LLMs such as ChatGPT-4 are significantly more capable than their previous predecessors [70].

In short, this comprehensive report presents results in various imperative directions, including: 1) a thorough literature review of the most recent publications on LLMs in higher education, 2) a survey from computing students and instructors on their perception of LLMs, 3) an interview of instructors who have adapted their courses to LLMs 4) ethical considerations of LLMs through ACM's Code of Ethics [29], and 5) performance of LLMs on various computing education data sets. The combination of these results provided the

community with insights that are practical and can be infused within computer science courses in the coming semesters.

2.3 ChatGPT's ethical, assessment, and integration Challenges

An early study conducted in January 2023 on ChatGPT and traditional assessment in higher education by Rudolph et al., indicates that this chatbot raises concerns about using essays and online exams as an assessment method within all disciplines. Furthermore, the authors argue that instructors may resist in adapting to the change in assessment methods and this may cause problems in the future as "it might not be long before Microsoft integrates ChatGPT's technology" [79]. After this integration, Rudolph et al. argue that ChatGPT would become the new norm and it could be "too late for educational institutions to adjust policies to guide their students" as it would be heavily integrated in professional tools within academia. This call for action by Rudolph etl al. is imperative and requires a timely response by educational institutions in order to proactively adapt their policies and practices. As Rudolph et al. highlight, this approach is essential for academic institutions to effectively integrate tools like ChatGPT within their courses and assessments. Interestingly, Rudolph et al. propose an opportunity for educators to introduce an "innovative assessment" within their courses to "foster students' creative and critical thinking abilities" [79]. With this respect, Rudolph et al. recommend educators to avoid assessments that are "so formulaic that nobody could tell if a computer completed them" and shift towards peer evaluations and teach-back techniques to measure students' learning [79]. However, the study by Rudolph et al. falls short in providing concrete examples or detailed strategies for implementing these innovative assessment methods. While the suggestion to move towards peer evaluations and teach-back techniques is valuable, the study does not elaborate on how these methods can be effectively integrated into existing curricula or assessment frameworks. This lack of specificity leaves an important gap in understanding the practical application of their recommendations.

An literature review conducted by [52] in early February of 2023, delved into the ethical and responsible application of ChatGPT in educational contexts. Mhlanga, a researcher from the University of Johannesburg in South Africa, suggests that this AI chatbot could possibly "completely transform the method by which students acquire knowledge and access information within the realm of education" [52]. As part of this review, the Mhlanga examined 23 publications that discussed ethics of AI in education and responsible use of ChatGPT, drawn from academic libraries such as Google Scholar [2], Web of Science [57], and ResearchGate [3]. As part of the findings of this review, the author argues that students can potentially use ChatGPT for personalized learning that are aligned with their interests and needs, with the added advantage of global accessibility, given the chatbot's

multilingual capabilities and proficiency across many subjects. Despite the advantages, Mhlanga cautioned users about their ethical and social obligations when utilizing ChatGPT in an educational setting. Furthermore, the author expressed concern that the chatbot could inadvertently "reinforce preexisting prejudices and forms of discrimination", which could negatively affect the quality of students' learning experiences [52]. Mhlanga firmly asserted that protecting user privacy should be the "primary priority" when it comes to using AI tools such as ChatGPT in an educational context [52]. Moreover, the author advocates for educating students about the necessary steps they should take to protect their personal data from ChatGPT. The study also explored the potential of ChatGPT as an grading tool, however, Mhlanga emphasized that students should not be treated differently or be discriminated against because of their use of ChatGPT, irrespective of their colour, gender or background. Above all, the study stressed the importance of maintaining transparency in using ChatGPT to preserve integrity among educators. While this review provided an insightful on ChatGPT's educational usage, it did not delve deeper into the practical integration of ChatGPT within existing courses and frameworks, leaving an imperative gap in understanding how this tool can be embedded in current curricula. Lastly, despite the timely literature review (about 3 months after the release of ChatGPT), it is evident that further research is needed to fully understand the impact of ChatGPT in educational settings, especially in a post-secondary environment.

A two-stage study conducted by Shoufan in mid March 2023, explored students' perception of ChatGPT through a thematic analysis and follow-up survey [88]. In the first stage of this research, the author recruited 48 out of 56 senior students enrolled an embedded systems course to evaluate ChatGPT using their own words after completing a learning activity by using the chatbot [88]. The second stage of this study included a 27-item questionnaire which was designed based on the themes identified from the first part [88]. Thematic analysis of students' response ($N=48$) to an open question resulted in 67% comments that reflect positive perception of ChatGPT while the remaining 33% comments included negative perception [88]. The study results highlight students' enthusiasm and excitement about ChatGPT technology due to its ability to "improve quality of work/study" and the "human-like" responses that it can produce [88]. On the contrary, students raised concerns regarding the chatbot's "inaccurate output" and inability to understand user prompts [88]. The follow-up survey results of this study suggest that the overall student perception of ChatGPT is positive and the majority feel motivated to use it; which is inline with other studies results in this realm [45, 63]. However, some drawbacks of the chatbot include its inability to replace human intelligence and the extensive prior knowledge required to use ChatGPT to its full potential. Overall, the study results suggest that "a new era of information technology" is coming soon, which could include an "unprecedented [level of] interest in ChatGPT" to benefit students' learning [88]. Shoufan's study, while revealing significant insights into post-secondary students' perceptions of ChatGPT, does not fully explore cer-

tain important aspects. It overlooks a detailed analysis of the negative perceptions that nearly 33% of the participants provided. The study also misses examining how ChatGPT might impact different learning styles, an area that is imperative for understanding its integration into different settings. Additionally, the potential for students' over-reliance on ChatGPT and its implications on their critical thinking is not addressed. Lastly, the study does not include perception of course instructors and their viewpoints on integrating ChatGPT into their courses. This perspective is necessary, as faculty members play a key role in shaping how such technologies are adopted and used for teaching and learning. Without acknowledging the educators' views and concerns, there's a gap in understanding the full implications that ChatGPT might bring into the education space. This study, similar to the ones reviewed in this thesis, leaves room for further research into the unaddressed areas to gain a better understanding of ChatGPT's role in higher education, both from the students' and educators' perspectives, which this thesis aims to fill.

A similar study, published in mid July 2023, on students' voices on generative artificial intelligence by Chan and Hu reveals a "complex and nuanced picture of both enthusiasm and concerns" [17]. As part of this study, 399 undergraduate and postgraduates from various disciplines (including computer science) in Hong Kong were surveyed. The findings of this study suggest that students are "generally familiar with GenAI [Generative AI] technologies" and their familiarity is influenced by frequency of use and prior knowledge of AI technologies. Furthermore, the study results indicate that students demonstrated a good understanding of GenAI technologies and showed "positive attitude towards using these technologies in their learning, research, and future careers" [17]. The top identified benefits of GenAI technologies include personalized learning and support for writing, brainstorming, research, analysis, administrative tasks, visual and audio multi-media [17]. Despite the positive perception, the study also revealed students' worries regarding GenAI's "reliability, privacy, and ethical issues" and its potential influence on "personal development, career prospects, and societal values" [17]. The study findings noted the following as challenging concerns associated with GenAI technologies: accuracy, transparency, privacy, ethical issues, career prospects and human values. As a whole, this study highlights the complex perception of students towards GenAI technologies in their academic and professional journeys. While the study by Chan and Hu shed light on students' perception of GenAI, the research also misses some aspects. In particular, the study touches ethical, privacy and reliability issues, however it lacks more in-depth analysis for these ethical dilemmas and does not offer any solutions. Furthermore, the study overlooks the role of educational institutions in integrating GenAI into curricula. Without this consideration, the study does not address how the use of GenAI can be guided and monitored within academic. Lastly, while identifying challenges associated with GenAI, the study falls short in suggesting strategies to mitigate these concerns.

In August 2023, an interview-based study titled "Generative AI in Computing Education: Perspectives of Students and Instructors" was conducted by Zastudil et al., explored generative AI's impact on computer science education [106]. Through semi-structured interviews with 12 students and 6 instructors from the computer science department at a large R1 university in Unite States, the study delved deeper into their experiences and perceptions, highlighting both the potential benefits and concerns associated with generative AI (GenAI) in education. Some of the advantages of generative AI tools that were identified by participants include: help students understand code and computer science concepts, reduce the effort to write code, provide on-demand learning and aid in creative processes (e.g. brainstorming and developing coding solutions) [106]. On the other hand, the study also surfaced several concerns. Among these concerns include: the potential for over-reliance on generative AI tools, inaccurate or misleading responses (trustworthiness of the output) and the increase of plagiarism among students (academic integrity) [106]. The results of the study suggest that students and instructors believe "computing course curricula and assessment methods should be updated to include GenAI tools" [106]. Through this approach, instructors could "teach students how to use GenAI tools by teaching students the best ways to prompt tools such as ChatGPT and the limitations and risks of using these tools" [106]. The research findings indicate that this shift could potentially allow students to engage more deeply with the material and develop a more comprehensive understanding of computer science concepts [106]. While the study provides rich insights into how students and instructors perceive generative AI in computing education, it is important to acknowledge its limitations. The study's findings are based on a small sample size (*N=18*) and the authors do not distinguish the academic level of the students involved in the study. In addition, both the instructors and students were recruited from a single R1 university, which includes a relatively narrow demographic representation. With those limitations in mind, this study provides an opportunity for further research in this space to better understand the implication of GenAI in an education setting. Although there are similarities between this research and the studies discussed in this thesis, it's important to note that the studies in the thesis were conducted in early March 2023, whereas the work by Zastudil et al. was published in August 2023, about five months later.

An interview-based study by Limna et al. conducted in mid May of 2023 delved deeper into the experiences and perceptions of educators and students regarding the integration of ChatGPT in an educational setting [45]. As part of this research, the authors (researchers from 2 universities in Thailand) recruited a total of 25 participants (unknown disciplines), with a mix of educators (*N=10*) and students (*N=15*) from various academic institutions in Thailand. Primarily, the findings of this interview-based study indicate that both educators and students view ChatGPT as a positive tool, especially for its ability to "quickly respond to students' questions and provide additional resources to enhance their understanding of a given topic" [45]. From the educators' perspective, a significant highlight includes

ChatGPT's ability to streamline workload by "answering common questions and freeing up time for [educators] to focus on more complex issues" [45]. However, with such efficiency came critiques from various educators who noted ChatGPT's incapability to respond to non-intuitive questions and warned that the chatbot is "not a substitute for personalised support and guidance that educators could provide" [45]. Furthermore, educators raised concerns regarding the ChatGPT's inability to provide accurate and unbiased responses due to the chatbot's "pre-programmed algorithms, which might not always account for the specific nuances of a given question or topic" [45]. Lastly, data privacy in ChatGPT emerged as a significant concern for both educators and students. Participants noted that using ChatGPT in an academic setting might involve sharing personal information, such as student names, email addresses, and academic grades. This, in turn, could pose a risk for "potential data breaches or cyberattacks that could compromise their personal information" [45]. The study by Limna et al. offers valuable insights into the use of ChatGPT in education, but it overlooks several key areas. In particular, the study highlights educators' concerns about ChatGPT not being a substitute for personalized support, however it fails to discuss how AI could serve as a supplementary tool for traditional teaching methods. The interview-based study also did not disclose the academic background of participants, thus it is difficult to apply the results of the research to a specific domain. Furthermore, Limna et al. do not address how reliance on AI tools like ChatGPT could impact the development of students' critical thinking and problem-solving skills. Lastly, the study touches on the issue of data privacy but does not explore the broader implications of using generative AI in an educational environment where sensitive student data is involved. This study serves as a launchpad for future researchers to delve deeper into areas such as the potential for AI to complement traditional teaching, and the impact of AI on the development of critical thinking skills in students.

Chapter 3

Exploring ChatGPT's impact on post-secondary education: A qualitative study

3.1 Introduction

My first study [1] sought to understand the immediate implications of ChatGPT within the academic space, specifically in regards to how it should be incorporated into assignments and the indirect impact on assessment evaluation. Because of the rapid pace at which ChatGPT spread through academia, in early 2023, many faculty members were caught off-guard on how to infuse such technology into their courses. The primary goal of this study includes investigating what education stakeholders think about its potential in higher education. This March 2023 focus group study aims to address the following research questions:

- RQ1: How do students/faculty believe ChatGPT should be incorporated into future courses and assignments?
- RQ2: How does ChatGPT impact in-class and take home assignments?
- RQ3: How should professors assess students and make sure the ChatGPT usage is adequate?
- RQ4: How would ChatGPT affect students' learning and/or job preparedness?

The analysis of the data suggests that integration of ChatGPT in post-secondary education presents both exciting opportunities and serious challenges. Opportunities such as

[1] Parts of this chapter were originally published in Parsa Rajabi, Parnian Taghipour, Diana Cukierman, and Tenzin Doleck. Exploring ChatGPT's impact on post-secondary education: A qualitative study. *In Proceedings of the 25th Western Canadian Conference on Computing Education*, WCCCE '23, pages 1–6, New York, NY, USA, July 2023. Association for Computing Machinery. [76]

facilitating learning, helping with debugging and reducing time needed to read long material, are all areas that ChatGPT thrives in. Nonetheless, issues such as academic dishonesty, inaccurate responses and possible over-reliance on the chatbot, are elements of concern. To combat these, there is a need for clear AI policies, more in-class elements, mandatory report of ChatGPT usage, and proactive discussion on responsible practices. These steps can help maximize the benefits of ChatGPT while minimizing its potential drawbacks in an academic setting.

3.2 Methodology: Focus Groups

To examine our research questions, we structured our study based on a 120 minute focus group where participants discussed and documented their answers to the questions provided to them. The session, conducted in early March 2023, offered sufficient scaffolding to help facilitate the discussion on this emerging area.

3.2.1 Study design

This research study leveraged an existing program called *The Teaching Talks (TTT)* which is available to both undergraduate and graduate students, as well as faculty members at Simon Fraser University (SFU), a research university in Canada. SFU has a student population of over 35,000, and the TTT is specifically offered within the Faculty of Applied Science, which includes 1,300 undergraduate students, 200 graduate students, and 55 faculty members. The TTT provides a platform for individuals to discuss topics related to teaching and learning within the faculty, and undergraduate, graduate, and postdoctoral students can participate alongside faculty members. The Faculty of Applied Science is composed of four schools: Computing Science, Engineering Science, Mechatronic Systems Engineering, and Sustainable Energy Engineering. The session, titled "ChatGPTTT: Listening to the Students' Voices" was open to students and faculty members from all four schools.

With approval from the university's ethics office, the study adopted a focus group method to gather the thoughts and opinions of participants. All participants were informed about the study and consented to have their data included. Alongside the educational event director from the undergraduate computer science society (CSSS) [22], we prepared materials for the ChatGPTTT session, which served as the foundation for the focus group discussions. The TTT organizer, Diana Cukierman, and I led the focus group session and participated in the activities alongside participants.

3.2.2 Participants

During the session, there were a total of 40 participants who were divided into six groups. Each group consisted of 6-7 people and was randomly organized based on the participants' seating arrangements in the room. However, facilitators did ensure that a faculty member

was present for each group (at each table). Among the 40 participants, 13 were undergraduate students, 21 were graduate students and 6 were faculty members from across the four schools. At this session, 38 participants attended from computing science, while the remaining 2 were from Engineering Sciences. No other demographic information such as age or gender was collected.

3.2.3 Data collection

The study was conducted within a 120 minute TTT session that included 36 in-person and 4 virtual participants. After some initial ice-breakers, aimed at fostering a collaborative atmosphere, participants were introduced to the topic of ChatGPT in an educational context and observed a quick demo of how ChatGPT works. To facilitate the group discussions, a PowerPoint slide (as shown in Appendix A) was provided to each group which provided a space for the group to brainstorm and collaborate.

During these discussions, each group designated a notetaker which captured and documented the group's answers in their respective PowerPoint slide. Due to the dynamic nature of group discussions, we acknowledge that not every discussion item was captured, but the notetaker summarized the discussions and included the relevant information for the study. Following the discussions, each group had an opportunity to present their main takeaways and provide others groups in the session with what their group had discussed. The session concluded after some general discussion where all groups were able to share their answers with other participants.

3.2.4 Data analysis

After the session, a research collaborator and I aggregated the responses to each question from all groups. During this process, the data was cleaned to fix spelling mistakes and remove any identifiable information. We then independently analyzed the responses, identifying themes for each question using Thematic analysis [20]. Afterwards, we met to discuss any discrepancies and arrived at a consensus for the major findings. Each research question served as a main category that we used to analyze the collected data. Similar responses were grouped and direct quotes were extracted from the responses to support the findings associated with each question. The research collaborator assisted with cleaning and analyzing the data, which supported my own analysis. This was done to confirm the major findings through two separate independent analysis. The collaborator did not participate in writing any sections during this process.

3.3 Results

In our analysis, we observed diverse opinions and approaches to incorporating ChatGPT in post-secondary education (RQ1), however, there was consensus that the chatbot would

inevitably be used by students in courses, regardless if course instructors choose to integrate or not. For RQ2, participants suggested more in-class and synchronous elements to combat the misuse of ChatGPT in assignments. Discussion on RQ3 indicated that course instructors should report their ChatGPT usage in assignments and develop better plagiarism detection tools. Moreover, for RQ4, while participants acknowledged the benefits of ChatGPT for students' learning, they also emphasized that inappropriate use of the tool could have negative effects. In the following sections, we explore the findings related to each research question. To protect anonymity of the participants, the whole focus group was designed so a volunteer notetaker would be present to capture the discussion of the group. In this section, major themes in the group discussion are shared as G# (e.g G1, G2, etc.) where # is the number associated with the group.

3.3.1 Incorporating ChatGPT in courses

The majority of groups acknowledged that educators in post-secondary would inevitably have to face the reality of having the AI chatbot in their course or assignments. Some groups drew similarities between the current conversation on ChatGPT and the introduction of Google in the 1990s (G1, G2, G4, G6). ChatGPT could be described as an *"advanced search engine"* (G3) that *"facilitates learning"* (G4) and is *"good for making something out of nothing but not good for building on existing concepts"* (G2). Groups G1 and G3 respectively argue that *"regardless of what we think, ChatGPT will be used"* and *"[ChatGPT] should not be completely banned. Everyone will eventually use it"*. Moreover, one group suggested that *"googling"* is an important skill as *"programmers do not know all the tools to build a program"* (G4) and thus, teaching how to use ChatGPT effectively could be a way to incorporate it within the classrooms. Potential use-cases of ChatGPT include initiating ideas for assignment, finding and fixing code mistakes and completing tasks where one can verify its accuracy (G2, G3, G5).

Although all groups were in favor of incorporating this tool into post-secondary courses, concerns regarding academic integrity were raised. The lack of guidelines from the university and instructors on what would dictate misuse of ChatGPT was a recurring theme. G1 raised two questions that exemplify this issue: *1) "what if I expand my idea on ChatGPT? Is that cheating?" 2) "How can students cite content generated by ChatGPT?"*. Both questions illustrate that without clear guidelines as to what constitutes academic dishonesty, incorporating ChatGPT into post-secondary courses could be troublesome. Furthermore, G6 stresses that the AI chatbot is known to provide incorrect or misleading information which could introduce another challenge for incorporating it into assignments. According to G4, ChatGPT could also be *"biased or poisoned by the pre-trained data"* which would further reduce its credibility and validity as an educational tool. G3 also advised that *"students should not accept the answers [provided by ChatGPT] right away"* and that fact-checking is an important caveat of using ChatGPT. Similarly, G2 also emphasized that the chatbot

"could be biased as its outputs might be different between those who exclusively use ChatGPT for niche tasks compared to those who integrate it into their life and in the classroom".

3.3.2 In-class vs. take home assignments

The idea of restricting students to in-class assignments was appealing to most groups. G1 noted that *"in-class assignments ... provide a controlled environment where ChatGPT cannot be used"* while G2 suggested using quizzes built on the assignments to ensure consistency. By focusing on more in-class assignments and quizzes, instructors could better control students' access to ChatGPT. G6 proposed designing creative take-home assignments that would be difficult for ChatGPT to solve or developing in-person closed-book written quizzes. Moreover, G1 argued that *"in-class assignments are essentially exams"* and by introducing too many of them could put students under more academic pressure to attend classes and perform in a time-restricted environment. Take-home assignments would reduce this pressure, but at the cost of students possibly using ChatGPT to complete them (G1). Conversely, G3 acknowledged that, *"ChatGPT can help reduce writing blocks"* and argues that educators should *"not try to stop, but embrace it"* and adapt their course elements accordingly. This group also stressed that *"students should still learn the general mechanics of a concept"*, however, educators should acknowledge ChatGPT's presence and make appropriate changes to accommodate it.

3.3.3 ChatGPT and student assessment

Assessing student's submissions has always come with the caveat that some may use unauthorized resources to complete their take-home assignments (e.g. Chegg [18]) however, with the introduction of ChatGPT, detecting its usage has posed a new challenge to instructors and teaching assistants (TAs). The idea of how to identify students who have used ChatGPT was a common theme amongst all groups. According to G1, *"using ChatGPT is cheating"*, however, if faculty members add constraints, it would push more students to use ChatGPT within their assignments. Building on that idea, G2 argued that *"as long as the final exam is in-person [and] closed-book, ChatGPT is free reign"*. Interestingly, the same group also proposed that instructors could include a requirement in their assignments for students to provide a report on how they used ChatGPT. In this approach, student assessment can be adapted based on the level of ChatGPT usage within the assignment. Furthermore, according to this group, better plagiarism detection tools could help with *"detecting people who use ChatGPT"*, however, developing AI-based plagiarism tools could pose false-positives results and thus, reducing the system's validity and credibility.

In regards to adequate usage of ChatGPT, G2 insisted that ChatGPT should be kept *"away from involvement in exams as much as possible (such as creating exams)"* as this could add inconsistency between what was taught in the classroom versus what is tested on the exam. On the other hand, another group proposed that ChatGPT could be used for

marking assignments and exams to both expedite the process and provide more detailed feedback to the learners (G6). By doing so, the teaching team could spend more time working with students to bridge the learning gap as identified by the assessment results. Although the idea may seem attractive, G5 posed the question of whether course instructors should communicate that ChatGPT would be used to assess students' submissions. According to the same group, course instructors should *"make it clear if [they] want students to use it or not"*, thus the same argument stands for usage of ChatGPT by course instructors and teaching assistants.

3.3.4 Student learning and job preparedness

Majority of the groups indicated that using ChatGPT could be beneficial for students' learning, especially if they know how to use it properly. Interestingly, G1 mentioned that in the past, students focused on recalling specific previously learned material, but now, they are remembering associations with how to search on Google and utilize tools such as ChatGPT. The idea of how well a student can use this tool seems to be related to their learning takeaways. Specifically, without knowing the subject or topic at hand, students would not be able to use ChatGPT's full potential. Other groups reported a similar idea, for instance, G1 argued that *"knowing the correct prompt for finding the right answer is to know the subject"* which is also inline with G2's response, *"a lot of ChatGPT's usefulness comes with how well you can give it keywords to search things up"*. In other words, these groups suggest that ChatGPT is building on the students' existing knowledge and therefore, using it could further aid in their learning.

On the contrary, other groups presented counter arguments that using ChatGPT could negatively impact students' learning in post-secondary. G3 highlighted that *"some students will probably blindly [use] ChatGPT's answers and this could reduce their learning progress"* and G6 raised a similar concern that *"[ChatGPT] may take away from the learning process"*. These groups seem to suggest that the convenience of ChatGPT could cause students to promptly use the chatbot's answer for their assignments, which would take away from the critical thinking and hands-on practice that instructors were hoping students would engage in. Additionally, another group presented a new perspective that using ChatGPT could introduce *"isolation for students since they [would] stop communicating [with their instructors] to solving their problems"*. This group seems to suggest that using ChatGPT would allow students to easily find the answers to their problems without engaging in a conversation with the instructor. By reducing this communication channel, instructors could potentially lose an informal way to gauge students' learning.

Although most groups did not comment on ChatGPT impact on students' job preparedness, G6 did indicate that *"overuse of ChatGPT will never let you learn and will prevent you from getting [a] job"*. This suggests that students could possibly be less prepared for future

job opportunities as they heavily relied on using ChatGPT throughout their education and thus, they were unable to learn the necessary skills for their future jobs.

3.4 Discussion

The use of ChatGPT in higher education is an exciting development that has potential to revolutionize the way we approach teaching and learning. As such, there is a growing need to explore how this technology is being used in educational settings and how it can be leveraged to improve teaching and learning processes.

The results of this study indicate that both students and faculty members have mixed perceptions about ChatGPT's usage in a post-secondary setting. The conversational AI tool provides students an unprecedented level of academic support, however, this also raises great concerns about academic integrity and its role within students' education. Furthermore, many participants found the topic to be highly interesting and expressed a desire for additional sessions related to it. In the remainder of this section, we highlight the main findings associated with each research question discussed above.

3.4.1 RQ1: How do students/faculty believe ChatGPT should be incorporated into future courses and assignments?

For RQ1, we found that participants came to consensus that ChatGPT will inevitably be incorporated into post secondary courses and assignments. In any case, groups indicated that clear guidelines on acceptable usage must be established by the university or course instructors to avoid academic dishonesty. However, based on the results, the participants appeared to have been unaware of the syllabi guidelines that the university had recently published [4]. We used this session as an opportunity to share such material with all participants after the discussion concluded. Afterwards, a large group discussion on this material revealed that the guidelines may require revision, however, developing such documents was a great step forward by the university and academics.

Future discussion on RQ1 indicated that ChatGPT could be used to facilitate learning, initiate ideas for assessments, identify and patch programming code mistakes, and serve as an aid for tasks that do not require critical thinking. Participants warned that ChatGPT users must be aware of the tool's limitations, such as potential incorrect or biased responses and stressed on the importance of fact-checking the chatbot's responses.

3.4.2 RQ2: How does ChatGPT impact in-class and take home assignments?

Next for RQ2, results suggest that adding more synchronous elements such as in-class assignments and quizzes may regulate ChatGPT usage, encourage student attendance and engagement. Nevertheless, shifting to in-class activities could also increase academic pres-

sure on students and reduce learning opportunities outside the classroom. It is essential to strike a balance between in-class and take-home assignments to minimize the potential misuse of ChatGPT while maintaining a conducive learning environment.

3.4.3 RQ3: How should professors assess students and make sure the ChatGPT usage is adequate?

Groups presented various ideas for evaluating students and ensuring adequate ChatGPT usage (RQ3), such as requiring students to report their ChatGPT usage in assignments and developing better plagiarism detection tools. Although there was no agreement on how instructors should assess students and ensure ChatGPT usage is adequate, most groups raised important topics such as: 1) how ChatGPT can be detected, 2) whether course instructors should use the tool for evaluations and 3) communication of ChatGPT usage by students and instructors. Despite the lack of consensus, all groups did indicate that ChatGPT will change how students are assessed and academics should make an effort to understand its impact to better adapt post-secondary courses.

The discussion on RQ3 also raised the topic of how ChatGPT could be used by instructors or TA for marking assignments and exams. Doing so will provide more time for educators to focus on teaching and bridging learning gaps. Undoubtedly, if educators discourage the use of ChatGPT, they should be cautious about using it themselves (or their TAs) to avoid creating a double-standard policy in the classroom. Course instructors should be transparent about their expectations and policies regarding ChatGPT usage and provide resources to guide students on acceptable practices.

3.4.4 RQ4: How would ChatGPT affect students' learning and/or job preparedness?

For RQ4, ChatGPT's influence on students' learning and job readiness showed mixed results. On one hand, ChatGPT can enhance learning by building on existing knowledge and assisting with research. On the other hand, relying on ChatGPT could hinder critical thinking, hands-on practice, and communication with instructors, potentially leading to reduced learning progress and a negative impact on job preparedness. Encouraging appropriate usage and emphasizing the importance of understanding subject matter before using ChatGPT can help mitigate these concerns.

3.5 Limitations

This study, like others in the field, has certain limitations that should be considered. First, the participant sample may not fully represent the diversity of post-secondary settings nor the Faculty of Applied Sciences (FAS). Although *The Teaching Talks* (*TTT*) session was open to all undergraduate and graduate students, faculty, and staff within FAS, a majority

of the attendees were graduate students (*N=24*), with a smaller number of faculty members (*N=6*). Moreover, participants were primarily from (*N=38*) the computer science program, while the remaining *N=2* were from Engineering Sciences. Therefore, this study echos the perspective of computer science majors, which is only one of four schools within FAS. Additionally, since *TTT* is a series associated with FAS, the study did not capture perspectives from non-technical disciplines like social sciences, humanities or medical sciences. Future research should include participants from non-computer science and non-technical backgrounds to ensure that the findings are generalizable across various academic disciplines.

Second, the time constraints of the session may have impacted the depth of discussion and documentation. The entire session lasted 120 minutes, with approximately 75 minutes dedicated to discussing and recording group responses to the questions provided (captured by volunteer notetakers on their computers). Given the complexity of the topic, it is possible that not all relevant aspects were covered within this limited time frame. Furthermore, in context of timing, this focus group session was designed and conducted in early March of 2023; a period during which only ChatGPT-3.5 was accessible to the general public. With the rapid growth of generative AI tools, each comes with their own unique strengths and weaknesses. Although the findings of this research emerged from ChatGPT-3.5 (i.e. the latest version readily available to the public at the time of the study in early March 2023), the overarching implications of conversational chatbots in education do apply to the greater community within this domain.

Lastly, the reliance on a single volunteer notetaker/group might have resulted in the omission of some discussion points, specifically for questions that sparked extensive conversation. To address this limitation, future work could include multiple notetakers or implement other methods, such as audio recordings, to ensure all discussions are captured.

Chapter 4

Bridging the Gap: From Focus Group to Survey

The findings from chapter 3 provide a broad overview of ChatGPT's role within post-secondary education, as perceived by students and faculty (predominately from computer science, *N=38*) conversations during a focus group discussion. To complement the previous research, a survey-based study (chapter 5) will delve deeper into more detailed perception of ChatGPT's usage, specific applications, benefits and drawbacks. This bridge section serves to connect the initial overview provided in chapter 3 with more granular findings discussed in chapter 5. Although both studies share some similarities, the focus group session was designed to explore ChatGPT's immediate impact with a broader perspective in mind. While, the survey-based study was deployed to capture rich insights at a more granular level.

4.1 Review of Chapter 3

This study highlighted the immediate reactions and perceptions of computer science and engineering students and faculty towards ChatGPT. The focus group session was conducted in early March 2023, at a time where ChatGPT had been released to the public for about four months. The intention behind conducting the study through *The Teaching Talks (TTT)* series was to mix faculty with students in each group and encourage conversations amongst them. This approach provided the opportunity for both stakeholders to better understand the opposing side, which resulted in more fruitful discussions. Upon a thematic qualitative analysis of the focus group notes, the study results suggest how ChatGPT can facilitate learning, help with idiation session, patch programming code mistakes and serve as an aid for tasks that do not require critical thinking. However, the focus group session also raised important considerations such as academic integrity, the chatbot's behaviour of providing incorrect or biased responses and inability of faculty members to detect students using such tool in their take-home assignments. Possible solutions to combat the spread of this

invasive tool were also brought forward. These proposed solutions include more in-class assignments, clear AI-usage guidelines and a redesign of course assessments to adapt to this new technology.

4.2 Chapter 5 Preview

Moving forward into chapter 5, the study presented serves as a follow-up survey which was developed and deployed to examine usage and various use cases of ChatGPT within an academic context. The survey was made available to the participants of the focus group and the greater student and faculty community within the Faculty of Applied Sciences. The intention with this survey was to provide an opportunity for more students and faculty to provide their insights on this topic and gather more results. Since attending the focus group required participants to be available at a specific time/day, this survey was deployed with the idea that those who were unavailable for the focus group could share their perception. Furthermore, gathering more results would have provided the chance for conducting analysis on student versus faculty perception of ChatGPT. However, due to the low number of responses from faculty, a separate analysis was not possible. Additionally, the faculty members who did take part in the survey expressed their lack of experience with using ChatGPT. This was another reason as to why a comparison analysis between student and faculty was not conducted. Despite the thematic similarities between the two studies presented in Chapters 3 and 5, the survey-based study was designed to gather more detailed feedback. In addition, the survey introduced in the following chapter outlines potential advantages and disadvantages of integrating such tools in courses, which was not explicitly covered as part of the focus group study. The survey was designed through a mixed-method approach, which provide the necessary foundation to draw results from both qualitative and quantitative data. Lastly, this study provided an opportunity to build on the findings from chapter 3 and examine each topic in more detail.

Chapter 5

Perceptions of ChatGPT in post-secondary education

5.1 Introduction

The focus group that was conducted in chapter 3 provided clarity on the immediate impact of ChatGPT within the academic space. Following this theme, this second study is intended to further explore the perception of students and faculty about using ChatGPT as an educational tool. Specifically, this study aims to better understand the specific benefits and drawbacks of this conversational chatbot, particularly as these were not explicitly discussed in the focus group session. In addition, how ChatGPT is used by students and faculty was not specifically included in the focus group discussions. To address these ideas, the following research questions were crafted as part of this survey-based study [1]:

- RQ5: How is ChatGPT regarded as an educational tool?
- RQ6: How is ChatGPT used by post-secondary students and instructors?
- RQ7: What are the potential benefits and drawbacks associated with using ChatGPT in post-secondary education?

Based on the analysis of the survey results, ChatGPT is perceived as a revolutionary tool in the scope of post-secondary education. Survey results indicate a generally positive perception of ChatGPT, highlighting its helpfulness, efficiency, and potential to transform traditional educational practices. However, concerns regarding accuracy and ethical issues such as privacy and bias are noted. A substantial majority of students and instructors (74.4%) have adopted ChatGPT for a variety of academic purposes, from drafting emails

[1]This chapter was presented as a workshop session at The Western Conference for Science Education Conference 2023 [75]. The extended version of this work is being prepared for submission as a paper to the journal of *Education and Information Technologies*. It will undergo the peer-review process for potential publication.

to learning new concepts, despite their relatively recent introduction to the tool. The intent to continue its use (82.1%) highlights its role in helping individuals solve problems and for its ability to be efficient. Despite its strong presence in academia, the results suggest that careful steps must be taken into account before the chatbot is integrated any further. In particular, future decisions should be guided by ethical, privacy and bias considerations in mind to ensure both students and instructors maximize on its benefits while mitigating the potential drawbacks.

5.2 Methodology: Anonymous Survey

5.2.1 Study design

To examine our research questions, we designed an anonymous questionnaire which was conducted within the Faculty of Applied Science (FAS) at Simon Fraser University (SFU). The survey included 15 varied types of questions (e.g. short answer, multiple choice, matrix and long answer) aimed at capturing the respondents' views on ChatGPT within a post-secondary context, covering perceived usage, benefits, and drawbacks. To improve the clarity of the survey results presented in this thesis, the sequence of questions analyzed has been modified. The original ordering of the questions can be found in Appendix B, however, all references to questions within this thesis are based on the ordering that is included in Tables 5.3, 5.6, 5.10 and 5.12. Furthermore, each set of questions are mapped to a specific research as shown in Table 5.1.

5.2.2 Data collection

With approval from the university's ethics office, the survey was distributed to participants from the focus group session (chapter 3) and members of the FAS community (1,300 undergraduate students, 200 graduate students, and 55 teaching and research faculty) through mailing lists and word of mouth. The faculty is composed of four schools: Computing Science, Engineering Science, Mechatronic Systems Engineering, and Sustainable Energy Engineering. In line with ethical procedures, respondents were informed about the study and provided consent for their answers to be included. The survey did not ask if the respondents participated in the focus group and since responses were anonymous, there is no way to confirm this.

5.2.3 Participants

A total of 39 participants completed the survey, comprising 11 undergraduate students, 24 graduate students, and 4 faculty members. Of these, 37 were from the computing Science program, and 2 were from engineering sciences. No further demographic or metadata was collected.

5.2.4 Data analysis

The first step of analysis included data cleaning. Answers from respondents were considered invalid and disregarded from data analysis if the participants abandoned the survey midway (and did not complete the remainder of the questions). Through this process, only one (*N=1*) invalid submission was removed, reducing the total number of valid submissions from 40 to 39. To analyze the data, each survey question was mapped to a specific research question, which is included as part of each subsection of 5.3. The relationship between the survey questions and research questions is outlined in Table 5.1. This correspondence between the research and survey questions was determined to be essential while the survey was being designed. Although the ordering of the questions in which they are presented in the results section (5.3) does not match the original survey (Appendix B), this rearrangement provides more clarity for the results. A Thematic analysis [20] was deployed to analyze the data and gather results to answer each research question.

Research Question	**Survey Question**
RQ5: How is ChatGPT regarded as an educational tool?	#Q1-6 (Table 5.3)
RQ6: How is ChatGPT used by post-secondary students and instructors?	#Q7-11 (Table 5.6)
RQ7: What are the potential benefits and drawbacks associated with using ChatGPT in post-secondary education?	#Q12-15 (Tables 5.10, 5.12)

Table 5.1: A table illustrating how each research question are mapped to survey questions.

5.3 Results

In our analysis, we observed diverse opinions about ChatGPT in post-secondary education. In the following section, we explore the findings related to each question from the survey questions. The 17 question survey prompted participants about their perception of ChatGPT, the breakdown of the questions related to ChatGPT (excluding the 2 demographic questions, 15 questions) are included in Table 5.2.

Although participants of this study are anonymous (no identifiable information were captured), each respondents' answers are quoted and tagged as *P#* (e.g. P1, P2, etc.) where X is the number associated with the order which the responses were received.

5.3.1 Perception of ChatGPT

The questions highlighted in Table 5.3 were included in the survey to get a better understanding of what students and instructors think of ChatGPT as an educational tool.

Next, the analysis of each question in the survey is presented.

Question Type	Number of questions
Open-ended	7
Multiple Choice	3
Checkbox	3
Likert Scale Matrix (Table 5.4)	1
Percentage Scale Matrix (Table 5.7)	1

Table 5.2: Breakdown of question type regarding ChatGPT, excluding the 2 multiple choice demographic questions.

Q#	Question	Question Type
1	Describe your overall impression of ChatGPT in one word.	Open-ended
2	Included in Table 5.4	Likert Scale Matrix
3	What do you think of ChatGPT as an educational tool? a) It is a tool creating mostly positive educational opportunities. b) It is a tool causing mostly negative consequences in education. c) I am not sure.	Multiple Choice
4	Please elaborate on the answer you provided to the previous question.	Open-ended
5	Who do you think is responsible for defining how ChatGPT should be used in an educational context? a) University-wide Level b) Faculty Level (i.e. Applied Science) c) Department Level (i.e. Computing Science) d) Course Instructors e) ChatGPT Developers (OpenAI)	Checkbox
6	How do you think the use of ChatGPT in post-secondary education may evolve over time?	Open-ended

Table 5.3: A table of survey questions 1-6 related to perception of ChatGPT.

One-word Impression of ChatGPT

The single-word impressions of ChatGPT provided by participants for question #1 from Table 5.3 were summarized as a word cloud (Figure 5.1). The term "helpful" stands out, with 6 out of 39 participants (15.4%) using it to express their impression of ChatGPT. The word "impressive" was noted by 3 participants (7.7%). "Efficient" and "useful" were each mentioned by 2 respondents (5.1%). Other favourable descriptors of ChatGPT included "time efficient", "interesting", "new era", "revolutionary", "adequate", "great", "confident", "resourceful", "efficiency", "inspiring", "versatile", "cool", "futuristic", "awesome", and "innovative".

However, not all impressions were positive. Terms such as "evil," "scary," "overrated," and "misleading" were each mentioned once by a minority. Additionally, two participants

Statement	Q2: Rate each statement based on the following likert scale
a	ChatGPT can improve student engagement in post-secondary education.
b	ChatGPT can improve learning outcomes in post-secondary education.
c	The use of ChatGPT in post-secondary education is more trouble than it's worth.
d	There are too many ethical concerns surrounding the use of ChatGPT in post-secondary education to justify its use.
e	ChatGPT can help me to personalize my teaching or learning experiences.
f	ChatGPT can help students to learn at their own pace.
g	ChatGPT is a distraction that takes away from other important aspects of teaching and learning in post-secondary education.
h	I am confident in my ability to use ChatGPT effectively to obtain the answers I'm seeking.
i	ChatGPT will become a common tool for teaching and learning in post-secondary education in the future.
j	I am excited about the potential of ChatGPT to enhance teaching and learning experiences in post-secondary education.
k	I believe ChatGPT is NOT an appropriate tool to use in post-secondary education.
l	The use of ChatGPT in post-secondary education challenges the traditional teacher-student relationship.
m	ChatGPT requires a significant investment of time and resources to use effectively in post-secondary education.
n	ChatGPT has the potential to change the way we think about teaching and learning in post-secondary education.

Table 5.4: **Q2: Rate each statement based on the following likert scale.** This table includes the statements presented to respondents. Respondents were asked to rate their answer on the following scale: *Strong Agree* / *Agree* / *Neutral* / *Disagree* / *Strongly Disagree*.

described ChatGPT using more than one word, framing it as a "helpful writing assistant" and stating "It is good. It has its limitations, but so far so good".

Figure 5.1: A word cloud highlighting survey participants' one-word impressions of ChatGPT, with "helpful" being the most frequently mentioned, surrounded by a range of other descriptors that indicate a predominantly positive perception.

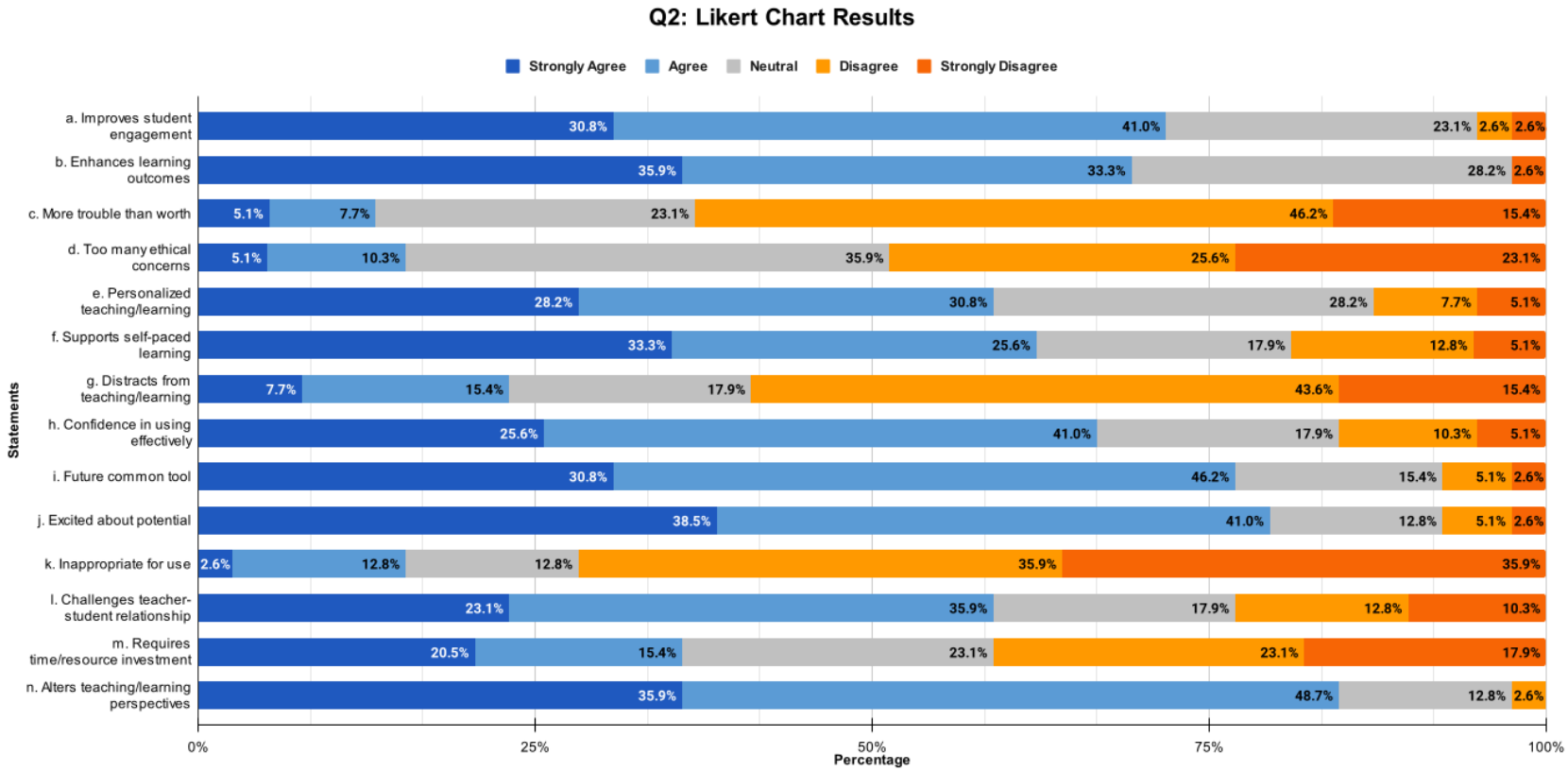

Figure 5.2: Survey results for #Q2 of Table 5.4 summarized in a detailed bar graph. The visualization illustrates strong agreement that ChatGPT improves student engagement and enhances learning outcomes. However, there is a notable split in perceptions regarding whether ChatGPT raises too many ethical concerns. A majority of respondents are optimistic about ChatGPT's role in to personalizing education, supporting self-paced learning, and its future potential. The graph clearly indicates that ChatGPT is seen as an innovative tool for altering teaching and learning perspectives in the future of education.

ChatGPT's Role in Teaching and Learning

Examining the results of the likert-scale question (Table 5.4) on attitudes towards ChatGPT in higher education indicates that a majority of participants have a positive view of the tool (as shown in Figure 5.3). In response to statement a (5.4): *"ChatGPT can improve student engagement in post-secondary education"*, a majority of respondents, 28 (71.8%), strongly agreed or agreed that ChatGPT can improve student engagement, while 9 (23.1%) remained neutral, and a minority of 2 (5.1%) strongly disagreed or disagreed with this sentiment. Similarly, 27 (69.2%) of participants strongly agreed or agreed that *ChatGPT can improve learning outcomes in post-secondary education* (statement b, 5.4), with 11 (28.2%) taking a neutral stance and only 1 (2.6%) of respondents strongly disagreed or disagreed with this idea.

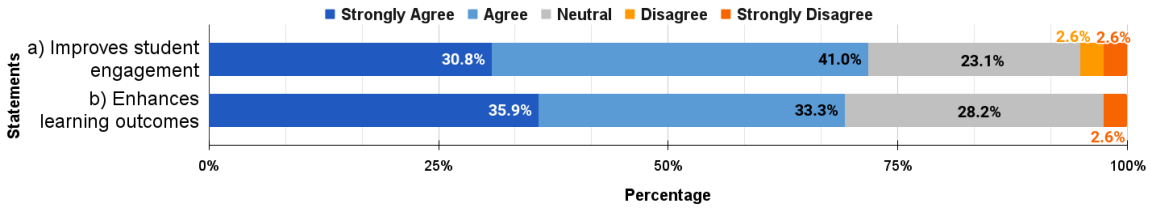

Figure 5.3: A bar graph illustrating survey respondents' attitudes towards the impact of ChatGPT on student engagement (statement a, 5.4) and learning outcomes (statement b, 5.4) in post-secondary education, indicating a predominantly positive.

When considering whether ChatGPT's use is more problematic than beneficial: *The use of ChatGPT in post-secondary education is more trouble than it's worth* (statement c, 5.4), only 5 (12.8%) strongly agreed or agreed, while a significant 24 (61.5%) strongly disagreed or disagreed and 9 (23.1%) expressed their neutral viewpoint. One of the controversial statements (as evident in Figure 5.4) of this likert-scale inquired about ChatGPT's usage and ethical concerns. Specifically, when posed with the statement d (5.4): *There are too many ethical concerns surrounding the use of ChatGPT in post-secondary education to justify its use*, only 6 (15.4%) of participants strongly agreed or agreed while 14 (35.9%) remained neutral and nearly half (19, 48.7%) strongly disagreed or disagreed.

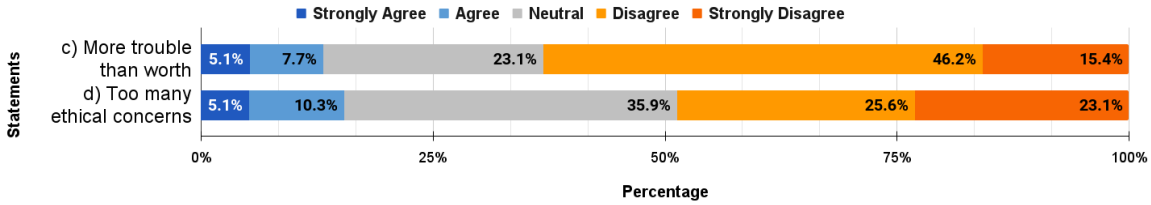

Figure 5.4: A bar graph highlighting survey results on the challenges (statement c, 5.4), and ethical considerations of using ChatGPT in post-secondary education (statement d, 5.4), with a significant number viewing it as NOT problematic.

On the possibility of ChatGPT personalizing teaching/learning experiences (*ChatGPT can help me to personalize my teaching or learning experiences*, statement e, 5.4), 23 (59.0%) of participants strongly agreed or agreed, 11 (28.2%) remained neutral, and 5 (12.8%) strongly disagreed or disagreed. As represented in Figure 5.5, an equal percentage of respondents (23, 59.0%) strongly agreed or agreed that *ChatGPT can assist students in learning at their own pace* (statement f, 5.4), with 7 (17.9%) neutral and an equivalent number (7, 17.9%) of respondents strongly disagreed or disagreed.

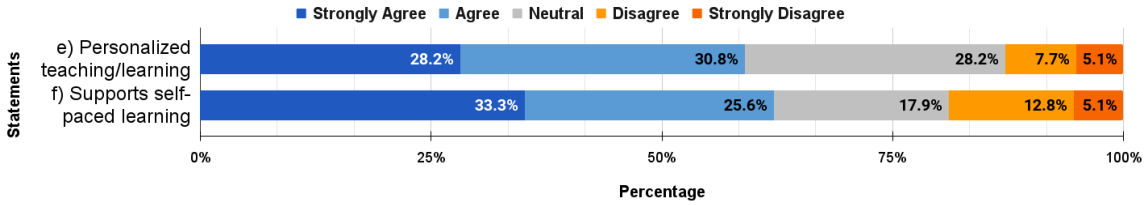

Figure 5.5: Survey results for statements e and f of 5.4, presented in a bar graph shows a majority of respondents supporting ChatGPT's role in personalizing teaching and learning experiences, as well as aiding students to learn at their own pace in post-secondary education.

When asked whether *ChatGPT is a distraction that takes away from other important aspects of teaching and learning in post-secondary education* (statement g, 5.4), 9 (23.1%) of respondents strongly agreed or agreed that ChatGPT is a distraction (as illustrated in Figure 5.6), while 23 (59.0%) strongly disagreed or disagreed, and 7 (17.9%) were neutral on this issue.

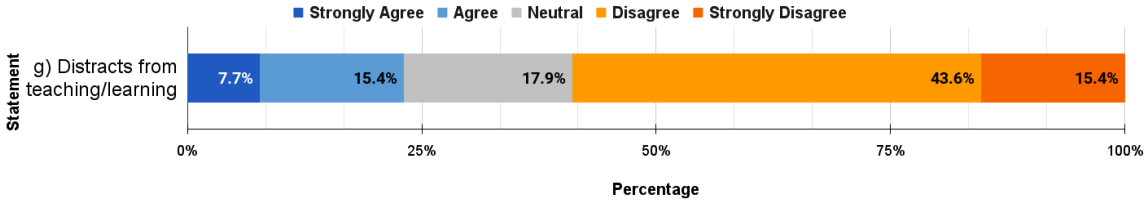

Figure 5.6: A bar chart analysis of statement g (5.4), highlights respondents' perspectives on ChatGPT, with a majority disagreeing with the notion that the chatbot distracts from important aspects of post-secondary education.

In regards to the participants' confidence in using ChatGPT effectively (*I am confident in my ability to use ChatGPT effectively to obtain the answers I'm seeking (in an educational context)*, statement h, 5.4), 26 (66.7%) of respondents strongly agreed or agreed (represented in dark and light green in Figure 5.7), 7 (17.9%) expressed their neutral position and 6 (15.4%) strongly disagreed or disagreed which indicated their lack of confidence.

Furthermore, as visualized in Figure 5.8, a significant number of participants, 30 (76.9%), strongly agreed or agreed that *ChatGPT will become a common tool for teaching and learning in post-secondary education in the future* (statement i, 5.4), 6 (15.4%) were undecided

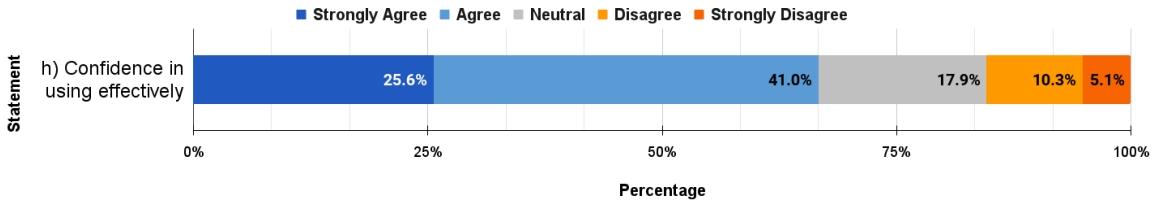

Figure 5.7: Survey respondents' confidence in utilizing ChatGPT effectively for educational use (statement h, 5.4) is shown in a bar chart, with a significant majority expressing confidence, a minority showing a lack of confidence, and some remained neutral.

(neutral), and only 3 (7.7%) strongly disagreed or disagreed with this item. A majority number of respondents (31, 79.5%) strongly agreed or agreed that they are *excited about the potential of ChatGPT to enhance teaching and learning experiences in post-secondary education* (statement j, 5.4) while 5 (12.8%) expressed their neutrality and no more than 3 (7.7%) strongly disagreed or disagreed.

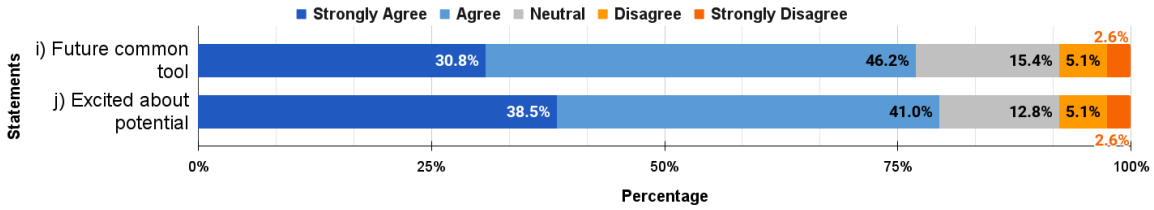

Figure 5.8: Survey responses for statements i and j of 5.4 visualized in a bar chart reflects strong optimism among participants regarding the future integration of ChatGPT in post-secondary education, with a majority expressing excitement about its potential to enhance teaching and learning experiences.

Additionally, Figure 5.9 highlights the belief that *ChatGPT is NOT an appropriate tool to use in post-secondary education* (statement k, 5.4), was struck down as 28 (71.8%) of respondents strongly disagreed or disagreed with this thought while 5 (12.8%) were on the fence (neutral) and only 6 (15.4%) strongly agreed or agreed. The idea that *ChatGPT requires a significant investment of time and resources to use effectively in post-secondary education* (statement m, 5.4) was another controversial topic with a slight majority of 16 (41.0%) individuals who strongly disagreed or disagreed, 14 (35.9%) respondents strongly agreed or agreed while the remaining 9 (23.1%) were on the fence (neutral).

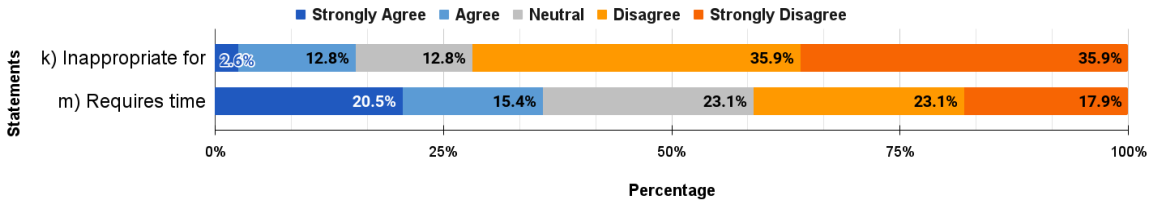

Figure 5.9: A bar chart presents survey findings of statements k and m 5.4, where a substantial majority of participants debunk the idea that ChatGPT is unfit for post-secondary education, and perception is divided regarding the need for significant investment to effectively use ChatGPT in educational settings.

On the idea that *use of ChatGPT in post-secondary education challenges the traditional teacher-student relationship* (statement l, 5.4) 23 (59.0%) of participants strongly agreed or agreed and recognized this challenge while 9 (23.1%) strongly disagreed or disagreed (as represented by light and dark red in Figure 5.10) and 7 (17.9%) maintained a neutral stance. Lastly, a notable 33 (84.6%) strongly agreed or agreed that, *ChatGPT has the potential to change the way we think about teaching and learning in post-secondary education* (statement n, 5.4), with 5 (12.8%) undecided (neutral) and only 1 (2.6%) who strongly disagreed or disagreed.

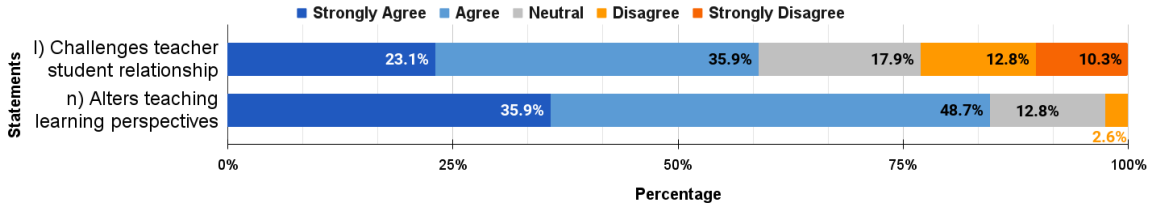

Figure 5.10: A bar graph visualization of survey responses for statements i and j 5.4, highlighting that majority of respondents agree ChatGPT challenges traditional teacher-student dynamics and believe it has the potential to transform the way we think about teaching and learning in post-secondary education.

ChatGPT as an Educational Tool

Taking a closer look at the results from question #3 of Table 5.3, survey results indicate that a majority of respondents view ChatGPT as a useful and positive educational tool. Specifically, 26 out of 39 participants (66.7%) believe ChatGPT primarily generates *positive educational opportunities*. On the contrary, a minority, 4 out of 39 (10.3%), hold the opinion that ChatGPT leads to *mostly negative consequences within the educational realm*. Meanwhile, 9 respondents (23.1%) were undecided on the matter, expressing uncertainty about ChatGPT's role as an educational tool.

When asked a follow-up question (#4 of Table 5.3) to elaborate on their previous answer, participants expressed a wide range of perspectives. One respondent expressed a common

ChatGPT in Education is...	Number of Respondents
Mostly Positive	26 (66.7%)
Mostly Negative	4 (10.3%)
Unsure	9 (23.1%)

Table 5.5: Results for #Q3 of Table 5.3: Perception of ChatGPT as an Education Tool.

concern: *"I believe people are using it assuming it is giving facts even though that is not the case"* (P1). Another participant noted the lack of academic adoption: *"I think academia has not embraced ChatGPT"* (P6). Others highlighted the utility of ChatGPT in assisting with assignments: *"You can get help from it for time-consuming labor parts of your assignments"* (P7) and its ability to respond without any delay: *"It can help explain topics in a human way without having to wait for friends, TAs, or the prof to reply"* (P8).

There was an acknowledgment of ChatGPT's positive and negative impact: *"Huge potential positives for helping learning. Huge potential negatives in students not actually learning"* (P9). Some saw it as a driver of systemic change: *"It causes mostly negative consequences in the current education system, but it increases productivity to such a high degree that the system will be forced to change and eventually embrace that capacity for productivity"* (P10).

A few responses called for a cautious approach to ChatGPT's integration into educational settings: *"There certainly are ways for profs to use ChatGPT effectively; however, I think talking about this (from a prof point-of-view) will negatively commercialize the usage of this tool"* (P11). Additionally, one respondent raised concerns regarding the chatbot's accuracy: *"it is still not accurate enough and might mislead students in some cases"* (P18). Moreover, the early phase and evolving nature of ChatGPT was also mentioned: *"ChatGPT is still very early in development and its full extent of capabilities has yet to be realized"* (P12).

Some compared ChatGPT to existing tools: *"it is a tool that aids the student that could be used nefariously or not the same way Google or meeting your peers could be in regard to academic integrity"* (P14). The comparison with Google's search engine was also echoed by other participants: *"it quite literally is just a more efficient Google"* and like *"it is like Google but boosted"* (P19).

Personalized learning was raised a positive point: *"Students can learn and understand concepts at their own pace"* (P24), and for deeper understanding: *"It helps explain concept[s] with deeper understanding than just knowing the tip"* (P25). The chatbot was also praised for its ability to be a ready helper: *"At any point in time, if a student gets stuck in understanding a concept, he/she can use ChatGPT"* (P26). The chatbot's ability to fill gaps in teaching was also noted: *"ChatGPT enables students to pick up topics that may not have been fleshed out heavily in class"* (P16). Lastly, the potential for shaking up education was also recognized: *"This is a disruptive technology brought into the pedagogical arena"* (P21).

Lastly, the potential of the chatbot was recognized: *"ChatGPT is still not perfect, but it is so good at laying some groundwork for me"* (P37), and for achieving learning goals: *"I believe it has potential to assist in achieving learning outcomes"* (P38), indicating a hopeful outlook on its future role in education.

Regulating ChatGPT in Education

Responses to who should oversee ChatGPT's implementation (question #5 of Table 5.3) in educational settings were varied: 29 participants (74.4%) pointed to course instructors as responsible for ChatGPT usage guidelines in their courses. Meanwhile, the university level, faculty level, and department level each had 16 (41.0%) supporters, and a smaller minority of 7 (17.9%) favored ChatGPT's own developers to set these guidelines. It is important to note that participants had the ability to choose more than one option as their response.

Future of ChatGPT

In regards to the future of ChatGPT in post-secondary education and how it may evolve over time (question #6 of Table 5.3), survey results indicate that ChatGPT *"will likely become specialized"* (P6), with expectations of it being integrated into daily academic tools similar to *"calculators and Google"* (P10). Participants foresee ChatGPT being significantly useful for *"code writing and generating research ideas"* (P15), potentially evolving into a *"new standard search engine"* (P17). If the chatbot becomes free and accessible to everyone, it could *"become integrated into the learning process"* (P23), hinting that an educational *"revolution* (P35) may be near. Moreover, another participant noted that ChatGPT is expected to evolve within the academic domain, thus becoming *part of the educational culture* (P21) for students and instructors.

5.3.2 Usage of ChatGPT

To better understand the usage of ChatGPT among students and instructors, the questions outlined in Table 5.6 were included in the survey.

Current Usage of ChatGPT

Examining the results for ChatGPT usage indicates that a majority of the participants have utilized the chatbot in an academic setting. Specifically, when asked, *"Have you utilized ChatGPT in your teaching/learning experiences in an educational context?"* in question #7 of Table 5.6, 74.4% of the participants responded with "yes" (29 out of 39) while the remaining 25.6% indicated "no" (10 out of 39).

While analyzing responses to survey question #7, it became clear that the faculty members who responded (*N=4*) reported limited experience with ChatGPT. Due to this lack

Q#	Question	Question Type
7	Have you utilized ChatGPT in your teaching/learning experiences in an educational context?	Yes/No
7a	If so, how many days have you used ChatGPT in total?	Open-ended
8	Do you intend to continue using ChatGPT? Please explain why.	Open-ended
9	How are you using ChatGPT? a) I never used it or used it a couple times only. b) I have been just playing with it, not to help any of my assignments or write up. c) I am using it briefly to guide me in my assignments, but not heavily at all. d) I am using it quite considerably to help me doing my assignments.	Multiple Choice
10	Included in Table 5.7.	Percentage Scale Matrix
11	What are some specific applications of ChatGPT in an educational setting?	Open-ended

Table 5.6: Survey questions 7-11 related to usage of ChatGPT in education, organized in a table.

Option	Q10: For each statement, specify your answer in terms of percentage
a	What percentage of students do you think are using ChatGPT for academic purposes?
b	What percentage of students do you think are using ChatGPT to strongly/very considerably help them with their assignments and write up?
c	What percentage of students do you think are using ChatGPT to complete coursework beyond the pre-established course policy/syllabus?
d	What percentage of students do you think are using ChatGPT to complete coursework within the pre-established course policy/syllabus?

Table 5.7: **Q10: For each statement, specify your answer in terms of percentage.** This table includes the statements presented to respondents. Respondents were asked to rate their answer on the following scale: *0-20% | 21-40% | 41-60% | 61-80% | 81-100%.*

of familiarity, a thorough comparative analysis between students and faculty on their experiences and viewpoints concerning the use of ChatGPT was deemed unfeasible due to the insufficient data from faculty members.

The responses to the follow-up question #7a (5.6) regarding the length of time participants have used ChatGPT indicates that on average, most participates who are using the chatbot have been using it for about a month. The specific breakdown of responses can be seen in Table 5.3.2. A total of 9 respondents (31.0%) reported using ChatGPT for less than a month. An equal number of participants (31.0%) indicated they have used the chatbot for a duration of 1-2 months. Furthermore, a small minority of 2 individuals (6.9%) have utilized the tool for a period of 2-3 months. Moreover, 5 respondents, accounting for 17.2%

ChatGPT usage	0-20%	21-40%	41-60%	61-80%	81-100%
(a) Academic purposes	0	9	12	12	6
(b) Within assignments	8	11	11	4	4
(c) Beyond course limit	11	12	8	5	3
(d) Within course limit	11	8	13	5	2

Table 5.8: Table of ChatGPT Usage in Academia: Participant Estimates

Duration of ChatGPT usage	**Number of Respondents**
Less than a month	9
1-2 months	9
2-3 months	2
3-4 months	5
No Answer	4

Table 5.9: Duration of ChatGPT Usage Among Respondents, presented in a table.

of the total, have been chatting with ChatGPT for 3-4 months, while 4 participants (13.8%) who responded with "yes" to question #7 (5.6) did not provide an answer to the follow-up question #7a (5.6).

In response to the follow-up question (question #8 of Table 5.6) on weather they plan on continuing to use ChatGPT, 32 out of 39 responses (82.1%) showed a positive inclination to keep using the chatbot due to its time-saving capabilities for automating programming tasks, assisting with *"writing email"* and *"help proofread or rephrase"* write-ups. Notably, several respondents valued ChatGPT's role in *"explaining new concepts"*, offering a unique way to approach a problem and its ability to be used as an ideation tool and getting started on an idea. Despite ChatGPT's academic and professional advantages being echoed by the majority, a small subset, specifically, 3 out of 39 of the respondents (7.7%), expressed their hesitancy to continue using the chatbot as it *"removes the joy of thinking"* and *"answers are not always accurate"*. The remaining 7 participants (10.3%) did not provide an answer to this question.

Context of ChatGPT Usage

Question #9 (5.6) of the survey provided participants an opportunity to shed light on how they use ChatGPT (if at all). As part of the results, a large majority of participants (17, 43.6%), reported that they use ChatGPT in a more exploratory manner, without applying it to assist with their assignments or academic writing (option 9a, 5.6). Moreover, a notable number of respondents (12, 30.8%) disclosed a more targeted yet limited use of ChatGPT (option 9c, 5.6), specifically using it "briefly to guide me in my assignments, but not heavily at all". Furthermore, a small minority consisting of 5 (12.8%) respondents, expressed a more intensive use of ChatGPT (option 9d, 5.6), noting that they are "using it quite considerably

to help me doing my assignments". Lastly, 4 (10.3%) of the participants responded with option 9a (5.6), stating that they have "never used it or used it a couple times only".

Presumed Student Usage of ChatGPT

Participants also provided their insights on the perceived academic footprint of ChatGPT. As shown in Table 5.8, a substantial majority (30 out of 39, 76.9%) estimated that students' engage with ChatGPT for academic purposes, with the 41-60% and 61-80% brackets both receiving 12 responses each. The data further suggests that students place a considerable reliance on ChatGPT for completing their assignments and write ups. Notably, the 21-40% and 41-60% brackets both tied with 11 responses. Examining usage of ChatGPT against limits set within course policy/syllabus indicate a wide range of beliefs from strict compliance to exceeding established guidelines within the course. Specifically, 23 out of 39 respondents (59.0%) believed that 21-40% of students might be overstepping boundaries set by course policies, with the 0-20% and 21-40% brackets receiving 11 and 12 responses respectively. Furthermore, 13 out of 39 respondents (33.3%) indicated that 41-60% of students may be using ChatGPT within the pre-established limit in their courses while 11 out of 39 participants (28.2%) felt that 0-20% of students are using it in an appropriate manner.

ChatGPT's Applications in Educational Setting

Examining the results for question #11 of Table 5.6 reveals various themes associated with applications of ChatGPT in an educational setting. Specifically, four themes were identified based on responses from students and faculty members:

1. Educational Content and Resource Development
2. Learning Support and Skill Enhancement
3. Research, Technical Assistance, and Assessment
4. Innovation in Teaching and Administrative Processes

Educational Content and Resource Development The survey responses indicate that one of the predominant themes of ChatGPT usage includes development of educational content. Participants frequently cited its use in *"Helping come up with initial templates"* and *"Generating creative prompts"*. Additionally, its role extends to *"improving lectures"* and providing *"good examples"*, indicating its significant role in improving educational content.

Learning Support and Skill Enhancement The question results further suggest that ChatGPT can be used as a learning aid. With many mentions of its ability to provide *"real time assistant and guide"* and supplying *"additional examples [and] additional explanations"*. Furthermore, the chatbot's applications extend to support users with their writing and

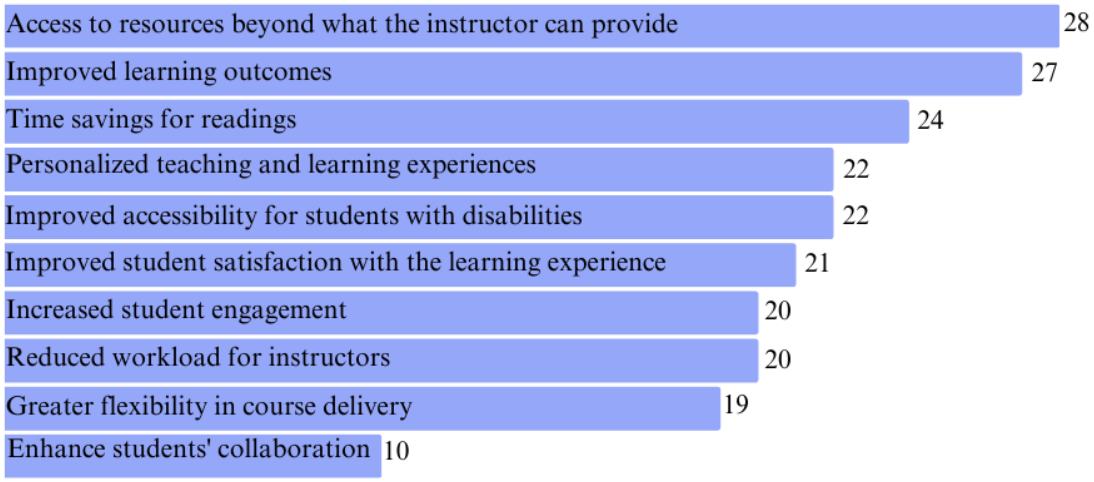

Figure 5.11: A bar chart highlighting the perceived benefits of ChatGPT in education by survey respondents: "Access to resources beyond what the instructor can provide" and "improved learning outcomes" top the list, while "enhance students' collaboration" was ranked last.

communication skills by *"providing clean answers"*, *"revising essays"*, and *"fixing grammar issues, rewording sentences for clarity"*, many participants praise ChatGPT's value in an academic skill development.

Research, Technical Assistance, and Assessment Results from the survey imply that ChatGPT has a strong presence in research activities such as *"speeding up researching"* and *"searching for technical words in papers"* which highlights its application in academic research. Furthermore, the results denote that ChatGPT can be used in technical education by helping users in *"figuring out how to use a new, nonstandard API"* and *"getting a base idea in technical courses"*. Moreover, some participants hint of ChatGPT's application in assessment processes. Specifically, the chatbot could *"simplify the assignment evaluation process"* and be used within exams by *"writing/marking exams by passing in the rubric"*.

Innovation in Teaching and Administrative Processes The last theme identified from the survey results points to ChatGPT's potential to inspire educators with *"coming up with innovative ways to test the learning outcome"*. Moreover, in an administrative setting, ChatGPT can be utilized for *"communications (emails, paperwork, etc.)"* and *"creating a template for a writing assignment"*, which can improve efficiency within educational institutions.

5.3.3 Perceived benefits and drawbacks of ChatGPT

Similar to any new technology, ChatGPT's presence in academia comes with its own unique advantages and disadvantages. In this section, we explore benefits of this chatbot in edu-

cation such as "access to resources beyond what the instructor can provide" and "improved learning outcomes". Moreover, specific drawbacks are acknowledged which include "adequate response accuracy or relevance" and "potential for misuse or academic dishonesty".

Perceived Benefits

To explore the possible benefits of ChatGPT in an academic setting, students and instructors were asked the follow questions in the survey:

Q#	Question	Question Type
12	Included in Table 5.11	Checkbox
13	Does ChatGPT have any other benefits in post secondary setting that were not mentioned?*	Open-ended

Table 5.10: Survey questions 12-13 related to perceived benefits of ChatGPT. **Note: In the original survey (7), questions #13 and #15 (5.12) were combined, but they were divided into two separate questions for the purpose of analyzing the results.*

Option	Q12: Select benefits of using ChatGPT
a	Increased student engagement
b	Improved learning outcomes
c	Personalized teaching and learning experiences
d	Time savings for readings
e	Access to resources beyond what instructor can provide
f	Improved accessibility for students with disabilities
g	Improved student satisfaction with learning experience
h	Enhanced collaboration among students
i	Reduced workload for instructors
j	Greater flexibility in course delivery
k	Other (please specify in space provided below)

Table 5.11: **Q12: Select which one(s) can be considered as benefits of using ChatGPT in post-secondary education**. This table includes a list of possible benefits of ChatGPT presented to respondents for checkbox question.

As shown in Figure 5.11, the survey results for perceived benefits of ChatGPT in post-secondary education included several key findings. Most prominently, 28 out of 39 participants (71.8%) indicated that ChatGPT can provide access to more resources beyond what the instructor could provide. This option was closely followed by 27 respondents (69.2%) acknowledging that the chatbot could improve learning outcomes in an academic setting. Moreover, the benefit of time saving for readings ranked third, with 24 participants (61.5%) endorsing this option. Personalized teaching experiences and improved accessibility for disabled students each drew agreement from 22 respondents (56.4%).

In response to the open-ended question, the majority of participants acknowledged ChatGPT's potential to significantly assist in writing tasks. Moreover, some highlighted the

chabot's ability to provide personalized learning experiences, emphasizing its role in enhancing quality of code by identifying bugs and possible solutions.

Perceived Drawbacks

As part of this study, the following questions were designed to gather the perceived drawbacks of ChatGPT by students and instructors in an academic setting:

Q#	Question	Question Type
14	Included in Table 5.13	Checkbox
15	Does ChatGPT have any other drawbacks in post secondary setting that were not mentioned?*	Open-ended

Table 5.12: Survey questions 14-15 related to perceived benefits of ChatGPT presented in a table. **Note: In the original survey (7), questions #13 (5.10) and #15 were combined, but they were divided into two separate questions for the purpose of analyzing the results.*

Option	Q14: Select drawbacks of using ChatGPT
a	Ethical concerns
b	Technological barriers (e.g., connectivity issues, learning curve for users)
c	Reduced face-to-face interaction with students
d	Inadequate response accuracy or relevance
e	Potential for misuse or academic dishonesty
f	Lack of human interaction in the learning process
g	Limited ability to provide personalized feedback to students
h	Cost of implementation and maintenance
i	Limited ability to foster critical thinking skills
j	Limited applicability to certain subjects or courses
k	Other (please specify in space provided below)

Table 5.13: **Q14: Select which one(s) can be considered as drawback of using ChatGPT in post-secondary education**. This table includes a list of possible benefits of ChatGPT presented to respondents for checkbox question.

An overview of the responses for perceived drawbacks of ChatGPT in post-secondary education can be seen in Figure 5.12. Most importantly, 28 out of 39 respondents (71.8%) expressed great concern regarding ChatGPT's response accuracy and relevance. Following this, 27 participants (69.2%) echoed their fear for the chatbot to be misused as it could open the door for academic dishonesty. Ethical concerns regarding ChatGPT's role in post-secondary education were also acknowledged by 25 respondents (64.1%). Other negative aspects of ChatGPT included its inability to foster critical thinking skills which was identified by 21 respondents (53.8%). A subset also voiced reservations regarding the chatbot's

technological barriers such as connectivity issues, learning curve for users and lack of human interaction in the learning process.

Moreover, in a follow-up open-ended question about other unmentioned drawbacks, participants raised concern about various attributes such privacy of data, ethical implications and potential outdated or incorrect information, especially for coding and research purposes. The predominant concern of trusting a private AI-based company with personal information was echoed by the majority of respondents. In addition, participants highlighted the system's potential inability to replace human learning as it should be used as an aid for learning, not a substitute for it.

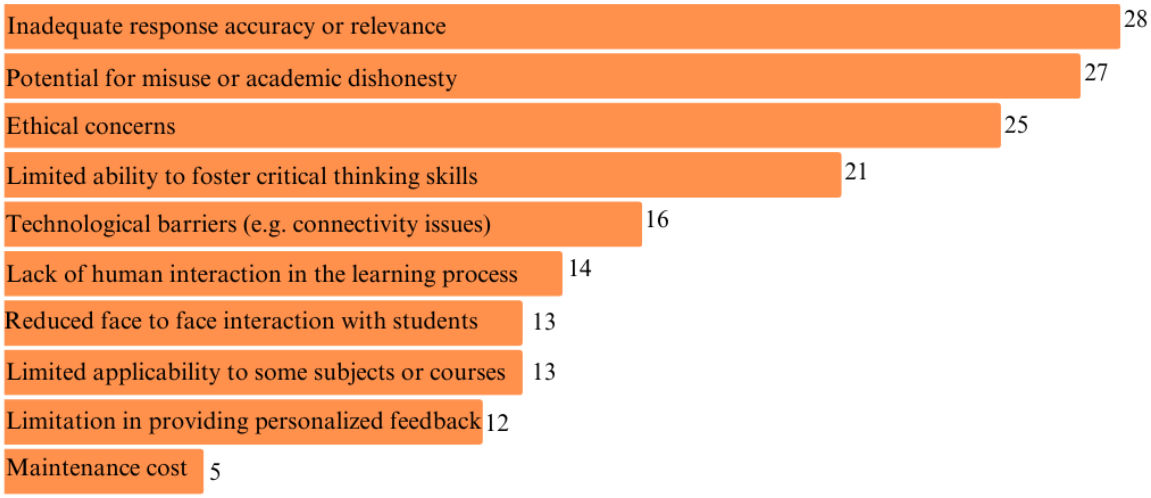

Figure 5.12: A bar chart highlighting the perceived drawbacks of ChatGPT in education by survey respondents: "Inadequate response accuracy or relevance" and "potential for misuse or academic dishonesty" top the list, while "maintenance cost" was ranked last.

5.4 Discussion

The emergence of generative AI such as ChatGPT in post-secondary education signals a revolutionizing of the way we approach teaching and learning. Consequently, there is a growing demand to understand its implications in an educational setting and how it can enhance or diminish teaching and learning techniques.

The findings of this study suggest that both students and instructors have mixed perceptions about ChatGPT's usage in a post-secondary setting. While the tool offers unparalleled academic assistance to students, it concurrently plays a negative role in students' education due to its potential to be used for academic dishonesty. In this section, we highlight the main results associated with each research question identified as part of this study.

5.4.1 RQ5: How is ChatGPT regarded as an educational tool?

To address this research question, the results of the all the questions in Table 5.3 are analyzed and presented. Furthermore, a summary of the discussions for RQ5 is included in section 5.4.2.

Word Cloud: ChatGPT in one-word

As evident in the word cloud from survey #Q1 (5.3), the results reveal a predominantly positive perception, with "helpful" being the most frequently mentioned descriptor. This may indicate that students and faculty members primarily view the chatbot as a beneficial tool in an educational setting, offering support and assistance to users. The word cloud also includes other favourable terms such as *"impressive"*, *"efficient"*, and *"useful"* which reinforce this positive view. Nonetheless, a minority of participants expressed their negative outlook on ChatGPT using descriptors such as "evil", *"scary"*, *"overrated"* and *"misleading"*. Although the occurrence of these negative items were infrequent, they do bring awareness of the chatbot's limitations and potential negative implications.

Likert Scale: ChatGPT's role in Education

The general positive attitude towards ChatGPT from #Q1 (5.3) is carried through to likert scale matrix #Q2 (5.4), which examines ChatGPT's specific impact on the dynamics of teaching and learning. The results from this likert-scale question (#Q2, 5.4) show a strong belief (71.8%) in ChatGPT's ability to improve student engagement, with a majority of participants expressing agreement. This highlights ChatGPT's potential to make learning more interactive and engaging. Similarly, the responses to its impact on learning outcomes (statement b of #Q2 5.4) indicates a significant confidence (69.2%) in ChatGPT's capability to enhance the quality and effectiveness of education. This suggests that ChatGPT is regarded as a tool that not only supports learning but also contributes to better educational outcomes. Moreover, this perception is crucial as student engagement is often linked to higher academic achievement, deeper understanding of content, and increased motivation to learn.

Examining the survey results for statement c of #Q2 5.4, suggest only a small percentage (12.8%) strongly agreed or agreed that the use of ChatGPT in post-secondary education is more trouble than it's worth. This suggests that most participants (61.5%) view the challenges associated with ChatGPT as manageable and not significant enough to outweigh its benefits. This is a notable indicator as it alludes to students and faculty being ready to embrace the use of AI technology like ChatGPT in their teaching and learning practices.

However, this process of integrating ChatGPT into educational settings must include careful ethical considerations. The survey results, particularly in response to statement d of #Q2 5.4, highlight this need. Notably, 48.7% of respondents either strongly disagreed

or disagreed with the statement that *"there are too many ethical concerns surrounding the use of ChatGPT in post-secondary education to justify its use"*, indicating a belief that while ethical issues exist, they are not unbeatable. However, the fact that 15.4% agreed or strongly agreed that there are significant ethical issues, coupled with the 35.9% who remained neutral, suggests a considerable level of concern or uncertainty regarding the ethical implications of ChatGPT's use. The lack of a clear majority position on this issue points to the complexity involved in ethical discussions around AI tools in education. This illustrates the importance of developing robust ethical guidelines and frameworks to address concerns such as data privacy, information accuracy, and the potential for misuse. These considerations are vital to ensure that ChatGPT's integration into post-secondary education is done responsibly and with a clear understanding of both its potential benefits and limitations.

On the statements regarding ChatGPT's ability to assist with personalizing teaching or learning experiences (e from #Q2 5.4) and support students learning at their own pace (f from #Q2 5.4), a significant number of participants (59.0%) strongly agreed or agreed. This consensus suggests a belief that ChatGPT could be effective in adapting to individual educational and learning styles needs, which are worthy of attention, especially in today's diverse educational environments. The idea that students can learn at their pace with ChatGPT also suggests an appreciation for its potential to support differentiated learning strategies which will help enhance their educational experiences.

In regards to ChatGPT becoming a distracting tool that *takes away from other important aspects of teaching and learning in post-secondary education* (statement g of #Q2 5.4), a notable 59.0% of participants strongly disagreed or disagreed. This majority viewpoint reflects a general idea that ChatGPT isn't seen as taking away from important educational activities. Instead, this perspective denotes that the chatbot could potentially enhance the traditional educational practices by offering additional resources.

Furthermore, the benefits of ChatGPT can only be recognized if the chatbot users are capable of using the tool. In response to a question on whether participants feel confident with their ability to use ChatGPT effectively (statement h of #Q2 5.4), a strong 66.7% of respondents strongly agreed or agreed. This high level of confidence suggests that a majority of users feel ready to effectively use the chatbot in an educational context. Furthermore, this sentiment is essential for the successful integration of ChatGPT as users should be comfortable with its functionalities to truly benefit from using it. However, it is important to note that using such new technology may require a significant investment of time and resources to use effectively. When prompted on the learning curve associated with ChatGPT (statement m of #Q2 5.4), participants had a division in opinions. Specifically, 35.9% strongly agreed or agreed that *ChatGPT requires a significant investment of time and resources to use effectively in post-secondary education*, while 41.0% strongly disagreed or disagreed. This split of results suggests that while some see ChatGPT as a tool that demands considerable investment, others may find it more accessible or user-friendly. This

could reflect varying levels of familiarity with the technology or differences in how it is being implemented across educational settings.

Moreover, the popularity of ChatGPT has been increasing everyday. A significant number of participants (76.9%) believe that ChatGPT will eventually become a common tool in post-secondary education (statement i of #Q2 5.4), indicating a strong expectation of its integration into the educational system. This idea is evident by examining the responses to the statement k of #Q2 (5.4): *I believe ChatGPT is NOT an appropriate tool to use in post-secondary education.* A majority of respondents (71.8%) struck down this belief, which further reinforces the idea that chatbots such as ChatGPT will inevitably become common and appropriate tools to use within the post-secondary education system. Additionally, this sentiment is further echoed by 79.5% of participants who expressed their excitement for the chatbot's potential to enhance teaching and learning experiences (statement j of #Q2, 5.4). These results suggest a general optimism and readiness between students and faculty to embrace the use of generative AI technologies as part of the teaching and learning process. Furthermore, a significant number of participants 84.6% strongly agreed or agreed that *ChatGPT has the potential to change the way we think about teaching and learning in post-secondary education* (statement n of #Q2 5.4). This overwhelming consensus suggests that ChatGPT is not solely seen as an additional tool, instead, it may be capable of reshaping the future of education.

In regards to ChatGPT's ability to challenge the traditional teacher-student relationship (statement l of #Q2 5.4), 59.0% of participants strongly agreed or agreed and recognized this challenge. This result is indicative of a notable perception shift regarding the role of technology in the educational systems. Specifically, unlike teachers who have constraints on their availability, ChatGPT offers students constant access to information and support, which students can use to receive immediate feedback any day or time. Additionally, this shift could prompt a change in the teacher's role from being the sole provider of knowledge to a facilitator or guide. In this evolving dynamic, teachers might increasingly focus on helping students navigate and engage with the information obtained from AI tools like ChatGPT. Lastly, the presence of ChatGPT as a supplementary educational resource opens doors for students to explore and learn independently. This aspect of ChatGPT can empower students to take charge of their learning journey, reducing their reliance on teachers for lecture material and explanation. This provides an opportunity for students to develop self-directed learning skills, an essential component in modern education.

ChatGPT as an Educational Tool

In the context of #Q3 (5.3) and what participants think of ChatGPT as an educational tool, a majority number of respondents (66.7%) indicated that they view it as a useful and positive educational tool. This perspective is supported by various comments for #Q4 (5.3), which highlight both the positive potential and the concerns associated with ChatGPT's use

in educational settings. Specifically, the positively of ChatGPT can be illustrated through the following comments:

- *"You can get help from it for time-consuming labor parts of your assignments"* (P7).
- *"It can help explain topics in a human way without having to wait for friends, TAs, or the prof to reply".* (P8)
- *"Students can learn and understand concepts at their own pace"* (P24).
- *"It helps explain concept with deeper understanding than just knowing the tip"* (P25).
- *"At any point in time, if a student gets stuck in understanding a concept, he/she can use ChatGPT"* (P26).
- *"I believe it has potential to assist in achieving learning outcomes"* (P38).

Together, these comments paint a picture of why participants believe ChatGPT should be used as an educational tool. Its ability to reduce workload, provide immediate explanations and meet the needs of individuals for learning, provide enough justification as to why such a tool could be used to enhance the teaching and learning experience of students and faculty members. However, while these positive aspects are noteworthy, they should be balanced with an awareness of potential limitations and the need for a critical approach to integrating AI tools like ChatGPT into educational frameworks. The following comments shed light as to the possible negative aspects of adapting such tool within academia:

- *"I believe people are using it assuming it is giving facts even though that is not the case"* (P1).
- *"I think academia has not embraced ChatGPT"* (P6).
- *"it is still not accurate enough and might mislead students in some cases"* (P12).
- *"It is a tool that aids the student that could be used nefariously or not the same way Google or meeting your peers could be in regard to academic integrity"* (P14).
- *"ChatGPT is still very early in development and its full extent of capabilities has yet to be realized".*

These statements illustrate why students and faculty members are hesitant to adapt such new technology within the classroom. The comments reveal the possible negative implications ChatGPT may have, such as providing inaccurate information and opening the door for academic integrity. Furthermore, the results indicate that ChatGPT is still evolving on rapid pace and without knowing the full extend of its capabilities, the chatbot could become problematic as students and faculty can not rely on its consistency and stability.

This unpredictability of ChatGPT's evolving capabilities can be a significant concern for educational institutions. As the technology rapidly advances, it becomes challenging for students and faculty to keep pace with its changes and understand its limitations. This unpredictability can lead to confusion and mistrust, particularly in an academic setting where consistency and reliability are essential.

Regulating ChatGPT

Regardless of adapting generative AI in education or not, this groundbreaking technology is here and is being used. Numerous comments from respondents further support this idea: "I believe people are using it..." (P1) and "I think academia has not embraced ChatGPT" (P6). With the introduction of such new technology, the question of who should be overseeing its implementation in education arises. This is a crucial aspect of integrating generative AI like ChatGPT into educational settings, as effective oversight can help mitigate many of the concerns previously mentioned. Examining the results for question #Q5 (5.3) reveals that nearly two-thirds (74.4%) of respondents pointed to course instructors as the primary regulating body of ChatGPT. However, the task of overseeing AI integration in education ideally involves a collaborative approach among various stakeholders including (but not limited to): generative AI developers (e.g. OpenAI) and administrators from the university, faculty and department levels. Through a multi-stakeholder approach, the integration of AI like ChatGPT in education can be more effectively managed, ensuring that it serves the educational objectives while addressing the various concerns and challenges it presents. Furthermore, each stakeholder brings in specific unique perspectives that could help with shaping policies that best suit their own needs. This process would also provide a framework for universities to follow to assess future groundbreaking technologies such as ChatGPT through a timely and thorough approach.

Future of ChatGPT

Although the future of ChatGPT remains unknown, results from #Q6 5.3 allude to a future where generative AI technologies are integrated into daily academic tools similar to "calculators and Google". The comparison to calculators and Google suggests a future where AI tools are seen as indispensable aids in the educational process, much like how calculators revolutionized numerical calculations and Google transformed information retrieval. This also raises the idea of whether educational institutions would ever purchase licenses for such generative AI tools for research and teaching. If ChatGPT becomes yet another tool like calculators or Google, then considerations in regards to its accessibility to everyone would be of interest.

The respondents also believe ChatGPT has a potential to become specialized and further assist with *"coding writing and generating research ideas"*. With such a promising future, ChatGPT may *"become integrated into the learning process"* (P23) for students and ed-

ucators. This anticipation of ChatGPT and similar generative AI technologies becoming essential to academic life reflects a growing recognition of their potential to transform how education is delivered and received. The belief that ChatGPT could specialize in areas like coding, writing, and generating research ideas points to its potential role as a facilitator of creativity and efficiency in academic work. For coding, it could assist in debugging, offering coding suggestions, or even teaching programming concepts. In writing, it could help with structuring essays, proofreading, or generating ideas for creative writing tasks. As for research, ChatGPT might aid in brainstorming research topics, synthesizing existing literature, or even suggesting novel research directions. Regardless of its use-case, ChatGPT is expected to evolve within the academic space and grow to become an ordinary tool used in this domain.

5.4.2 Summary of RQ5 discussion

Based on the discussion from the survey results for questions outlined in Table 5.6, ChatGPT is largely regarded as a promising and valuable educational tool. The word cloud from survey question (#Q1 5.6) highlights a predominantly positive perception, with descriptors like *"helpful"*, *"impressive"*, *"efficient"*, and *"useful"* frequently mentioned, indicating a general belief in its benefits for educational settings. Despite some concerns about potential negatives such as inaccuracy or ethical issues, the majority of respondents view these challenges as manageable rather than prohibitive. The strong belief in ChatGPT's ability to improve student engagement and learning outcomes, as shown in survey question #Q2 (5.6), reveals its potential to enhance the quality and effectiveness of education. This optimism is further reflected in the belief that ChatGPT could become as integral to learning as calculators and Google, aiding in tasks like coding, writing, and idea generation.

Additionally, the survey results suggest that the integration of ChatGPT is expected to evolve beyond a mere assistive tool, potentially reshaping traditional teaching and learning dynamics. The majority of respondents anticipate that ChatGPT will not only complement but also significantly change the educational landscape, highlighting its potential to facilitate personalized learning experiences and support self-paced learning. While there are divided opinions on the level of investment required to use ChatGPT effectively, the general consensus is one of readiness and excitement for its integration into post-secondary education.

Ultimately, the data indicates that ChatGPT is predominantly viewed as a beneficial, innovative, and groundbreaking tool in education, with the potential to significantly enhance both teaching and learning processes. Its integration, however, calls for careful management, ethical considerations, and collaborative oversight to ensure that its benefits are maximized while minimizing any potential drawbacks. The future of ChatGPT in education seems not only promising but also indicative of a shift towards more technologically integrated and personalized educational experiences.

5.4.3 RQ6: How is ChatGPT used by post-secondary students and instructors?

To address this research question, the results of the survey questions mentioned in Table 5.6 are analyzed and presented. A summary of the results for this research question (RQ6) can be found in section 5.4.4.

Current Usage of ChatGPT

In assessing the usage of ChatGPT by participants (#Q7, 5.6), the results reveal that majority of participants (29 out of 39, 74.4%), have used the tool in their teaching and learning experience. For many, ChatGPT offers a wide range of services that draws them to continue using the tool. Particularly, students and instructors may use the chatbot to save time while reading content, draft emails, proofreading material and even learn new concepts. Consequently, this may suggest that ChatGPT will inevitably be used by students and instructors throughout their daily tasks within an academic context. When asked about the length of time that participants have used ChatGPT (#Q8, 5.6), results suggest that the majority of participants are relatively new users of ChatGPT. On average, most respondents have interacted with the tool for about a month, suggesting that their exposure to and experience with ChatGPT is fairly recent. Breaking down the data further, it's interesting to note that there is a significant portion of users at the earlier stages of usage. Specifically, 31.0% of the respondents have used ChatGPT for less than a month. This indicates that a significant number of participants are in the beginning phase of exploring the capabilities and functionalities of ChatGPT. Their experiences and perspectives might be shaped by their first impressions and early interactions with the tool. Similarly, another 31.0% of respondents reported having used ChatGPT for a duration between 1-2 months. This group represents users who have had a bit more time to familiarize themselves with ChatGPT, potentially developing a deeper understanding of its strengths and limitations. They might have started to integrate the tool more significantly into their tasks or routines. A smaller subset of the survey population, 6.9% (2 individuals), have used ChatGPT for a period of 2-3 months. Although this group is smaller, their longer interaction period with ChatGPT might have allowed them to gain more in-depth insights into the tool's functionalities. They could be leveraging ChatGPT for more complex tasks and might have a better understanding of how it can be effectively utilized. Additionally, 5 respondents, making up 17.2% of the total, have engaged with ChatGPT for 3-4 months. This group likely represents some of the more experienced users, who may have been using the tool since its release in November of 2022. Their longer-term engagement might provide valuable insights into how ChatGPT has evolved and how it can be integrated into more unique and complex domains. Interestingly, 4 participants (13.8%) who answered "yes" to #Q7 5.6 opted not to specify the duration of their usage of ChatGPT. The reasons for this are unclear but could range from uncertainty about the exact duration to a general hesitancy to share specific details. However, their

positive response to using ChatGPT (#Q7 5.6) indicates their inclusion in the broader context of users familiar with the tool. Overall, the relatively short duration of use among the survey participants suggests that the integration of ChatGPT into their daily practices is still in a developing stage. It also implies that the overall community's experience with ChatGPT is evolving, and perspectives on its utility and impact may continue to change as users gain more extended exposure to the tool. This early stage of adoption offers a unique opportunity to track how user attitudes and applications of ChatGPT develop over time, particularly in educational settings where its role is still being defined and understood.

Future Use of ChatGPT

When inquired if participants would continue using ChatGPT (#Q8 5.6), the majority of the respondents, 82.1%, expressed a strong inclination to continue using ChatGPT, primarily citing its time-saving capabilities. This positive reception highlights the tool's role in automating repetitive tasks, such as email write up and proofreading. The use of ChatGPT for emails or rephrasing write-ups suggests that the chatbot is not just seen as a technical tool, but also as an aid in general communication tasks. This points to a broader application of AI chatbots in improving written communication skills, an essential aspect of academic and professional life. The value placed on ChatGPT for these tasks also indicates a recognition of its potential to enhance language skills and the quality of written outputs. Notably, several respondents appreciated ChatGPT's role in explaining new concepts. This emphasizes its potential as a supplementary educational tool, offering alternative explanations and approaches to problem-solving. The fact that it is seen as a tool for ideation and getting started on an idea further extends its usage beyond just being an answer-giving machine to a creative human. Such a role can be particularly valuable in fields that require a high level of creativity and innovation, such as research projects or creative writing. However, the results also revealed a minor yet significant level of hesitancy among some users. The concern that ChatGPT *"removes the joy of thinking"* is indicative of a deeper concern about the potential over-reliance on AI for tasks that traditionally require critical thinking and problem-solving. This idea echoes extensive debates in the field of educational technology about the balance between technology use and maintaining essential cognitive skills. Furthermore, the point about the answers from ChatGPT not always being accurate is an important reminder of the limitations of current generative AI technology. This highlights the need for users, especially in an academic context, to be vigilant of the information provided by generative AI tools, cross-referencing the results with other sources and their own knowledge. Lastly, the fact that 10.3% of participants did not respond to the question about future use of ChatGPT could suggest uncertainty or ambivalence about the tool's role in their academic practices. It might also reflect a lack of sufficient experience with the tool to form an opinion.

Participant's Use Context of ChatGPT

Although nearly two-thirds (74.4%) of the participants reported using ChatGPT, the context which each individual reported using the tool is differently. Question #9 (5.6) of they survey provided a medium for respondents to indicate how they use ChatGPT in their workflow. Examining the results, a large group, 43.6%, indicated that they use ChatGPT for experimentation and casual learning rather than a formal academic resource. Such usage might involve investigating new concepts, understanding topics outside their academic specialization, or satisfying curiosity, which, while not directly related to their coursework, can contribute to a broader educational experience.

The 30.8% of respondents who use ChatGPT briefly for guiding their assignments, but not extensively, point to a mindful but practical application of the tool. This moderate use suggests that students and faculty members are exploring the balance between traditional learning methods and generative AI assistance. They seem to recognize the value of ChatGPT in providing quick guidance or alternative perspectives, yet they maintain a level of self-control to ensure that the core learning process remains unchanged.

The smaller group, 12.8%, who reported using ChatGPT considerably for their assignments, suggests a growing trust in generative AI capabilities among some users. This group likely takes advantage of the efficiency and range of information that ChatGPT can offer, finding it a valuable tool in their academic toolkit. However, the number being relatively small reflects a careful approach by the larger academic community in fully embracing generative AI for significant academic reliance.

Interestingly, 10.3% of the survey participants have barely used ChatGPT or not at all, reflecting either a lack of awareness, access, or a preference for traditional learning methods. This group's minimal engagement with ChatGPT might draw from various factors, including doubtfulness about the tool's correctness, concerns about academic integrity, or simply a lack of perceived need in their current academic practices.

ChatGPT Usage in Academia: Participant Estimates

Furthermore, as we delve deeper into the community's perception of ChatGPT role in post-secondary education, certain trends emerged. Specifically, all students and instructors approximated that ChatGPT is being used within an academic setting in one shape or form. Although usage cases and extent might differ, participants all agreed that at the minimum, 21% or more of students are using it for academic purposes. Interestingly, the perception of ChatGPT usage for assignment and write-ups seems to be mixed. The results suggest that approximately 21-60% of students are using the chatbot to assist with assignment writing and a smaller portion may either be using it extensively or quite minimally. Moreover, looking closely at the results presented in Table 5.3.2, majority of participants agreed that students are using ChatGPT in a reasonable and appropriate amount, as noted by 23 out

of 39 (59.0%) respondents who selected 0-40% in response to the following question: *"What percentage of students do you think are using ChatGPT to complete coursework beyond the pre-established course policy/syllabus?"*. Subsequently, participants had conflicting thoughts in regards to students' ChatGPT usage within the pre-established course limit. Specifically, 11 individuals (28.2%) expressed their concern by acknowledging that 0-20% of the students may be using the ChatGPT within the established guidelines, in other words, they believe some students may be abusing the chatbot to complete their coursework. Conversely, 13 participants (33.3%) seemed untroubled with ChatGPT usage by students, as they believe 41-60% of the students are using it within the set parameters in the course. Overall, despite the mixed perception, the results highlight the importance of setting clear course policies for students and instructors to adhere to in regards to ChatGPT usage within academia. In addition, this illustrates that without clear guidelines as to what constitutes academic dishonesty, incorporating ChatGPT into post-secondary courses could be troublesome.

Applications of ChatGPT in Education

The survey results for question #11 (5.6) highlight four different ways that ChatGPT is being used in education:

Educational Content and Resource Development The leading use of ChatGPT in developing educational content is particularly evident. Participants' references to ChatGPT's assistance in creating *"initial templates"* and *"generating creative prompts"* suggest its use in the initial and brainstorming stages of educational content creation. Its contribution to improving lectures and providing alternative examples speaks to its value in refining instructional materials. This further indicates that ChatGPT is not only a tool for content generation but also a resource for increasing the quality and diversity of educational materials, especially when it comes to examples. Improving interesting and relevant examples could possibly help students remain engaged in disciplines such as computer science [37].

Learning Support and Skill Enhancement ChatGPT's role as a learning aid is clearly reflected in the survey responses. Its capability to provide *"real time assistance"*, *"additional examples"*, and *"explanations"* speak to its value for students seeking supplementary learning support. The tool's effectiveness in helping users improve their writing and communication skills, evidenced by its usage in *"revising essays"* and *"fixing grammar"*, highlights its potential in skill development. This suggests that ChatGPT is increasingly being viewed as an integral part of the learning process, contributing to academic skill enhancement.

Research, Technical Assistance, and Assessment The application of ChatGPT in research and technical education areas is another significant finding. Its use in "speeding up research [activities]" and defining technical terminology illustrates its use in improving

academic research processes. Additionally, ChatGPT's ability to guide users in developing technical knowledge (e.g. understanding Application Programming Interfaces (API)) and providing assistance with technical courses points to its role as a technical education aid. The potential use of ChatGPT in simplifying assignment evaluations and helping in exam processes by "writing/marking exams" suggests its looming role in educational assessments. Although this domain has traditionally been driven by humans, it would be interesting to investigate how generative AI technologies can develop and assess exams in an education context. This approach may require extensive deliberation in terms of ethics such as privacy and bias, however, automating this process using ChatGPT could free up resources for teaching teams to assist students with course content (e.g. more office hours, review sessions etc.).

Innovation in Teaching and Administrative Processes Finally, the survey results highlight ChatGPT's role in innovating teaching and administrative tasks. Its ability to inspire new ways to test learning outcomes and assist in administrative tasks (e.g. emails, paperwork, etc.) suggests its broader impact beyond classroom teaching. This points to ChatGPT's potential to not only improve teaching practices but also streamline administrative processes within educational institutions.

Collectively, these themes reflect ChatGPT's diverse roles in education, with strong emphases on its ability to serve as a versatile tool for all stakeholders including but not limited to instructors, researchers, students and administrators.

5.4.4 Summary of RQ6 discussion

Based on the discussion from the survey results for questions included in Table 5.6, ChatGPT is extensively used by post-secondary students and faculty members, with a majority (74.4%) incorporating it into their teaching and learning experiences. Commonly cited uses include time-saving activities such as reading content, drafting emails, proofreading, and learning new concepts. Most participants are relatively new to ChatGPT, with about 62% having used it for 1-2 months, suggesting their experiences are still in the early stages. Notably, a smaller group (6.9%) have used it for 2-3 months, potentially having a deeper understanding of its functionalities.

Looking ahead, a significant majority (82.1%) plan to continue using ChatGPT, valuing its efficiency in tasks and its role in explaining new concepts. However, some expressed concerns about its potential to reduce critical thinking and the accuracy of its answers.

In terms of specific applications, ChatGPT is used for a variety of educational purposes. These include developing educational content, such as creating templates and improving lectures, supporting learning through real-time assistance and skill enhancement, helping in research and technical tasks, and innovating teaching and administrative processes.

The diverse usage patterns indicate ChatGPT's growing role as a complex educational tool, offering substantial benefits in various academic activities. However, this broad application range also highlights the need for clear guidelines to ensure its responsible use in educational settings.

5.4.5 RQ7: What are the potential benefits and drawbacks associated with using ChatGPT in post-secondary education?

To address this research question, the results of the survey questions presented in Tables 5.10 and 5.12 are analyzed and presented. Meanwhile, a short summary of RQ7 is provided in section 5.4.6.

Perceived Advantages

Analysis of survey results revealed that ChatGPT is seen as a valuable learning tool that offers additional resources beyond the course material and improves learning outcomes. Such findings highlight the potential of ChatGPT to not only supplement, but possibly, enhance the educational resources currently accessible by students. This benefit could stem from ChatGPT's ability to provide instant information and break down complex problems for users, thus enhancing the learning experience. Moreover, a key finding from the study is the perceived ability of ChatGPT to tailor to individualize learning. Specifically, 22 respondents (56.4%) agreed that ChatGPT could be used for "personalized teaching and learning experiences" and "improved accessibility for students with disabilities". This suggests that the chatbot could cater to individual student needs in a diverse learning environment, which are inline with previous studies on this topic [34, 102]. These ideas were also reflected in responses to the open-ended question on other benefits of ChatGPT. Themes such as time savings for readings and personalized learning experiences were perceived as direct advantages, highlighting the potential for ChatGPT to be integrated within post-secondary education classrooms. These aspects no only improve the efficiency of the learning process but also provide a more inclusive approach to meet the needs of individual students, regardless of their academic background on a specific topic. Moreover, the timing saving benefit of ChatGPT is crucial in the context of education where students are often overwhelmed with extensive readings, assignments and exams. This benefit would allow users to focus more on understanding the content, than spending time on long readings.

Perceived Disadvantages

Although ChatGPT may come with many benefits, the results suggest that users should exercise caution while using it as an educational tool. Most importantly, analysis of survey responses indicates ChatGPT often produce "inadequate response[s]" due to incorrect facts or relevance to topic, which has been noted before in previous studies [47, 51, 102]. This inconsistency in reliability can be problematic in an educational setting where accuracy of

information is significant. Users of ChatGPT should exercise great caution in trusting the information provided by the chatbot and should verify the information on a regular basis. Using ChatGPT as the sole source of information should be avoided. Moreover, results suggest that using ChatGPT in an educational setting could result in academic dishonesty cases, especially if the chatbot is misused beyond the pre-established limit set by the course or instructor. These findings signify that while ChatGPT may be a useful educational tool, its reliability and potential for being abused in an academic setting cannot be overlooked. The concern surrounding academic dishonesty could possibly be mitigated by faculty members establishing clear guidelines communicating the acceptable usage of ChatGPT in their courses. Furthermore, respondents indicate that ChatGPT may negatively impact the development of critical thinking and research skills and cause students to use the tool before attempting to solve class exercises or projects by themselves. This convenient way of obtaining answers could lead to students bypassing the process of exploring and understanding concepts on their own. Additionally, study findings reveal that the community feels uneasy in regards to using the tool due to ethical concerns, which align closely to previous studies [48, 52]. As mentioned by respondents to the open-question on other drawbacks of ChatGPT, students and instructors worry about sharing personal information with OpenAI, a private AI-based company.

5.4.6 Summary of RQ7 discussion

In short, the integration of ChatGPT in post-secondary education presents both exciting opportunities and serious challenges. Students and instructors seem eager to continue using the chatbot within their academic space and despite its pitfalls, ChatGPT could gain popularity as an educational tool within the coming months. The general perception of the chatbot is quite mixed, however, notable benefits include time savings for readings, facilitate learning, initiate project ideas, identify and patch code mistakes, and serve as an aid for tasks that do not require critical thinking. In contrast, users must be aware of ChatGPT's disadvantages, such as possible incorrect or biased responses, potential usage for academic dishonesty and ethical considerations.

5.5 Limitations

Similar to the limitations mentioned in chapter 3, this study also suffers from lack of diversity among the participant sample. Despite the survey being open to all undergraduate and graduate students, and faculty, within the Faculty of Applied Science, a majority of the respondents were graduate students ($N=24$), followed by a subset of undergraduate students ($N=11$) and finally, a small number of faculty members ($N=4$). Among these participants, ($N=37$) individuals came from computer science while the remaining ($N=2$) were from engineering. As a consequence of having a majority of respondents from a technical

background, the results presented in this study can not be generalized, instead, the findings are only applicable within the computer science education domain.

Furthermore, given the rapid pace of generative AI technologies, it is important to acknowledge the timing associated with this study. The follow-up survey was developed and deployed in early March of 2023, a period of time where ChatGPT-3.5 was the most readily available version for public use. Therefore, the specific findings of this study may not apply to the new capabilities and limitations of newer versions such as ChatGPT-4, however, the broader implications remain the same.

Lastly, the reliance on a stand-alone 15-question survey could have resulted in the omission of some data. Given the complexity of ChatGPT and education, it is possible that not all relevant aspects were covered within the survey. Additionally, due to ethical reasons, respondents were provided the option to skip answering questions, and in some cases, a subset of participants did exercise their rights to not answering. An ideal follow-up study to this could include more questions and/or alternative data collection methods (e.g. interviews) for more in-depth discussion, allowing participants to share their perceptions in more detail.

Chapter 6

Reflections, implications, and future work

This chapter serves as a retrospective section where I summarize the discussions and limitations from chapters 3 and 5 and outline broader implications and impacts of this research as a whole. Furthermore, I reflect on ChatGPT within computer science education and the possibilities of leveraging the chatbot's benefits to teach and learn computer science concepts. Additionally, I outline various initiatives that I believe could benefit the greater community as more students and educators turn to using ChatGPT in their workflows. Moreover, I present a subset of promising future directions which offer insights into potential areas where ChatGPT's role and capabilities can be tested. I also discuss how I, as a course instructor, was able to translate the insights gained from the focus group and survey into a pilot study within my second-year computer science course (CMPT 276: Introduction to Software Engineering [95]) at Simon Fraser University.

6.1 Discussion highlights of chapters 3 and 5

The discussion in chapter 3 highlighted the inevitability of ChatGPT's presence in post-secondary education. This inevitability, however, is the catalyst for researchers and academics to develop clear and effective usage guidelines to prevent academic dishonesty. ChatGPT's ability to provide instant feedback, generate programming code examples, and support debugging challenges, has the potential to transform the traditional classroom in many ways, including but not limited to, student assessments. The challenge faced by instructors in identifying the right balance between in-class and take-home assessments illustrates the barrier to adopting such new technology. While increasing in-class activities like quizzes could enforce ChatGPT usage, it does introduce additional challenges such as diminishing the value of at-home learning and over burdening students with additional undue stress and anxiety. Other implications of ChatGPT include, inconsistency or bias in responses, privacy

and over-reliance which could hinder critical thinking, especially in preparation of entering the job force.

In chapter 5, ChatGPT is perceived by students and faculty members as a positive and valuable tool for enhancing student engagement and learning outcomes, with its role compared to previously revolutionary tools such as calculators and Google's search engine. Specific applications of the chatbot that were derived from the focus group and survey results include, time-saving for readings, drafting emails, proofreading and patching programming bugs which draw more users to continue using the tool in their day-to-day workflow, despite concerns over bias and inaccuracy. The integration of ChatGPT is seen as a shift towards more personalized learning, especially its ability to provide resources beyond what the instructor can provide. The focus group and survey results highlight that a careful integration approach with ethical considerations, and clear guidelines to ensure responsible use, can mitigate potential drawbacks of ChatGPT in higher education.

6.2 Limitations of focus group and survey

While my findings captured a broad range of student and faculty perception of ChatGPT's role and usage, it is worth considering some potential shortcomings of my study methodologies and how complementary perspectives could further improve this research.

Firstly, the audience of the focus group session and the respondent profile of the anonymous survey include a large majority of participants from computer science and a small minority from engineering. However, it is important to note that prior work has shown that results obtained from qualitative studies with small sample sizes can still provide valuable insights for the topic being researched [96, 105]. Therefore, despite the concentrated focus on computer science and engineering education, broader implications of ChatGPT in post-secondary education remain the same. In order to gain a better understanding of ChatGPT's impact on other non-technical disciplines, future research should include participants from disciplines like social sciences, humanities or medical sciences which may shed light on other implications of generative AI tools in their respective fields.

Second, with the rapid emergence of new generative AI tools, it is imperative to discuss the timeline associated with these studies. Both studies presented in this thesis were designed, developed and executed in early March of 2023; at at time where only ChatGPT-3.5 was available and accessible for free by the general public. By this time, ChatGPT was released for only about four months, however, shortly after these studies, in mid March of 2023, OpenAI announced ChatGPT-4 [61], a new multimodal model that "outperforms existing large language models on a collection of NLP tasks, and exceeds the vast majority of reported state-of-the-art systems" [59]. Nonetheless, the findings of these studies are most applicable to ChatGPT-3.5, the broader and overarching implications of generative AI tools in an educational context remain predominantly the same. It is important to note

that results from chapter 3 submitted, peer-reviewed and presented at Western Canadian Conference on Computing Education (WCCCE) [98] in May 2023, were considered timely, especially as some faculty members were in the process of redesigning their courses for fall 2023 semester.

Lastly, the research methodologies used in both studies also pose some limitations. In particular, the focus group approach used in chapter 3 included a time constraint. With only 120 minutes for the whole session, approximately 75 minutes of that period was used to discuss and record group responses to the prompts provided. Additionally, only one volunteer notetaker was assigned per group, which may have resulted in omission of detailed discussion points. Moreover, the 15-question anonymous survey deployed as part of chapter 5 may not be comprehensive enough to capture all aspects of ChatGPT's role and usage within an academic context. The scope of this survey was kept small to ensure participants provided accurate responses within a reasonable time frame (e.g. long surveys could deter participants away). Given the complexity of ChatGPT and education, it would be ideal for future studies to employ data collection methods that provide a space for more in-depth discussion within a reasonable scope and time period.

6.3 Reflection and Implications

While reflecting on the studies presented in this thesis, I have come to realize the magnitude of ChatGPT's impact in our daily lives. It has become increasingly clear to me that ChatGPT is not just a technological tool, but a catalyst for a significant change in the way we communicate, learn and process information.

6.3.1 Computer science education

In a computer science education context, as highlighted in the studies, ChatGPT serves as a bridge between traditional teaching methods and the digital age. In the coming months and years, I foresee many students enrolled in computer science using chatbots to further accelerate their learning. In particular, I believe future introductory courses on computer science (CS1) will change forever. Incoming students may come with their own personalized co-pilots installed, assisting them with every single line of code they author. Moreover, teaching staff including instructors and teaching assistants (TAs) may likely start using ChatGPT for instructional purposes such as developing content for slides, authoring assignments and possibly grading student submissions.

However, I strongly advocate for the computer science community to unite and develop a set of standard universal guidelines that provide instructors with options to choose and incorporate into their own courses. By doing so, I believe students would be able to have a clear understanding of to what extent they can use the tool in their learning. Nonetheless, prior to any standardized guideline, I call upon the computer science community to

join forces with colleagues in humanities subject areas to address the ethical and societal implications that will arise from such integration of AI technologies in education. This collaboration is crucial to the future of AI-education, as the humanities offer deep and rich insights into ethical, philosophical, and societal aspects of technology. By involving experts from both humanities and computer science disciplines, we can hope that the development of guidelines for ChatGPT take into account broader ethical considerations, the impact on human-computer interaction and social dynamics.

This transformation in computer science education opens up exciting opportunities to re-imagine the CS1 and other introductory CS curricula including the teaching pedagogies associated with them. Furthermore, it pushes course instructors to re-design their courses to adapt and possibly embrace this technological tool within their domain. It is my belief that possibilities of academic courses being solely developed and taught by artificial intelligence systems (e.g. a robot with ChatGPT as its core system) are not far from reality. However, this process requires extensive research on the societal impact of smart robots teaching the next generations of humans as any inaccuracy could cause serious harm to students' learning experience. Lastly, it is imperative to consider the long-term implications of such a shift in educational methodology. While short-term advantages may be attractive, it is imperative to maintain a human-centric approach in education. I believe the role of educators in fostering skills such as critical thinking, creativity, and ethical decision-making remains irreplaceable. Therefore, any integration of AI (e.g. ChatGPT) into the computer science education system should be viewed as supplement to, rather than a replacement for, the human aspect of teaching and learning.

6.3.2 Equity and accessibility

Moreover, the widespread of ChatGPT in computer science education raises questions about digital equity and accessibility. As an educator, it is my strong belief that all students, regardless of their academic background or resources, should have equal access to educational resources to maintain fairness (i.e. having access to the same AI model). Furthermore, students with accessibility needs (e.g. vision impairments) are often forgotten about, thus it is crucial to ensure that technological tools such as ChatGPT are developed and implemented in a way that is inclusive and accessible to all. I believe future iterations of ChatGPT (or similar generative AI tools) should be designed with universal design principles in mind, ensuring they are usable by those with a wide range of abilities and disabilities. For instance, features such as screen reader compatibility, and alternative text options can make these AI tools more accessible to those with vision impairments. Moreover, following pre-established user heuristics could help with developing user-friendly interfaces to improve the overall user experience of all users.

Additionally, I stand for more policies that provide students from underprivileged background with the necessary resources such as laptop or smartphones and internet access.

This could involve initiatives such as loaning devices, reducing internet costs or establishing more accessible computer facilities on university campuses. As of writing this thesis, OpenAI's ChatGPT-3.5 is free and accessible to everyone (as long as individuals have access to a computer or mobile phone), however the more powerful model, ChatGPT-4, remains locked behind a $20 USD monthly subscription plan. This disparity in access between the freely available ChatGPT-3.5 and the subscription-based ChatGPT-4 highlights the digital divide, illustrating the need for equitable access to advanced technologies such as generative AI. If students from less privileged backgrounds are unable to afford these tools, they could miss out on significant educational opportunities. In my perspective, guaranteeing equitable access to technology is not only a matter of fairness but also imperative in preparing all students for a future where digital AI literacy is increasingly important. This idea builds on question #5 (5.3) of the survey which prompted respondents with *"who do you think is responsible for defining how Chat-GPT should be used in an educational context?"*. It is my belief that regardless of who regulates the usage of ChatGPT in education, this raises a new issue: *should universities and academic institutions provide their students and faculty members access to generative tool such as ChatGPT?* Since many students area already using the chatbot, perhaps post-secondary institutions could purchase a shared license that is accessible by all students and faculty members, similar to how tools such as Adobe [6] and Microsoft [53] provide educational versions of their products to universities. Through this approach, universities can bridge the digital divide, ensuring that all students and faculty have equal access to generative AI tools like ChatGPT for their educational use.

6.3.3 AI for all

The growing importance of digital artificial intelligence (AI) literacy is undeniable, and its adaptation into the computer science education system calls for an inclusive approach to ensure AI is accessible and understandable to everyone, regardless of their academic background. I believe an initiative such as *AI 4 all* [1] could spark the beginning to foster an inclusive and equitable digital space.

Firstly, it is my vision that AI education is infused into K-12 teacher training programs. This essential approach would equip teachers with the knowledge and skills required to understand and teach basic AI concepts within their classrooms. Through this strategy, we can ensure AI literacy trickles down into students within the K-12 system, which would better prepare them for more advanced AI applications in higher education. Given the importance of teachers in K-12, the training for them should not only focus on technical aspects of AI systems, but also the various ethical, social and cultural implications of the AI in society. Additionally, I envision K-12 teachers would also be provided with specific applications of AI in their domain as each subject may leverage the tool in different ways.

In the post-secondary context, specifically in computer science, curricula should integrate AI education through an approach that builds upon the prior knowledge acquired in earlier

education stages (K-12). I believe this system would provide a continuous, progressive, and rich learning experience for students to embark on a successful AI-infused professional career.

Furthermore, I hope the *AI for all* [1] initiative provides an opportunity for AI education to be accessible and open to everyone, regardless of their age, computer fluency or background. Programs such as community education centres, online classes, and public academic workshops could play a role in spreading AI literacy beyond the academic institutions. I expect these programs to be designed with accessibility and equity in mind so it serve a diverse multilingual audience, with a wide range of learning needs and backgrounds.

6.4 Promising directions for future work

Building on the insights and limitations identified in chapters 3 and 5, several areas of future research can be identified.

6.4.1 Expanding the sample size, demographic, while including other post-secondary institutions

Future studies within this space should aim to leverage a larger sample size with a wide range of demographic background, from multiple post-secondary institution. Through this approach, participants from a wider range of disciplines, including social sciences, humanities and medical sciences could shed light on how this technology impacts their scope of work. Additionally, by including multiple post-secondary institutions (possibly from different countries or continents), could further improve diversity and the sample size, which consequently will diversify the results. This research will provide imperative insights for academic leaders including university administrators to make more informed and educated decisions in regards to adapting this technology within their institutions and classrooms.

6.4.2 Investigating ChatGPT's long-term and short-term effect on student learning outcomes: My exploration as an instructor

Considering the development speed of AI technology, there is a growing need for longitudinal and cross-sectional study to track the impact of generative AI tools over a specific timeline. Longitudinal studies should focus on the evolving capabilities of AI models, such as the transition from ChatGPT-3.5 to ChatGPT-4, and their impact on student learning. Meanwhile cross-sectional studies should aim to examine how students are currently using it within a specific course. As mentioned in chapter 1.2, a cross-sectional study is currently underway as part CMPT 276 at Simon Fraser University. As an instructor for this course, I allowed students to use generative AI tools such as ChatGPT and required a detailed AI-usage disclosure form to be submitted alongside each assignment, lab and project milestone submission. The focus of this study will include investigating the specific use cases

of ChatGPT in an intro Software Engineering course while also examining its impact on student learning outcomes and, academic performance and job preparedness.

6.4.3 Guidelines on ChatGPT usage while considering ethical, privacy, bias and potential misuse

Future work within this domain should include developing a set of standard guidelines on how ChatGPT can or can not be used within an academic context. In this approach, various important factor should be considered. In particular, the results of the studies mentioned in this thesis suggest that ChatGPT users are concerned regarding their privacy, the potential bias embedded in the chatbot's responses and ethical use cases of the chatbot. By addressing these key areas, future researchers can pave the path for educators to adopt policies within their courses to avoid misuse of generative AI tools by their students. Furthermore, further research is needed to identify and address ethical considerations with generative AI tools. This includes efforts to better understand copyright laws for genAIs (e.g. DALL-E [58]), reduce bias, and develop guidelines for ethically training AI models.

6.4.4 Integration vs. incorporation of ChatGPT within computer science education

With this new AI technology, one particular area that requires attention is whether educators within the computer science community should opt to incorporate AI tools (e.g. ChatGPT) within their existing courses or start fresh by integrating it into new courses from the ground up. A notable example includes, Porter and Zingaro's book (published September 2023) on "Learn AI-Assisted Python Programming" [68], which leverages generative AI tools such as GitHub Copilot and ChatGPT as part of the learning experience for students in an introductory programming course on python. Course instructors that opt to use this textbook should investigate students' learning experience and share their experiences within the greater community. Additionally, researching this topic could inspire more educators to adapt with new technology tools. Although simply allowing ChatGPT to be used within existing course material such as assignments, labs and project could be considered as incorporating AI tools; this results of this approach still unknown. Therefore, studies on how AI tools could be best incorporated or integrated within computer science education could also result in valuable insight for the community.

These areas of future work will not only contribute to the academic literature, but also guide policymakers, academic leaders, and faculty members in leveraging the potential of AI tools like ChatGPT in computer science education and beyond.

Chapter 7

Conclusion

The exploration of ChatGPT in post-secondary education settings presents both exciting opportunities and significant challenges. In this thesis, we investigated perceptions of ChatGPT's role in post-secondary education, with an emphasis on exploring its usage, benefits and drawbacks in computer science education as reported by both students and faculty members within this domain. This mixed-method thesis included results from two empirical studies: 1) A focus group session with 40 participants, 2) An online anonymous survey completed by 39 respondents. The findings from both studies reveal a general consensus among participants that ChatGPT will inevitably be incorporated into post-secondary courses and assignments. Based on its wide range of capabilities, ChatGPT was perceived as a positive and valuable learning tool in both studies. In particular, some benefits of this generative AI tool were noted as its ability to unlock additional resources for students, provide immediate answers, reduce time needed to complete readings, assist with programming bugs, and personalize the learning experience for students, especially those with accessibility needs. Nonetheless, the results from both studies highlight various shortcomings of this disruptive tool. Specifically, the chatbot's inconsistencies, inaccurate responses, and it's ethical considerations must be addressed before educators can confidently adopt or integrate it within their teaching. The findings of chapter 3 also offered conducting in-class quizzes as a possible solution to enforce ChatGPT's usage. Furthermore, the study results identified concerns about the potential for students to become over-reliance on ChatGPT, leading to reduced critical thinking and computational thinking [101] skills. This concern is particularly relevant in computer science education, where problem-solving and independent thinking are imperative skills.

The research included in this thesis contributes to the rapidly growing literature on ChatGPT's influence in post-secondary education, specifically computer science education, by highlighting its perceived usage, advantages and disadvantages in an academic environment. Additionally, the results signify the importance for academic institutions to actively tackle potential challenges, such as academic integrity, ethical issues, privacy and bias stemming from ChatGPT's usage among the community.

While both studies presented in this thesis have limitations in terms of scope and participant diversity, they offer timely insights from students and instructors within the computer science education community. This research also lays the foundation for future work that may include studies on, 1) ChatGPT's long-term and short-term effect on student learning outcomes or 2) exploration of different strategies educators can take to integrate/incorporate ChatGPT within the computer science courses. With ChatGPT rapidly becoming more popular in the educational field, it is essential for academics to engage in ongoing discussions and develop policies and practices to leverage the potential benefits of this technology while minimizing its challenges within an academic setting.

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Appendix A

Focus Group Questions

This section includes the focus group questions used to spark discussion among the participants as part of the study conducted in chapter 3.

- What are your opinions on how ChatGPT should/ should not be incorporated into future courses and assignments?
- Should courses have more in class assignments instead of take home assignments?
- How do you think professors should assess students and make sure the ChatGPT usage is adequate?
- Are you worried about how ChatGPT may affect students' learning and/or job preparedness?

Appendix B

Survey Questions

The following pages includes the original survey deployed as part of study conducted in chapter 5.

TTT - Listening to the students' voice - Spring 2023 (Anonymous)

ChatGPTTT

Thank you for participating in the TTT Listening to the Students' Voices session about ChatGPT!

If you have any further comments about ChatGPT, please answer the questions in this form. **By completing this form**, which is completely anonymous and optional to complete, you are consenting to have your comments be considered as part of a summary that will be sent to all FAS faculty members, and also you are consenting to have your comments considered as part of CS Education research. Completing this form may take you about 5 minutes.

Completing this form is optional and you may skip answering some or all questions, although your feedback is certainly appreciated!

To participate in the gift card draw you need to traverse all questions in this form (answering or not as your prefer), and then you will be automatically asked to enter a second survey where you are asked to provide your contact information for the session organizers to contact you about the gift card. That second survey is independent from this one and your answers in the surveys cannot be connected. All data collected will be stored locally at SFU.

Feel free to complete the surveys more than once if you would like to add more comments. The survey will be open until the end of Sunday, March 12 2023. Notice that you will be considered in the draw only once independent of the number of entries in the survey/s.

Thank you once again for your participation in the TTT and your valuable input!
FAS FTF and CSSS.

If you have any concerns about your rights as a research participant and/or your experiences while participating in this study, please contact the Director, SFU Office of Research Ethics, at [redacted] or [redacted]. Additionally, if you have any questions regarding the study or session, please feel free to reach out to Diana Cukierman , CS University Lecturer, FAS Faculty Teaching Fellow, [redacted] or Parsa Rajabi [redacted]. Ethics Study Number: 30001591

Q1 . What is your role at SFU?

- ○ Undergraduate Student
- ○ Graduate Student
- ○ Faculty
- ○ Staff

Q2 . What is your department/program:

- ○ Computing Science
- ○ Engineering Science
- ○ Mechatronics Systems Engineering
- ○ Sustainable Energy Engineering
- ○ Other

Q3 . Have you utilized ChatGPT in your teaching/learning experiences in an educational context?

- ○ Yes
- ○ No

Q4 . If so, how many days have you used ChatGPT? (in total)

Answer :

Q5 . How are you using ChatGPT? (remember this is completely anonymous)

- ○ I never used it or used it a couple times only
- ○ I have been just playing with it, not to help any of my assignments or write up

- ○ I am using it briefly to guide me in my assignments, but not heavily at all
- ○ I am using it quite considerably to help me doing my assignments

Q6 . Do you intend to continue using ChatGPT? Please explain why.

Answer :

Q7 . Describe your overall impression of ChatGPT in one word.

Answer :

Q8 . Please rate each statement

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
ChatGPT can improve student engagement in post-secondary education. :	○	○	○	○	○
ChatGPT can improve learning outcomes in post-secondary education. :	○	○	○	○	○
The use of ChatGPT in post-secondary education is more trouble than it's worth. :	○	○	○	○	○
There are too many ethical concerns surrounding the use of ChatGPT in post-secondary education to justify its use. :	○	○	○	○	○
ChatGPT can help me to personalize my teaching or learning experiences. :	○	○	○	○	○
ChatGPT can help students to learn at their own pace. :	○	○	○	○	○
ChatGPT is a distraction that takes away from other important aspects of teaching and learning in post-secondary education. :	○	○	○	○	○
I am confident in my ability to use ChatGPT effectively to obtain the answers I'm seeking (in an educational context). :	○	○	○	○	○
ChatGPT will become a common tool for teaching and learning in post-secondary education in the future. :	○	○	○	○	○
I am excited about the potential of ChatGPT to enhance teaching and learning experiences in post-secondary education. :	○	○	○	○	○
I believe ChatGPT is NOT an appropriate tool to use in post-secondary education. :	○	○	○	○	○
The use of ChatGPT in post-secondary education challenges the traditional teacher-student relationship. :	○	○	○	○	○
ChatGPT requires a significant investment of time and resources to use effectively in post-secondary education. :	○	○	○	○	○
ChatGPT has the potential to change the way we think about teaching and learning in post-secondary education. :	○	○	○	○	○

Q9 . For each statement, please specify your answer in terms of percentage

	0-20%	21-40%	41-60%	61-80%	81-100%
What percentage of students do you think are using ChatGPT for academic purposes? :	○	○	○	○	○
What percentage of students do you think are using ChatGPT to strongly/very considerably help them with their assignments and write up? :	○	○	○	○	○

What percentage of students do you think are using ChatGPT to complete coursework BEYOND the pre-established course policy/syllabus (more than it is allowed) :	○	○	○	○	○
What percentage of students do you think are using ChatGPT to complete coursework WITHIN the pre-established course policy/syllabus :	○	○	○	○	○

Q10 . What do you think of ChatGPT as an educational tool?

- ○ it is a tool creating mostly positive educational opportunities
- ○ it is a tool causing mostly negative consequences in education
- ○ I am not sure

Q11 . Please elaborate on the answer you provided to the previous question

Q12 . What are some specific applications of ChatGPT in an educational setting?

Q13 . Who do you think is responsible for defining how ChatGPT should be used in an educational context? Select all checkboxes that apply

- ☐ University-wide Level
- ☐ Faculty Level (i.e. Applied Science)
- ☐ Department Level (i.e. Computing Science)
- ☐ Course Instructors
- ☐ ChatGPT Developers (OpenAI)

Q14 . Please select which one(s) can be considered as benefits of using ChatGPT in post-secondary education

- ☐ Increased student engagement
- ☐ Improved learning outcomes
- ☐ Personalized teaching and learning experiences
- ☐ Time savings for readings
- ☐ Access to resources beyond what the instructor can provide
- ☐ Improved accessibility for students with disabilities
- ☐ Improved student satisfaction with the learning experience
- ☐ Enhanced collaboration among students
- ☐ Reduced workload for instructors
- ☐ Greater flexibility in course delivery
- ☐ Other (please specify in space provided below)

Q15 . Please select which one(s) can be considered as drawbacks of using ChatGPT in post-secondary education

- [ ] Ethical concerns
- [ ] Technological barriers (e.g. connectivity issues, learning curve for users)
- [ ] Reduced face-to-face interaction with students
- [ ] Inadequate response accuracy or relevance
- [ ] Potential for misuse or academic dishonesty
- [ ] Lack of human interaction in the learning process
- [ ] Limited ability to provide personalized feedback to students
- [ ] Cost of implementation and maintenance
- [ ] Limited ability to foster critical thinking skills
- [ ] Limited applicability to certain subjects or courses
- [ ] Other (please specify in space provided below)

Q16 . Does ChatGPT have any other benefits or drawbacks in post secondary setting that were not mentioned? Please specify here.

Q17 . How do you think the use of ChatGPT in post-secondary education may evolve over time?

--- Feedback for The Teaching Talks (TTT) ---

Q18 . We are possibly planning further sessions about ChatGPT. Please check if you would be interested in any of the following:

- [ ] A technical session accessible to non-experts
- [ ] A conversation session analogous to what we did today
- [ ] A panel with invited speakers
- [ ] Participate in interviews/videos/further research

Q19 . Please write any comments or further feedback about this session. Please include both what went well and suggestions for improvements.

Please submit and enter in the next "websurvey" to complete the sign out process, allowing you to participate in the gift card