Getting Comfortable with AI: A Study on Student Use, Impact, and Opinion

Ethan Aubert

April 8th, 2024

Departmental Honors Thesis

Department of Molecular Cellular and Developmental Biology

College of Arts and Sciences

University of Colorado Boulder

Thesis Advisor: Mike Klymkowsky, PhD

Department of Molecular Cellular and Developmental Biology

Honors Council Representative: Cheryl Pinzone, PhD

Department of Molecular Cellular and Developmental Biology

Outside Reader: Maciej Walczek, PhD

Department of Chemistry

CONTENTS

<u>Abstract</u>

The immediate response of the higher education establishment to the introduction of ChatGPT and AI-based Tools has focused primarily on Academic Integrity, that is students using Artificial Intelligence, or AI, to "cheat". How AI-based tools could positively impact students' comprehension of material as well as inclusiveness has been secondary, if considered at all. It was also unclear to what extent students were aware of AI-based tools and using these technologies, impacting their approaches to learning. There are gaps in our understanding of how undergraduate students are viewing, being impacted by, and thinking about ChatGPT and other AI-based tools in an academic context. To begin to address these questions I asked students their thoughts on AI-based tools. I interviewed and surveyed a set of Molecular Cellular and Developmental Biology (MCDB) undergraduate majors at the University of Colorado Boulder to gain insight into the research question; how is AI utilized by students, impacting their education, and being perceived within an academic context? Paired with background research, the data collected from students showed the impact of AI-based tools on undergraduate students' learning processes, their perceived value of education, and how they are approaching the future.

Introduction

The introduction of ChatGPT in the fall of 2022 marked a novel event because accessible artificial intelligence was introduced to the public. ChatGPT (and other AI tools) are based on large language models (LLM). Their abrupt introduction has brought into focus the possible positive and negative impacts of AI technology on higher education. The technology has demonstrated unprecedented capabilities and availability to students and educators. According to IBM, LLMs are a "category of foundation models trained on immense amounts of data making them capable of understanding and generating natural language and other types of content to perform a wide range of tasks"(IBM, 2024). People can tell ChatGPT precisely what to generate whereas previous "tools" such as a search engine or textbooks provided only an avenue to find the right information. It is not widely appreciated or understood how students are using AI tools. The goal of this project was to better understand what students think about AI, how they use AI tools, and how it might impact students' education. Students could use ChatGPT-like tools for a wide variety of tasks impacting the way they complete coursework, study, and approach learning. Because the author is an MCDB major, I decided to focus on my fellow majors. This made it easier to work with others in others in MCDB, including MCDB professors, instructors, and students. MCDB students are required to be proficient in a range of skills that could benefit from interactions with AI tools. Additionally, instructors could use these pioneering AI tools similarly, and have been using them, to push education to new heights. Knowing how some undergraduate students and instructors are using such technologies presently is useful knowledge for students, instructors, and administrators in the future.

At the start of the project, I collected background information from peer reviewed and popular press articles, AI companies, and current events that addressed how students are using

AI and its possible impacts on higher education. I was curious as to how students, educators, and universities have been responding to the accessibility and evolution of AI tools. After a period of background reading, I carried out one informal group interview to explore how my fellow MCDB students were using and thinking about AI in an educational context. After conducting a preliminary group interview, I developed an IRB protocol, which was approved after two rounds of revisions. Subsequently, with input from Drs. Pinzone and Klymkowsky, I designed a series of questions for in-person, one-on-one interviews and for a larger Qualtrics survey. A group of MCDB professors advertised the interviews and distributed the surveys to their undergraduate students ranging from introductory to upper division courses. Both one-on-one student interviews and surveys were designed to explore the main research question of the project: how is AI being utilized by students, impacting their education, and perceived within an academic context? This question involves three sub-questions (Table #1), RQ1: What have students been using AI for?, RQ2: How has AI been impacting students 'education?, and RQ3: What are students thinking about AI in an academic context?

In sum, the outcome of my research project was a recognition that the majority of students have been using AI for schoolwork and they have generally felt that AI has positively impacted their educational experience. The research revealed a diverse range of students' opinions and innovative ways that they use AI tools, which provided a new perspective to understand the impacts of AI on college students. My observation suggests several more rigorous future studies on how educators should incorporate AI to aid learning and how to ensure equity and inclusion amongst diverse groups of students.

Understanding AI

At the start of the project, I set out to understand what AI tools are currently capable of, why AI is impacting higher education for both students and educators, and the societal context of ChatGPT's release. Looking at reports from early adopters of ChatGPT provided insight into how CU Boulder MCDB students might be using, thinking about, and being impacted by AI. Just before the release of ChatGPT, higher education had to accommodate an increase in online learning due to the COVID-19 pandemic. From the fall of 2019 to the spring of 2021, remote classes were the only option for many universities and an increase in the reports of cheating jumped by more than 79% (Dey, 2021). The lasting impact of COVID was that an increased number of students' tests and work became online-oriented, even after classes returned to in-person.

The availability of AI tools has raised concerns regarding academic honesty and the potential for over-dependence on such tools (Hadi Mogavi et al., 2023). Students report using ChatGPT to take tests, write papers, and complete schoolwork (Westfall, n.d.). A primary concern for universities is that students can "cheat" on tests, using AI tools, and so obtain a college degree without learning what they are expected to know (Johns Hopkins Editorial, 2023). There is considerable uncertainty about the current abilities, evolution, and overall impact of AI tools on educational outcomes.

Uncertainty surrounding AI has not been limited to higher education. Several AI industry leaders have exited the field and warned that AI poses a risk of extinction for humans on the scale of "pandemics and nuclear war" (*Metz*, 2023). Other AI experts have more optimistic views, saying that AI is a useful tool that can change the world for the better by allowing automation or enhancement of essential jobs such as cancer screening (Zhang et al., 2023). With

whichever prevailing viewpoint, AI tools are expected to change the world, involving impacts on higher education.

In the specific case of MCDB undergraduates at CU Boulder, it was unclear how students were utilizing and contemplating AI tools. The question arose; are these students employing ChatGPT to cheat their way through school, validating the fears of higher education authorities, or do they view using AI tools as cheating as opposed to useful and appropriate educational tools? The existing information I have gathered reflects the opinions and reports of several "early adopters", small samples of student opinions from AI companies, and a sample of university responses. Together this information provides a better picture of how students are currently using (and viewing) AI tools important for understanding the information gathered from CU MCDB students. Many aspects of AI tools are explicitly not considered. For example, how these tools work and what the introduction of AI could mean for humanity, in philosophical, social, and economic terms.

ChatGPTs' Educationally Relevant Capabilities

A literature review indicates that ChatGPT and other AI tools can complete a variety of tasks relevant to college students. These tools can generate passing papers on a variety of subjects with citations. They can carry out (in some cases) accurate computations, generate working computer code, summarize information to aid research, and answer test questions (Hadi Mogavi et al., 2023; Roberts, 2023). ChatGPT and other LLM AI are different than previous technological tools because they are built around prompt engineering and conversational response. AI has demonstrated the ability to "ace" logic tests (Fowler, 2023), provide psychological therapy, give a productivity boost to weaker writers (Lenharo, 2023), and provide customer support for

businesses (*FAQ - CustomGPT*, 2023). Beyond educational tasks, students have been using this technology to suggest gift ideas, exercise workouts, and idea generation (Svurluga & Natanson, 2023).AI tools are being used for image generation including pieces of artwork, logo designs, re-creating photos, and more. One student said, "The limit (of AI) is only human imagination" (Svurluga & Natanson, 2023). ChatGPT4, the paid version of the technology available to the public for $20 a month, is claimed to be able to pass freshman year at Harvard (*Pricing*, 2024; Bodnick, 2023). ChatGPT can take over much of the technical work required from college students such as writing, researching, or taking assessments. ChatGPT can pass many quizzes or exams, solve quantitative problems relevant to STEM classes, summarize readings or lecture notes, and provide tutoring to students (Mollick, 2023).

ChatGPT is among the most relevant LLMs for students because anyone with access to the internet can access the free version, ChatGPT 3.5. Recently, ChatGPT came out in an app version that students can access at any time through their phones. One student said that they use ChatGPT to do the "lion's share of thinking" because it is easy to have AI complete the assignment for you and then edit the work to look like your own (Kichizo-Terry, 2023). Interestingly, 51% of college students in a recent study said that they thought using ChatGPT for school was cheating (Gordon, n.d.). Whether different socioeconomic groups of students with different access to technology hold the same opinion is unclear. The ability for students to use AI to edit their writing, or to generate a "first draft", creates an issue of integrity for class assignments as well as publications (Flanagin et al., 2023). Both the National Science Foundation and the National Institutes of Health have adopted explicit rules for the use of AI tools in proposal writing and review (NIH, 2023; Lauer et al., 2023; NSF et al., 2023). Some students say they use ChatGPT to help them study or in ways that they do not perceive as

cheating (Chen, 2023). Challenges for students and educators have been created because ChatGPT can do so much for students with as of yet no clear line for when using AI is cheating and when it is not.

<u>Response from Educators</u>

A recent study found that over half of students use generative AI tools. In contrast, more than 75 percent of faculty members do not regularly use the technology (Coffey, n.d.). The result is concern surrounding academic integrity. Some of these concerns come from a gap in understanding the capabilities of AI. AI tool-generated text often seems clear, eloquent, and well-researched leading to a concern that students will become too reliant on AI. Students and faculty should be aware that AI tool-generated materials may not be accurate or complete. A concern is that student use of AI tools could result in less learning and subpar work (Extance, 2023).

The real question is whether the use of AI-generated materials amounts to academic dishonesty. In response, universities, and individual course instructors have created policies in response to AI use. This can involve changes in the institution's Honor Code (at the University of Colorado) or similar, or faculty being empowered to give students a zero on exams or assignments. At the same time, identifying students who have used AI to cheat versus using it as a "helper" is difficult because the use of technology can be difficult to trace. Detection tools implemented by universities have been found to do a mostly inaccurate job of identifying cheating, often falsely identifying the use of AI (Bertram Gallant, 2017; Oxford Centre For Teaching, 2024; UDL, 2024). One option has been to intuitively identify students turning in AI-generated work. A teacher said that work created with AI was "obviously" not created by a

student but was as if "written by an alien" (Roberts, 2023). Some AI bots do worse on certain types of tests and quizzes than college students (Fowler and Merrill 2023). Taking steps to detect AI use has been the main response from universities but might be largely ineffective. All these statements refer, however, to earlier releases of the tools, over time it is likely that these "AI failures" may disappear making student AI use more difficult to identify.

University response to AI has been shifting from detecting student AI use to creating ways to facilitate students' interaction with the technology to benefit their learning. Arizona State University announced in January 2024 that they are partnering with OpenAI, the creators of ChatGPT. In their rationale, the university cites the claim that two-thirds of companies are integrating some form of AI into their business and that "augmented and artificial intelligence systems are here to stay". Ole Miss created an AI institute to help students learn how to use AI to aid their learning (Roberts, 2023). These universities hope to find new ways to incorporate AI into their educational programs, embracing ChatGPT instead of marking AI universally as a threat. In contrast, other universities across the country have banned using ChatGPT on campus by putting up firewalls on the school network (Gordon, n.d.). Some have pushed for methods of testing that AI cannot be used on, such as oral or in-person exams. Moving to oral or in-person-only exams might show better representations of learning anyway because they can (but do not aways) reveal a more nuanced characterization of student learning (Baule & Baule, 2023). In any case, higher education organizations have had to shift the ways that they approach assessing students learning, the work that they are presenting students with, and responding to this unprecedented technology with the recent rise of AI.

The University of Colorado Boulder's response to AI tools remains unclear. Information from the school says, "CU Boulder does not have a policy on AI in the curriculum because there

is no one-size-fits-all approach to using AI tools on our campus" (University of Colorado, 2023).

CU wants to "empower students to use the appropriate innovative tools to be successful in their

fields" but should "understand guidelines and clarify questions before using AI for coursework."

The policy also states that students should be aware of the Honor Code and that "unapproved use

of artificial intelligence could lead to a student gaining an unfair academic advantage, which is

considered academic misconduct… (which includes) using paper writing services and

technology, such as essay bots and other AI" (University of Colorado, 2023). CU's blanket and

rather nonspecific policy is important for understanding the context in which CU Boulder

MCDB students are permitted to use ChatGPT and other AI for schoolwork.

AI as a Resource for Students and Educators

While a threat to academic integrity, AI tools also provide the possibility to aid learning

when used in synergy with existing methods of learning (Yang, 2023). Professors have been

encouraging ChatGPT use by allowing students to ask questions to the AI and evaluate its

response, training bots to answer questions without giving away the answer (what Klymkowsky

et al refer to as a SocraticTutor, per. comm.), and by giving assignments that require specific

critical thinking related to the class that current AI cannot provide. Khan Academy's recently

released AI software is geared towards helping students understand the material (Khan, 2023;

Khan Academy, 2024). What is known as "process supervision" could encourage student

learning. In this model, an AI guides students' learning in a subject area like a tutor or

interactions with a teacher (Open AI, 2023). AI could offer students different ways to ask

questions without being judged or if they are nervous about talking in class. Process supervision

from AI could provide individual tutoring that has previously not been scalable aiding students in

getting extra help and improving their educational experience (Extance, 2023). Student interactions with coursework and material could be increased by providing AI as a positive resource and helping students to learn by previously unavailable methods.

The drawbacks for students using AI tools are that they may not be able to get questions answered accurately and can miss out on learning opportunities that come from doing research using traditional methods. By using AI tools, students may fail to recognize the limits of their understanding, decreasing their ability to develop new perspectives and build argument skills based on detailed analysis and reflection (Gordon, n.d.). Many educators say the value of an education is to learn how to educate yourself. In this way, the need for liberal education could be bolstered as AI will take over a lot of technical tasks (Trepanier, 2023). Diverse perspectives from educators warrant further investigation of student perspectives on AI use to provoke more information on how AI could be a positive or negative resource for students.

Looking to the future

AI-based Tools are expected to have a growing impact on medicine and scientific research heading into the future. These impacts could be better understood by examining how a sample of MCDB students interact with and feel about AI. AI is currently "not a substitute for health professionals" but as the technology improves it could potentially replace many jobs including in the field of medicine and STEM (Moor et al., 2023). AI has also shown strengths in the areas of numerical critical thinking necessary for STEM jobs (Zhang et al., 2023). A review with six months of assessing ChatGPT 4 for medical applications found that currently it can answer patient questions with a higher level of empathy than doctors (Lee et al., 2023). While AI shows promise for applications in science, there are still many apparent issues.

One danger of using AI in medical or research situations is AI hallucinations (Metz & Weise, 2023). During these hallucinations, AI can make up information that sounds right but has no basis in response to a prompt. A part of the hallucinations can be conveying biases and false information to users, sometimes distorting information the software has gathered (Kidd & Birhane, 2023). A recent study showed that AI was able to complete assessments and assignments at a level that could "ace" MIT classes. However, interviewed students think that the technology is not advanced enough yet to help a student pass college courses solely using ChatGPT (Bartlett, 2023). This group of students thought that the existing information on the usefulness of AI is exaggerated, claiming that AI is more useful to students and more dangerous to educators than it is (Bartlett, 2023). More information from current STEM students is needed due to the number of current unknowns about how AI will evolve with an abundance of claims to its efficacy for assisting with college-level work.

<u>Methods</u>

This research was approved by the University of Colorado Institutional Review Board protocol #23-0389. I conducted background research relevant to what tasks this technology is capable of, how AI tools are being utilized, how universities and educators are responding to AI's increased prevalence, and how students are using AI as it has become more relevant to gaining an undergraduate-level degree. The background research provided a broader context for the information gathered from students as well as a starting point for answering the three research questions (Table #1).

Table 1: Primary Research Questions for Understanding how students are using AI and its impacts on higher education.

Research Question #1	What have students been using AI for?
Research Question #2	How has AI been impacting students' education?
Research Question #3	What are students thinking about AI in an academic context?

I held an informal talk with ten MCDB students as a preliminary exploration to get an idea of the kinds of questions that should be asked in the interviews and surveys. The students were recruited from an MCDB class to participate in a confidential discussion on their experience with AI. The group interview session lasted about 25 minutes and I asked eight questions (Table #2). The purpose of the initial group session was to highlight the types of topics and questions that would provide the most useful information for addressing the project's three RQs. The interviews were not recorded to create a more relaxed and generative environment for the students.

Table 2: Initial questions posed to an informal group of students to inform interview and survey questions.

Initial Group Talk Questions	
1.	What do you know about ChatGPT?
2.	What do you think about ChatGPT?

3.	Have you used ChatGPT at all?
4.	How comfortable do you feel using it?
5.	What have you used it for academic or otherwise? How often?
6.	Do you trust ChatGPT as a learning tool/ Are you worried about misinformation from ChatGPT?
7.	Do you cross check information from ChatGPT if you do use it?
8.	Do you think that even if students use this technology for "cheating" could it still be providing some benefit to their learning?

In-person interviews and an online Qualtrics survey were used to collect data on CU Boulder MCDB students' views about AI tools during the fall 2023 semester. The interviews and survey were complementary, revealing different dimensions. The interviews were designed to encourage students to reveal their nuanced positions that might not appear through survey responses. In the interviews, students could elaborate as much as they wanted to for each question, and I was able to delve deeper and ask follow-up questions. The survey was designed to be completed by as many MCDB students as possible to provide a larger sample size of student answers to how they are using ChatGPT and other AI. The survey was composed of multiple-choice, to collect quantitative data, and short-response questions. Students were assured anonymity with their responses to encourage honesty and more accurate information. To recruit students, the interviews and surveys were advertised in MCDB classes. Free coffee was provided as an incentive for students to participate in the interviews, and many of the MCDB professors offered extra credit for students participating in the online Qualtrics survey at the end of the Fall semester.

Table #3 shows the script of available interview questions. I did not ask all the questions to every student due to time limitations and to allow students to elaborate on what they wanted to talk about. Each interview lasted about 20 minutes. The interview questions were pointed toward finding out how students have been using ChatGPT or other AI for school and their experiences with doing so. The students answered how they use AI, the impacts on their educational experience, and their thoughts on AI in education in general.

Table 3: One-on-one interview questions, each interview lasted approximately 20 minutes and not every question was asked in each interview.

Interview Questions	
1.	What are your thoughts on ChatGPT in the context of education?
2.	Is it cheating? Why or why not?
3.	Why are you or aren't you using ChatGPT? How often?
4.	Do you use this technology mostly for school or outside of the realm of education?
5.	Do you use any other AI for school? How often?
6.	Any positive or negative experiences? (misleading info, helps save time, etc.)
7.	Do you have any techniques for interacting with AI to avoid getting misinformation?
8.	When do you care or not care if the information you are receiving is correct?
9.	Is there a threshold or level of correctness that you care about?
10.	Do you have techniques for verifying information from ChatGPT or other similar AI tools?

11.	What specific tricks or tasks have you learned that ChatGPT can do that have stuck out to you, either on your own or from other people?
12.	What do you think professors should do to aid in the use of this technology to be more effective?
13.	What tools would you want to be given from a class or outside of school to be more effective in using ChatGPT or other AI technologies?
14.	Do you feel guilty using this technology for education?
15.	Other Comments

The survey (Table #4) was designed to take participants ~10-15 minutes. The survey gained quantitative information on how many students are using AI, how often, their level of confidence in using the technology for different aspects of learning, and their perceived accuracy of AI. On the qualitative side, the survey captured data on how and why students use AI, their perceptions of the acceptability of AI use, and thoughts on AI in the context of education in general.

Table 4: Quantitative survey questions asked to a large sample of MCDB students, faculty, and staff at the University of Colorado Boulder.

Survey Questions		
	Question	Response options
1.	Do you consent to participate in this survey?	- Yes - No
2.	Academic Year/Role	- Freshman

		- Sophomore
		- Junior
		- Senior
		- Graduate Student
		- Faculty/Staff
3.	Have you used ChatGPT or other AI?	- Yes
		- No
4.	How often do you use ChatGPT or other AI for school?	- Never
		- Once a week
		- Twice a week
		- Every day
		- More than once daily
5.	How much do you trust AI to provide accurate information?	Scale 0-10
		- 0 not at all
		- 5 a moderate amount
		- 10 a great deal
6.	How confident do you feel using AI to help complete coursework?	Scale 0-10
		- 0 not at all confident
		- 5 somewhat confident
		- 10 very confident
7.	How confident do you feel using AI as a study aid or to better understand material?	Scale 0-10
		- 0 not at all confident
		- 5 somewhat confident

		- 10 very confident
8.	Are you afraid to use this technology for education purposes? Why or why not?	Free response
9.	What kinds of assignments do you use AI for? (Math/Coding, Writing, Studying, Quizzes, etc)	Free response
10.	What specific tasks have you learned that this technology can help you with?	Free response
11.	Overall, do you think using AI saves you time or that you need to put in more time and effort to double-check its accuracy?	Free response
12.	How do you think instructors support or discourage use of AI?	Free response

I compiled interview and survey data to find themes in responses related to the research questions and connected the findings of this research to existing studies and literature. Specific examples of student responses for each of the interview questions and the free-response survey questions showed the major themes relating to each research question. ChatGPT was also used to analyze student responses and find major themes (OpenAI, 2024). RStudio was used to graph and analyze the quantitative survey data (RStudio, 2024).

Results

Interviews

The first interview session in the summer of 2023 highlighted important questions for the one-on-one interviews that took place in the fall. The questions that received the most responses were about how students use ChatGPT, their concerns about misinformation, and how the use of AI benefited their learning. All the students in the group said that they used ChatGPT. Several students admitted to using ChatGPT to cheat on tests as well as to help write papers. All the students in the group were worried about misinformation from AI which was a limiting factor for their use. The students said that they were worried about violating the Honor Code when using ChatGPT even when they were not using the technology in the ways that they identified to be cheating like helping on tests or writing papers for them. The major result of the preliminary group interview was that specific questions about how the students use AI, feel about AI in the classroom, and are changing the ways that they learn due to AI helped get better results by guiding their thoughts.

In total, there were 22 one-on-one interviews with MCDB students with a starting goal of 15-30. The most important observation from the interviews was that students' responses were extremely varied in terms of the three research questions (Table #1). As expected, some students had used AI more and were more positive in terms of its impact and usage, and vice versa. Some students varied from question to question on their overall opinions on AI. For example, a student who thought AI was useful for school and used it often, thought that the overall impact of AI on education was negative and that they feared for the future of education and job automation. Oppositely, a student who did not use AI seemed to think that the overall impact on education was positive and that ChatGPT was an exciting technology. I found that students are using ChatGPT by far the most out of all available AI technology, for many different tasks, and were cautious with their use of AI in school. Students expressed a lot of hesitation to use AI for

school-related tasks due to fears of misinformation, not wanting to violate academic honesty, not knowing what the technology could be useful for, or feeling like AI does not help them to learn. Students who were less hesitant to use ChatGPT gave many examples of how they use AI for school such as an aid to complete homework problems for chemistry or biology classes or to ask questions to understand certain cellular mechanisms. Regardless of specific usage or perspectives, using ChatGPT and other AI technology has changed students' interactions with technology in the classroom, and they have developed their own opinions on AI use in school.

Survey

We initially hoped that ~100 students would complete the online survey. Surprisingly, the survey received 536 complete responses from MCDB affiliates, perhaps due to the popularity of AI in general. The survey was composed of 12 specific research questions (Table #4). The
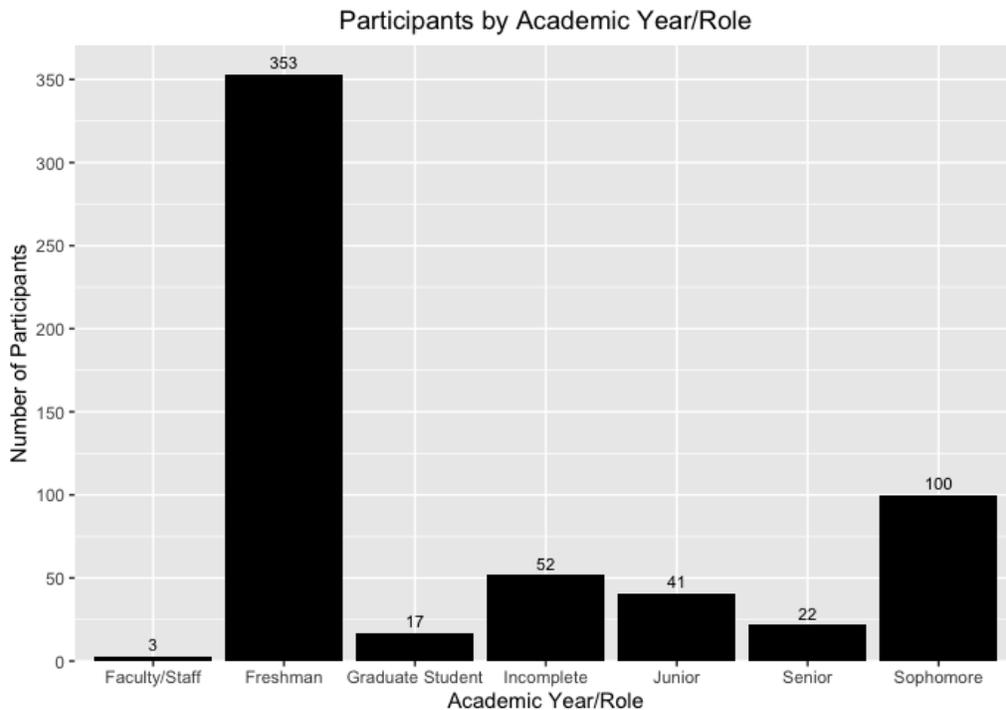

Figure 1: The distribution of survey participants by Academic Year or Role shows a large percentage of freshmen and sophomores

distribution of those who completed the survey (Figure #1), was 66% freshmen, 19%

sophomores, 8% juniors, 4% seniors, 3% graduate students, and 3 responses from faculty

members/staff. The introductory classes in MCDB have much larger enrollment which explains

why most of the students were freshmen and sophomores. Qualitatively, the large sample size of

students provided more insight into the three RQ's. The survey revealed additional quantitative

information on how much students trust AI, how often they use AI, and their confidence in using

AI for school.

<u>RQ1 What have students been using AI for?</u>

    From the one-on-one interviews and survey data, students explained that they have been

using AI, mainly ChatGPT, for biology, chemistry, math, studying, writing, tests/quizzes, and

coding. Students used ChatGPT to save time on assignments, study, or understand class material.

43% of students surveyed said that they never used ChatGPT or other AI for school while 58%
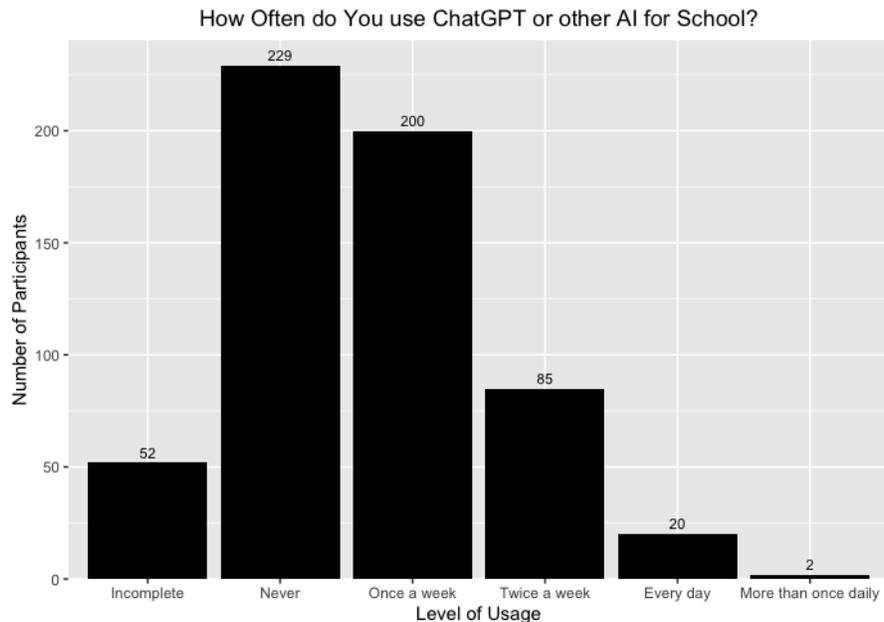

Figure 2: Most surveyed students either never used AI tools or only used them

once or twice a week.

used ChatGPT at least once a week (Figure #2). Students who did not use AI at all or did not use AI for school-related tasks feared cheating, receiving misinformation, or did not see a benefit to using AI. Most students who used ChatGPT identified several different tasks that they use ChatGPT for inside or outside of school. Student's use of ChatGPT varied between individuals but in general, they used it more during the school year. Interviewed students used the technology similarly to the surveyed group, once every couple of weeks, multiple times a day, or almost every day.

Distilled below in Table #5, I categorize the primary ways that students reported using AI. Seen in Table #6, I then used ChatGPT 4 (OpenAI, 2024) to list the main types of assignment categories to compare its work to mine. In biology, students reported using AI to aid in problem-solving and to break down complex material and concepts like a tutor. They asked ChatGPT to explain how a biological mechanism works, why certain processes occur, or their significance and application. Students commonly asked AI to paraphrase scientific writing or explain biology concepts in simpler terms or analogies. One student asked ChatGPT to "explain a signaling pathway as a metaphor like I'm 10 years old". Students turned to ChatGPT to ask clarifying and "easy to ask questions" which was "easier than going to office hours if they are under a time crunch", and to explain terminology (Table #5). Students also used ChatGPT to explain topics or answer questions on at-home quizzes and tests.

Students also reported taking advantage of ChatGPT and other AI tools provided by their courses for chemistry. For General Chemistry 1 and 2 courses, students were given access to beta testing an AI tutor through Achieve, their homework software (Dr. Ellen Broering, Personal Communication, 2024). Students enjoyed how easy it was to ask AI questions to get help with homework and general comprehension, which saved them time going to office hours for simple

questions. With an easy way to ask questions and get help, students experienced reduced stress related to chemistry courses and found AI useful for learning. Specifically, students would ask AI to give step-by-step explanations for how to solve certain types of problems.

Additionally, students reported using ChatGPT to help troubleshoot or write their computer code and help with math. Students liked ChatGPT for these applications because they could always test to see if the code did what they wanted it to do or if the math was correct. AI will also give a breakdown of what all the individual parts of the code do to help students learn and build their coding skills. One student used ChatGPT to "write split functions, recursive functions, and assert statements" (Table #5). Students used AI to help explain and solve math problems. Students specifically mentioned how ChatGPT was comparable to Wolfram Alpha or Mathaway which were existing "Computational Intelligence" programs. Students used ChatGPT to help with physics problems both conceptually and computationally. Some students said that they do not use AI for math or coding because they found the answers to be incorrect through trial and error. Certain students did not find using AI to be helpful for math and coding because of the time they spent double-checking the work.

Many students reported that they used ChatGPT as an aid for writing assignments. Some had ChatGPT write the assignments for them, either turning in the assignment unchanged or editing what the AI had written. Others only used ChatGPT to make an outline or to edit what they had already written, checking for things like grammar and organization. Students said that ChatGPT was good at responding to discussion posts. Some would provide their previous responses to similar prompts to have ChatGPT match their writing style or finish a paper for them to save time or when they were at a dead end. ChatGPT was also used to generate citations for essays already completely written, "brainstorm" writing topics, give example essays, and predict grades

on an essay. One creative example of using ChatGPT for the writing process is, "I had a children's book to write and draw and I used AI to create picture scenes for my book and used the pictures as inspiration" (Table #5).

Saving time was a common theme among students using AI tools for school-related tasks. In times of distress, such as "forgetting about an assignment due at midnight", students said that they used AI more. Time-saving activities included giving "summaries of papers and readings", providing helpful outlines for writing assignments, helping to troubleshoot code, and being used as an aid for music production. Students said they liked ChatGPT as a better search engine than Google because it eliminated the need to "search through the results to find what you need". Students used AI to save time when they did not want to do an assignment, did not have time, did not want to put the time required into doing an assignment they did not see as beneficial, or needed help to complete an assignment (Table #5).

Some students reported using AI-based tools outside of school, commonly to write resumes or emails. Students also enjoyed "toying" around with the technology to do tasks like creating recipes, providing ideas for how to talk to girls, or giving motivational speeches. Other uses were to design workouts, meal plans, and find jobs. One student created a trading bot for stocks using ChatGPT. ChatGPT was almost exclusively the only AI students used. Students also used Grammarly, other detection software to be able to turn in ChatGPT work such as writing assignments, Mathaway, Macmillan and Pearson's beta AI chats, Google Bard (now Gemini), Quizlet, Spotify (music), and Snapchat's "My AI". Three of the 22 students interviewed and several in the survey said that they used and liked Macmillan's AI tool integrated into their chemistry homework software. One student learned about a tool, "Hide my AI", that makes ChatGPT information or writing sound more human. Students also put what ChatGPT had

written into Grammarly to fix grammatical and structural errors. Students in the interviews said that they used Grammarly the second most to ChatGPT, the chemistry bot once a week, and everything else was experimentation.

Table 5: Students explained how they use ChatGPT in the interviews and survey questions, "What kind of assignments do you use AI for?", and "What specific tasks have you learned that this technology can help you with?".

Category of Use	Examples
Biology	- Explaining difficult material in simpler terms or in analogies - Layman's terms for difficult or long papers - Different ways to explain general concepts and to understand applications - Terminology - Refresh on material they learned a long time ago - Clarification on what a problem is asking - Provide functions of specific proteins or organelles - Finding proteins, genes, and their AA codes - "Summarizing… concepts, like a lipid raft and comparing it to a pool, making the content more accessible by using everyday examples" - "Understanding Lewis dot structures" - Troubleshooting software like ImageJ

As a Tutor for other Science courses	- "I like to use it like I would use a tutor in person, where I take something that I understand at maybe 50-70% and will ask questions/go over concepts/explore hypotheticals with GPT until I push that closer to a 70-90%." - Help to build problem solving skills - Physics, finding the right equations to use for a problem - "(It) can help synthesize information from many online sources in a concise manner to help learn about a topic."
Writing	- Outlines - Writing entire papers - Proofread/ Edit something they already had written - Like a "peer review" - Finish assignments they had written in the same style - Grammar - Creative writing - Predict grades on an essay they wrote - Generating citations for writing - Brainstorming - "I had a children's book to write and draw and I used AI to create picture scenes for my book and used the pictures as inspiration" - "Organizing thoughts/ideas… GPT wrote most of my recommendation letters/emails from a bulleted list)" - Lengthen what they already had

	- Transitions between paragraphs
Math	- Explaining concepts and checking work
	- Doesn't use it for math because it's wrong
	- Wolfram alpha
	- To double check work
	- Mathaway (AI Tool)
	- Physics
Chemistry	- Homework
	- Step by step explanations for how to solve types of problems
	- To look up laws
	- "My chem professor says that there is a new software that will Improve the chemical percent for chemical synthesis up to 40%"
Tests/ Quizzes	- Online
	- Practice exams
	- Organize Study sheets with exam topics
	- Reviewing large amounts of material, summaries
	- Explain concepts to chat and ask if the reasoning is sound
	- Create similar quizzes/ extra problems to solve for studying
	- For quick answers to homework or quiz questions
	- Help to narrow down multiple-choice answers
General Comprehension	- Dumb down or reword complex material
	- Asking questions / extra help
	- "What does _____ mean and how it is applied?"

Summaries/ Reading	- Has a decent knowledge of literature (concepts and published things that have been around for a while - Checking comprehension of reading as well - Condensing material - Read things out loud
Coding	- Perfect because you can always test to see if it works - Step by step breakdown - "I used it to write split functions, recursive functions, and to write assert statements" - "Test design and automating menial tasks"
Art and Creativity	- Graphic design and image generation - "The image AI real-ESRGAN has been helpful in upscaling images for me. AI art software provide visually pleasing images."
Other	- Spanish conjugation and grammar rules - Summaries of long articles in a variety of subjects (pdfs) - Explain terms in Sociology - General busywork - Emails - Job Search and preparation - Resume bullet points that utilize an action verb and give metrics

I was curious to see how ChatGPT 4s' analysis of the student responses compared to my own. As seen in Table #6 below, I entered all 536 student responses to "What kinds of

assignments do you use AI for?" and asked it to find the most common subjects that students use AI for and provide examples for each. ChatGPT 4 was able to provide a concise and accurate synopsis of the student survey responses which can be compared directly to my own in Table #5.

Table 6: I used ChatGPT 4 (OpenAI, 2024) to provide a categorical analysis of the 536 student survey responses to the question, "What kinds of assignments do you use AI for?"

Category	Summary of Use
Studying	Many respondents mentioned using AI for studying purposes, including understanding concepts, creating study guides, summarizing articles/textbooks, and generating practice questions.
Writing	AI was frequently used for writing-related tasks such as outlining papers, generating essay ideas, rewording sentences, proofreading, creating templates, and providing grammar checks.
Math/Coding	Several respondents mentioned using AI for math and coding assignments, including solving equations, understanding coding errors, generating code, and explaining mathematical concepts.
Homework	AI was used for general homework help, including chemistry, biology, physics, and other subjects. This included explanations of difficult concepts, solving problems, and generating ideas.
Quizzes/Tests	Some respondents used AI for quiz and test preparation, including creating quizzes, studying for exams, and understanding quiz questions.

Concept Clarification	AI was used to clarify complex concepts in various subjects such as science (biology, chemistry, physics), math, coding, and humanities.
Study Tools and Resources	AI was used to create study plans, generate flashcards, find relevant resources online, and search for definitions or explanations.
Grammar and Language	AI was used for grammar checks, sentence rephrasing, vocabulary enhancement, and simplifying complex language into layman's terms.
Coding Support	AI was used for debugging code, understanding coding concepts, providing coding examples, and generating code snippets.
Other Subjects	Respondents mentioned using AI for subjects such as Spanish, sociology, psychology, anthropology, English, history, and more.

RQ2: How has AI been impacting student's education?

ChatGPT specifically has enabled new learning approaches by both students and professors, increased the amount of available misinformation, and created new concerns surrounding academic dishonesty. Students have had to be cognizant of how they use AI to not cheat (if that was not their intention), aid their learning in ways that fit their courses, and obtain accurate and usable information. Students mentioned that they feel a need to learn how to use AI because while the possible implications for their education and future after graduation are still largely unknown, they suggest that they have accepted that AI is here to stay. Some students felt like they had not been affected by AI or ChatGPT at all in an educational setting. These students have not seen AI integrated into the classes they are taking yet and/or choose not to use AI for school. Students who felt that they were not being impacted cited AIs' responses as "not specific enough to explain science in helpful ways for classes" or full of "misinformation or wrong

answers" while sounding correct. This group of students also pointed to "getting caught cheating by the school" as a primary reason they did not see AI as a fit educational tool. While some students said they were not being affected right now, they felt that could quickly change if AI becomes more integrated into their education.

Interestingly, how professors have reacted to ChatGPT has influenced how and if students use AI in their courses and for many, how they feel about using AI in general. Students identified ways that professors have supported, discouraged, or not addressed AI use in the classroom that have impacted their educational experience in college. 72% of students surveyed said that they have used ChatGPT or other AI (Figure #3). The overall response from professors, according to MCDB students, has not been in support of AI, telling students not to use it or they will likely face academic dishonesty repercussions (Table #8).

Students have seen professors support AI use by telling students what ChatGPT can be used for within the context of their course, as a study tool, for outlines or idea generation, or to better understand AI's capabilities and shortfalls by using ChatGPT (Table #7). For example, the chemistry-specific beta version AI tool linked to Achieve homework software. AI has been encouraged across different types of courses to help students check their work or to ask clarifying questions in a similar way that they would use a textbook or ask a TA questions. Some students thought that professors want AI to be "conducive to learning" and support AI more than most students do. Several students were told to analyze ChatGPT-generated writing assignments or answers to course-related questions. One student realized, "It really shows that AI can sound confident without being correct" when reviewing work done by ChatGPT in class. Due to the support of AI from certain professors, students report having been able to save time using AI as an aid in their classes for studying, problem-solving, and working through course material while

building comprehension. 12 of the 22 interviewed students said they used AI to help save time with school. This study suggests that professors have provided opportunities to learn ways that AI tools could be useful, creating a supportive and open environment around AI use.

Table 7: Students expressed many ways that they perceived professors supporting AI tools.

How do you think professors support the use of AI?	Selected Survey Results
Telling students how AI can be used in their class	- To check their work - To ask questions - Learning "larger concepts" - Troubleshooting and learning computer code - In a way like how someone might use Wikipedia - Engineering seminar- How to use AI effectively for learning - Some professors support AI more than the students do - Allows as a tool but work can't be more than 15% AI - "I have one teacher who said she wants it to be conducive to our learning" - "Professors for MCDB wouldn't mind the use of AI since biology is a research-based subject so using AI would only help the research process to be more thorough"

	- "I believe that they are supportive of using AI as a tool to perfect something, such as perfecting a resume."
As a study tool	- As an aid or tutor and a way to save time understanding material, not using it to generate work or complete assignments - In the same way they would refer to a textbook or ask a TA questions - Building comprehension - "For a STEM field like physics, AI could theoretically provide lots of support to people who can't access tutoring or other resources" - Not as "#1 source for help or info still though"
Telling Students to use AI to better understand it's capabilities and shortfalls	- Compare your own essay with one written by ChatGPT on the same topic - Designing assignments to help students understand how AI responses can be right and wrong or somewhere in between. - "In my Intro to Global Public Health class, we did a lot with ChatGPT. We would plug in a question and then disprove the false information it outputs. It really shows that AI can sound confident without being correct." - In a Spanish class students were told to compare their writing to what AI would write to the same prompt. The student felt that "was one of the most creative and helpful

	assignments I have had when it comes to interacting with AI, and the assignment served to show our level of skill in Spanish and to illustrate the difference between student generated work versus that of AI."
For Outlines or Idea Generation	- "Instructors both in MCDB and Computer Science who give merit to its preliminary ideation capabilities"
Providing students with AI tools	- Chemistry Homework AI tool
Other	- "They support by giving us take home essays and open note tests" - "Online learning platforms (like canvas) indirectly support the use of AI" - Support its use outside of school where academic integrity is not a concern - "I think most of them don't really understand it so as long as we aren't cheating on a test they don't discourage it."

It was reported that professors have discouraged the use of ChatGPT and AI by telling students not to use AI, establishing policies that mark AI use as cheating, expressing that using AI is academically dishonorable or does not fit their course, not addressing AI use, or creating assignments that AI cannot be used for. Students report using ChatGPT in ways that violate academic honor codes including turning in assignments written by ChatGPT, using ChatGPT for tests and quizzes, or using ChatGPT to entirely complete their coursework. Some professors

have been clear about how students are not allowed to use AI for tasks like writing, tests,

quizzes, or copying homework problems. Others told students that AI should not be used for

their courses at all. Students in this study reported feeling like they do not know how to use AI to

their advantage when professors have blanket policies that discourage AI use or that they must

be proactive in using ChatGPT in ways that do not violate academic dishonesty (Table #8).

Students have reported that they will try to predict how instructors feel about using AI for

a course when professors do not address AI at all, saying that a "gray area" is created. Students

explicitly said they had to do a lot of "guesswork" to figure out how they could use AI for their

courses. Students assume that when the professor does not address AI usage for the course, they

"seem afraid of AI" or generally discourage its use. Another student said that "AI exists as a tool

that can be used with discretion" regarding coursework, explaining why AI is commonly not

addressed in classes. For science courses specifically, students expressed that the policy

surrounding AI was underdeveloped but may be overall neutral (Table #8).

Table 8: Students provided several ways that they perceive professors discouraging AI use,

including telling them not to use AI tools and expressing that AI use is dishonest.

How do you think professors discourage the use of AI?	Selected Survey Results
Explicitly telling Students not to use AI	- Writing - Tests - Quizzes

	- "I think that instructors are against using AI to copy homework problems" - "Most language and attitudes used by professors is discouraging towards the use of AI."
Policies established by Professors and the University to establish AI usage as cheating	- AI usage as plagiarism - Detectors for writing - Automatic zero for assignments or work that uses AI - Honor Code - Individual syllabi - In response to students "abusing" ChatGPT and other AI
Generally expressing that AI usage is academically dishonorable	- Not telling students why AI could lead to false information or how to avoid misinformation - Emphasizing the inaccuracy of AI - Not telling students how AI could potentially be used to aid learning in that course - "Empty threats" - "Almost all of my instructors are limited to thinking that AI is simply used to cheat."
Expressing to students why AI use does not fit their course or should not be used for learning in general	- Professors want to see their work so that they can teach students better and students learn - Takes away from learning and building problem solving skills - Misinformation

	- "they don't understand that most of us use it to help us learn and comprehend the material"
Not addressing AI at all	- "seem afraid of AI" - Because AI is new - "I have not seen an instructor support AI before!"
Creating Assignments that AI cannot be used for	- Creating homework, quiz, or test questions that AI does not know because they are very specific to the course material - Designing tests of knowledge that require conceptual and specific understanding related to the course

We find that misinformation from AI has had a large impact on student's education. Students have developed techniques to avoid getting misinformation but still report perceiving misinformation as a larger threat than it was before AI. Students who have experienced receiving misinformation from AI have shifted to work within the bounds of what they felt comfortable asking ChatGPT for help with or becoming selective with the types of assignments they use ChatGPT for. Students were more comfortable asking ChatGPT for help with math, coding, generating summaries of readings, and writing along with lower stakes or "simpler assignments". Students usually only had one or two subject areas that they were comfortable with using AI for. They reported using AI more for assignments that "(didn't) have to be 100%, just good enough" or to "Ask general questions like how to approach solving a certain type of problem". As precautionary measures, students learned how to reword and ask the same question in different ways, ask ChatGPT to cite its information, or for ChatGPT to explain why it gave a certain

answer. One student said ChatGPT "doesn't have up to date information, some things it just can't help with and you have to know that". Information from ChatGPT was rarely checked with another reliable source such as a textbook. The largest impact of misinformation on students' education has been that some allow themselves to turn in poor work or absorb incorrect information.

Students have disclosed that they have had to be conscious of using AI in ways that are not perceived as cheating. 11 of 22 interviewed students thought that using ChatGPT for school was cheating all or some of the time. Students identified quizzes, tests, writing, and using technology "similar to Chegg" as primary ways that students use AI to cheat. One student said that ChatGPT is "an efficient method of cheating." Students thought that using AI was not cheating when they were trying to aid their learning processes and comprehension such as "using it to have things explained to you," "like a search engine," as a place to start informational searches, for "studying," or creating "outlines or examples to construct your own work." Students have wanted to use AI to "engage in learning" and as an aid while turning in their "own work". One student said, "(we) need to know how to use AI for daily life because it will be integrated into the future, and you're at a disadvantage if you're not using it." Students have felt pressure since the introduction of ChatGPT to use AI so that they are not falling behind their peers in their ability to use the technology to their advantage for school or later in their professional careers.

RQ3: What are students thinking about AI in an academic context?

Understanding what students are thinking about AI explains how they are using AI and interpreting its impact on their education. A primary goal of the research was to understand how

students are adopting or not adopting AI and why. Two survey questions that provided useful insight into what students are thinking about AI in an academic context were "What are your thoughts on ChatGPT in the context of education?" and "Are you afraid to use this technology for education purposes? Why or why not?" General categories for students were those in favor, against, or who saw both sides of AIs' usefulness for learning. Most students were excited to talk about their opinions on ChatGPT and AI in the interviews regardless of their stance.

Students in favor of ChatGPT in the classroom said using AI was a great way to save time and as a helpful tool to get information quickly, like "using Google or a calculator". Students commonly thought "Why not use AI to save time?" Students liked using ChatGPT for idea generation, writing, and problem-solving in STEM classes especially when they did not know where to start. ChatGPT was not much different from the available resources, just faster, able to explain concepts differently, and quicker as a search tool because they did not have to filter results to get a pointed answer. Students made distinctions about how they were using the technology "correctly" as a "supplement to learning not a replacement," where they allowed themselves to be aware of the limitations of the technology while using it honestly to aid in their
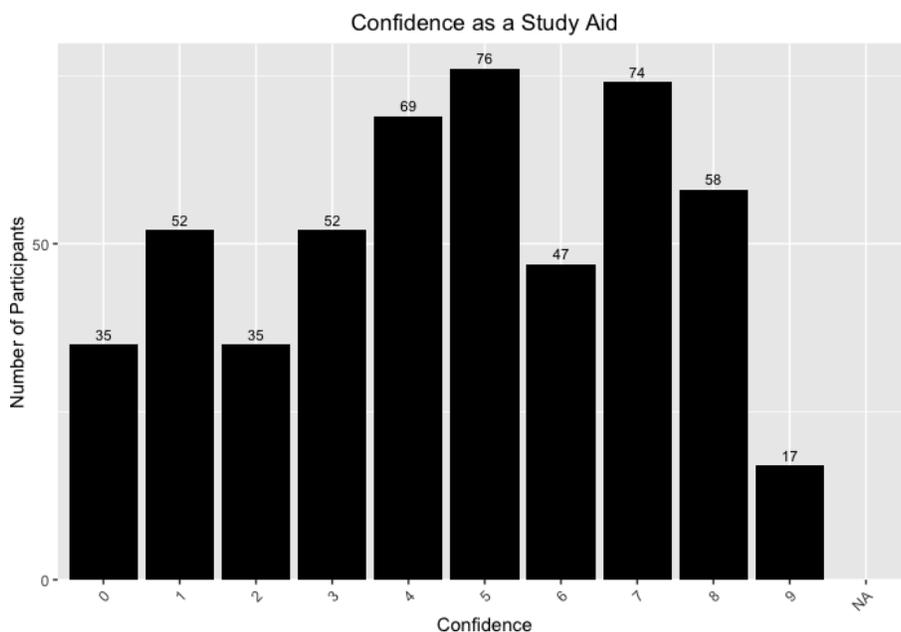

Figure 3: Students had the highest level of confidence using AI as a study aid.

Mean- 4.57   Std Deviation- 2.54

Variance- 6.495

understanding of the material. Surveyed students were overall not confident in using AI to help complete coursework, with a mean of 3.21 out of 9 and a skewed left distribution (Figure #3).

Students were slightly more confident in using AI as a study aid with a mean of 4.57 and a more even distribution (Figure #4).
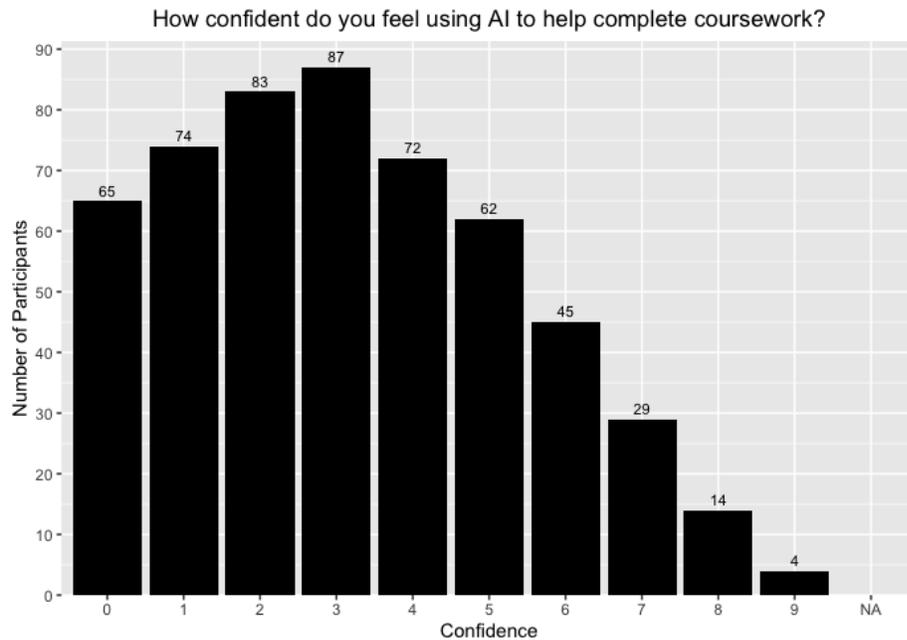

Figure 4: Students were less confident using AI to help complete coursework than as a study aid.

Mean- 3.21   Std deviation- 2.22

Variance- 4.91

Students who saw more negatives with AI use in an academic context had common complaints about having a lack of trust due to misinformation from AI, fears of using it incorrectly in an educational setting, or moral apprehensions. When students asked questions about classwork and received misinformation, they did not perceive AI as fit for college-level work. This group of students thought that AI reduced their exposure to course content and limited their use of critical thinking, going through the writing process, or learning new math skills. Paired with a lack of trust in receiving accurate information, students thought that AI could not replace existing studying methods, going through the learning processes of finding answers on their own or asking instructors for help. Some students described AI as a "crutch" for learning and reported being concerned that people will become "too reliant on it" or "felt guilty"

when using AI for schoolwork. They were worried that their peers were abusing AI-based tools to cheat on classwork, essays, and tests because catching students using AI to cheat is difficult. One student did not "want to give the impression that their work is from ChatGPT even if it just partially was" so they did not use AI. Not knowing how LLM AI works was a common student concern surrounding AI in education. The survey data showed that the average level of trust in AI to provide accurate information was 4.09 on a scale of 0 to 9 (Figure #5).
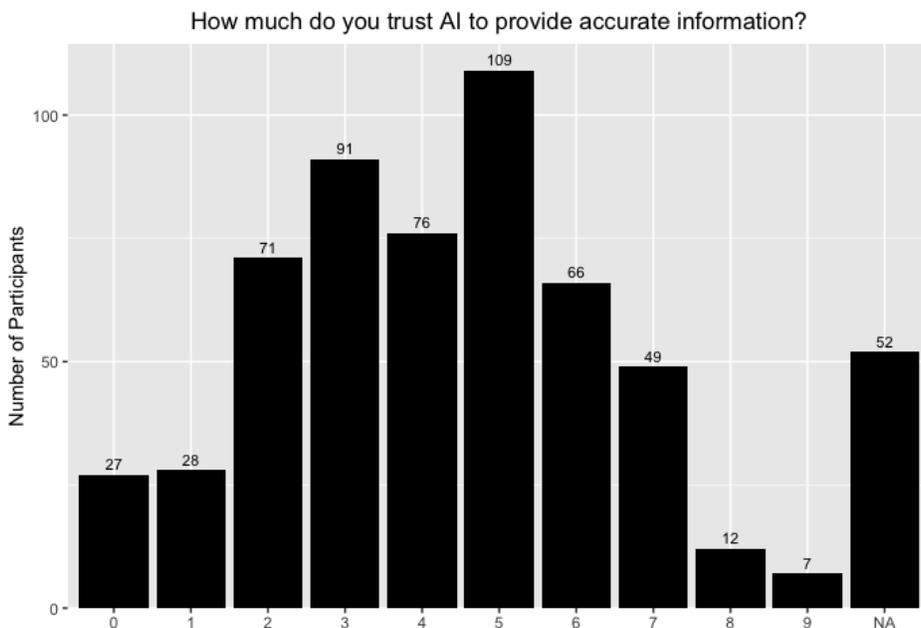

Figure 5: Students expressed a medium level of trust that AI would provide them with accurate information

Mean- 4.0858 Std dev- 2.04 Variance- 4.18

Students who saw both the benefits and drawbacks or were indifferent to AI use said that ChatGPT is fine to use for idea generation or creating outlines but saw potential issues with academic integrity. One student suggested that AI is not good in "its raw form, but maybe a limited one given a database. Some students reported feeling pressure to use AI because many of their peers are using ChatGPT for school. Another student thought "You get out of it what you put into learning how to use and check the information" (Table #9). Some students did not see AI as helpful, saying that "it creates worse work, especially for a lot of things MCDB, writing, and

analysis than the average student does", or that ChatGPT does not help with the kinds of tasks that they need to do for their biology classes. Another said, "You need to check it anyway, (using AI) doesn't help that much… (and leads to) misinformation or poorly done work" (Table #10). A wide range of thoughts on AI use in an academic context is seen in Tables #9 and #10 below.

Table 9: Students expressed common themes for why they were not afraid to use AI including that some professors are ok with students using AI and that AI can be a useful tool when used correctly.

Reasons Not Afraid to use AI for Education Purposes	Selected Survey Results
Some professors are ok with students using AI	- Chemistry homework beta bot - Assignments to encourage use
AI is a useful tool if used correctly	- Idea generation - Outlines - Clarification on topics - Generate study questions - Ask questions like you would ask a tutor - Practice tests - "Not a bad place to start when learning about a new topic" - Must be aware of the limitations

	- "Present difficult information in a digestible manner"
	- Uses as a "supplement to learning not a replacement"
	- "Can supplement my understanding of viruses lifecycles with GPT… generate questions… flashcards to summarize important topics… summarize my notes and elaborate where I have a lack of understanding."
	- "You get out of it what you put into learning how to use and check the information"
	- Not good in "its raw form, but maybe a limited one given a database"
Helps in times of stress or saves time	- Time crunch or long assignments - Summaries of readings
The information from AI can be verified	- For science, they trust AI because they check the answers - "AI is right with science stuff about 50% of the time" - Khan Academy AI gives "reliable info"
Students need to learn how to use AI	- "It is the future" - "Use of AI is unavoidable. People will be expected to use AI as a working tool/help in their careers, our

	students need to learn how to use it efficiently and ethically while being aware of the limitations" - "I mainly only use AI when I want to see what it can do, like writing a poem about cheese in the way of a Shakespearean Sonnet."
Trust the information	- "Fully trust the accuracy" - "Can tell you when it does not know something" - "I don't ask ChatGPT conceptual questions. I generally only ask it questions that can have a correct answer like: "What does this function mean?""
Not afraid for writing	- Can make AI writing undetectable "Turnitin.com" - Don't need to rely on accurate information
Indifferent – AI does not fit their learning style or preferences	- "AI is a way to bypass education… which is why I am not afraid of it, I just don't really use it. I don't really see the point in asking something else to do the homework for you, when doing it myself will take me more time, but give me a better understanding." - Learns by "hands on taking notes and being in class" - Not familiar enough with the technology yet - "By the time I figured out how to use AI in… Calc 3, material and energy balances, MCDB 1150, and

	Ochem 1… in a helpful way… (I realized) it would take less time to search the textbook and the answers would be more accurate."

Table 10: Students expressed that they were afraid to use AI for education purposes due to concerns around academic integrity, misinformation from AI, and AI not being good enough to help with their specific schoolwork needs.

Reason Afraid to use AI for Education Purposes	Selected Survey Results
Academic Integrity	- Professors and the University have tools to look for AI use - Plagiarism - Tests and quizzes - Gray area, especially class to class - Writing is easier to check for AI - Cheating themselves by using AI - Check work before turning it in (chemistry and math) - Moral concerns "feels like cheating" - "I don't know professors standards or opinions"
Misinformation	- Incorrect answers - Learn the wrong thing

	- "Answers are not correct or meaningful, but are presented with reasoning that makes sense" - AI hallucinations
AI is not good enough yet	- Only use in "dire situations" - AI doesn't understand questions or help students learn the material better - They want to succeed in school and don't feel as though using AI helps them to learn what they came to school to learn. - Would rather get help from people - Lack of knowledge concerning specific science or MCDB topics - "Terrible at biology-related problems" - Not up to date - "In the future, will be a great educational tool, lots to work out"
Increased Reliance on AI with use	- Don't want to become too reliant on the technology - "Crutch" - "Don't want AI to take away critical thinking skills" - "(students) ask questions blindly instead of even taking the time to consider them" - "I'm afraid that future students won't know the material they're turning in assignments for."

Lack of Trust	- Using AI allows data collection by those using it
	- "Feels taboo in STEM"
	- "Concerned that people's work might be taken and used for AI programs without consent or credit given"
	- "I didn't come to college to teach AI about my classes, I came to learn myself."
Using AI gives an unfair advantage	- "Those who would utilize the technology have a significant advantage over those who do not… those who do not have access to any type of technological device lose an opportunity to stand out"

Students reported that ChatGPT saved time when used in combination with students' existing knowledge and study strategies on writing, math, studying, and looking up information. Students "don't really use it for things that (they) don't already have a decent baseline understanding around." AI was able to save students trips to help rooms, from being stuck on problems for hours or wasting time trying to track down information online or in a textbook. One student had a disability that "makes using technology difficult and AI bridges that gap". Each student had a personalized approach to using ChatGPT to save them time depending on their individual needs, what type of classes they were taking, and comfortability with AI.

The students who did not think AI saved them time reported being generally less acquainted with the technology and did not have the same techniques developed as students who claimed that using AI saved them time. Many spent more time double-checking information

when using AI than they would have on the assignment otherwise, "For courses like chemistry, biology, genetics. It is very poor in accuracy" (Table #11). AI could not be used for many of the school-related tasks that students encountered or could not help them to learn the material. Students thought that ChatGPT was not useful for science courses because there were right and wrong answers and was "dangerous if used for replacing hard work and creativity" (Table #12). Similarly, students said that AI does not have the "critical thinking aspect that is needed in the more advanced field of biology" and that AI "is a massive waste of energy and only works for easy courses with answers that are readily available on the internet" (Table #12). This group of students mentioned that specifically for MCDB classes, they were required to search for information in textbooks or course materials directly to obtain accurate information for studying and assignments.

Table 11: Students commonly said that they use AI to help them save time with schoolwork.

AI Saves Time	Selected Survey Results
For simple tasks	- Studying - Math - Organizing - Outlines - Drafting and Editing - Writing - Double checking work - Fact checking

	- "The tech is constantly improving, with this, the ability to save people time will improve as well"
As an aid rather than having it do all the work	- "don't really use it for things that I don't already have a decent baseline understanding around -- I use it more like a tutor than an instructor" - While using prior knowledge and intuition alongside it - Like a search engine
Use with caution	- Can tell when answers that are correct or if it seems like the answer is wrong - Using intuition along with the technology helps to save you time - "I would not trust it to answer a problem which I lack any background information on."
Math	- "A lot of equations I would be stuck on for maybe hours at a time but AI tools significantly reduce that time and allow me to better understand the material since I can use it to help guide me." - How to start a hard problem
Other	- If you don't care about double checking, sometimes you don't need to or just don't care about the assignment - If you input the information or the AI is pulling from a trustworthy source (like chem or a potential bio bot - Instead of going to the help room - "It saves me a ton of time because my disability makes using technology difficult and AI bridges that gap for me at times. I don't

	rely on it for serious answers, mostly just for surface level information and figuring out concepts"

Table 12: Students expressed that they did not think AI saves them time because they need to double-check information from AI and they cannot use AI for many of the school-related tasks that they were faced with.

AI Does Not Save Time	Selected Survey Results
Must double-check information	- Comfort level necessitates the need to check the work even if it is probably ok
Cannot be used for many school-related tasks	- Courses usually modify their questions, so it requires more information specifically from the class, you have to go find it in the course materials anyway - You might as well write your own B- paper than have GTP write a c paper - Requires more effort to make it sound less like AI and undetectable to professors - For science, because there are right and wrong answers unlike writing - MCDB class "test by going back to exam 1 and inserting a question I got correct and seeing if AI would get it, but it came to the wrong

	conclusion, it lacks the critical thinking aspect that is needed in the more advance field of biology." - "It is a massive waste of energy and only works for easy courses with answers that are readily available on the internet anyway. For courses like chemistry, biology, genetics, etc it is very poor in accuracy." - Lacks "critical thinking aspect that is needed in the more advanced field of biology" - AI "is a massive waste of energy and only works for easy courses with answers that are readily available on the internet"
Cannot learn for you	- Even if you trust what you are getting, still must take the time to learn the material on your own - "Dangerous if used for replacing hard work and creativity" - "A lot of students in (MCDB) 1150 use it for assignments and do worse on tests or quizzes"

Students volunteered a lot of speculation and opinions on how AI should be handled in universities as well as what AI use will look like for college students in the future. One thought was that professors should not be worried about students using AI tools because the amount of work that students must do to acquire the same level of understanding of the material will not change. A freshman student said about AI, "A lot of students in (MCDB introductory course) 1150 use it for assignments and do worse on tests or quizzes" (Table #12). In the future, students expect that AI will become more acceptable and there will be more defined rules and guidelines

on how to properly use AI tools. Also expected is that individual courses would give students information on how to best use the available AI resources for that course.

Students also thought that universities would become better at finding students who cheat and expected professors to continue to adapt courses to become better suited to handling AI use. This would include changing the ways that students are assessed and are expected to complete coursework. Students hoped to learn how to use AI for the fields that they are going into after graduation. Some felt that they needed to learn how to use AI so that they did not fall behind peers who might gain an edge over them for graduate school or in the job market. Students also mentioned that they could see a biology tutor chatbot being implemented, especially in MCDB classes. Students currently found that one reason ChatGPT was not helpful for biology classes was that the database did not contain specific course material, which could easily change headed into the future as AI tools evolve.

Discussion

Existing information mirrored much of what I found through student interviews and surveys with CU Boulder students. I found novel examples of how students are using AI for school, the self-perceived impact of AI on their education, and how students are thinking about AI in the context of education. Much of the prior information available on how students are using AI for school has been based on a smaller sample size of students, some as small as one interviewee. By gaining a larger sample size of students, the interviews and survey revealed that students are using AI in complex ways and have nuanced opinions on how they are being impacted and view AI tools in an academic context based on their experiences.

Perceived Student AI Usage vs. MCDB Student Data

       Previous studies on how students are using AI were often speculative or based on a small group of students. Nevertheless, there were many consistencies with existing information on how students were using ChatGPT in the classroom such as for writing, tests, and as a tutor. The MCDB student data provided unique examples of how these students used AI. Almost no student's use of AI fits into the expected category of using ChatGPT simply to cheat on writing assignments and tests. Most students reflected on the value of their education and made conscious efforts to use ChatGPT to aid their learning within the bounds of academic integrity.

       Contrary to many reports claiming that students use ChatGPT to cheat on writing assignments and assessments, the data from MCDB students indicates that this is only a minority. Most students use ChatGPT and other AI tools to aid in comprehending materials or save time with difficult material, much like how one would utilize a tutor. Students' intentions were consistent with materials that Open AI, the company behind ChatGPT, put forward around their "developed process supervision" in the context of math tutoring technology. While some existing information showed that students use AI tools for more than cheating, these pointed to irrelevant tasks such as generating creative art and coming up with gift ideas (Svurluga & Natanson, 2023). MCDB students are using AI in more intricate ways than has been reported and with high levels of discretion. The data collected from MCDB students is consistent with one Stanford study in high schools saying that the fears surrounding AI for cheating may have been overblown with rates of cheating in high schools decreasing since the release of ChatGPT (Singer, 2023; Stanford et al., 2023). In contrast to studies that said many students claimed not even have heard of ChatGPT, almost all undergraduate MCDB students were aware of ChatGPT and made choices to either not use AI or use AI in ways that were beneficial to their learning.

Perceived Impact vs. MCDB Student Data

The perceived impact of AI on higher education has mostly focused on the response from universities. The impact on students and their responses has not been covered as in depth. What was clear is that some universities have yet to create coherent guidelines for AI usage and academic integrity while others have made decisions to fully embrace or reject AI tools. Our data revealed that trying to figure out the boundaries with using technology for school was not new to students, relating online school during COVID-19 to ChatGPT, "Overall it's easier to not do your own work and cheat on online tests." Students have increasingly been able to use online resources as a method of cheating as more assignments and tests were converted to an online format during the pandemic that is conducive to using ChatGPT. The data from MCDB students showed that many students face similar questions. Students have had to adjust how they use their resources, now including ChatGPT, so that they are not perceived as cheating. They have also had to interpret professors' stances on AI use, which has sometimes been difficult when they are not made explicit.

Many MCDB students do not feel an instructional impact on their education from AI. Most did not mention any adjustment in their classes at all such as a push for oral exams or different ways of demonstrating knowledge expected by some educators. Background research revealed that higher education may be forced to move to oral exams or other styles of assessing students in response to students' use of ChatGPT (Baule & Baule, 2023). In my studies, professors did seem to be making these adjustments to test taking. Some students saw ChatGPT use being encouraged in certain classes in certain situations, such as in understanding how the technology could be beneficial for their learning. Other students saw professors discouraging AI

use by telling students that using ChatGPT was not within the bounds of academic honesty. Some students mentioned that professors have implemented ways to check for AI in writing and involve the Honor Code if they felt that students were using ChatGPT to cheat. The CU Boulder students did not experience anything as drastic as partnerships with AI companies like those seen at Arizona State University, but did explain how they percieved AI-based tools being tested in introductory chemistry classes.

What MCDB Students Are Thinking

MCDB students had a variety of opinions about using ChatGPT and other AI for school. Many expressed that they tried to do their own experimentation and research to educate themselves on the limits to AI use. Similar to information gathered in background research, students generally did not agree with (or accept) claims that AI can pass college-level exams or provide college-level responses or work (Bartlett, 2023). The majority of MCDB students expressed caution and excitement but not much fear about AI, in contrast to what many of the published articles suggest (Singer, 2023). The students interviewed revealed in-depth opinions and specific examples related to when it is okay or not to use AI tools for coursework not described previously.

Generally, students reported seeing AI as a useful tool that helps them save time and should not be feared if used with caution. Consistent with the background information on ChatGPTs' potential to be used in the context of "process supervision", students thought that AI was a good resource to aid in learning, especially when paired with their existing knowledge and critical thinking skills. Some students thought that AI did not help with many questions related to biology or STEM because "ChatGPT didn't have the right background information". The MCDB

student data showed medium levels of confidence in ChatGPT's accuracy, its value as a study aid, and to complete coursework. Rather than using ChatGPT to complete coursework as previously suggested, the students interviewed here were more confident in using ChatGPT as a study aid. A theme from the student data was that most students are not blindly plugging questions or writing prompts into ChatGPT in hopes of a quick answer, but rather using it with a clear purpose and with the goal of better understanding course material.

Proposed Response and Limitations

Given the existing information on the interaction between AI, college students, and higher education (including the data described here), it seems clear that academic institutions and educators need to adjust. The expectations from universities and educators on how students are allowed and not allowed to use AI such as ChatGPT need to be made explicit and clear to students. Steps need to be taken to give students a useful introduction and access to AI in ways that will make them equipped to go into their field after graduating college. Finally, universities need to find equitable ways to incorporate AI into the classroom in ways that make sense for individual courses or departments.

Much of the negative impact of AI comes from inequitable use. Certainly, with the possible exception of some chemistry courses, AI has not been integrated into their courses at CU Boulder. Students are using ChatGPT and other AI tools for tasks related to schoolwork but at varying levels. Based on this work, and several other studies, it seems clear that college students are ready for AI to be incorporated into their courses in ways that aid in their learning and help them understand how to use AI tools. Students who have been using ChatGPT as a tutor have been better aquainted with AI which does not just promote better engagement (Stanford et

al., 2023), but gives them an advantage as they head into the professional world after college (CU Boulder, 2024). There would seem to be a benefit from course-specific AI bots trained with more accurate and relevant information. Currently, a biology-specific AI tutor bot is being developed in MCDB and has shown a lot of promise for both helping students to learn and instructors to address areas that students might need more help in (Klymkowsky, Personal Communication, 2023). The bot has shown promise in being able to provide bulk analysis of student responses to homework questions, answer specific questions related to the course, and provide Socratic-style tutoring to potentially help students think through and understand material at a deeper level.

Integrating AI-based tutors into college classes could alleviate the concern that the appearance of ChatGPT has created for both students and educators. Providing AI as a helpful option for students could clarify how students are expected to use AI and give students experience working with AI, e.g. prompt generation, creating an avenue for equitable use. Currently, students must pay ($20/month) for the upgraded version of ChatGPT (*Pricing*, 2024), creating a barrier for students from lower-income backgrounds and potentially putting them at a disadvantage. By providing access to AI in the form of things like the BioBot, a wider demographic of students would be able and encouraged to use the technology to their advantage. These students would be provided the opportunity to enhance their educational experience and as well as equitable use and exposure to AI.

Major limitations of this research include a lack of student demographic data other than academic year and a potential lack of truthfulness from students in the interviews and survey. Most of the students surveyed were underclassmen, and the students in the study were all MCDB majors at CU. Understanding how students in different areas of education that are not strictly in

biology or STEM are utilizing AI, being impacted, and thinking about AI in an academic context would help to create a more well-rounded data set. Similarly, no data was collected on the backgrounds of students culturally, financially, or otherwise, that might be impacting the ways that they use and think about AI. Other limitations included not creating a proper 1-10 scale in the survey software. Additionally, some of the survey and interview questions could have been phrased more clearly to elicit better responses from students.

Conclusion

The research on MCDB students at The University of Colorado Boulder partially matched existing information on how students were using, being impacted by, and thinking about AI-based tools. Some students use AI-based tools to cheat on exams and write papers. However, there was more to the story of how students have been utilizing novel AI tools like ChatGPT to enhance their learning experience. Students expressed that AI tools act like a tutor to help them comprehend material, complete assignments, and save time on challenging coursework. The major impact of AI-based tools on students is that those who have used AI-based tools have been able to gain perspective on what universities and educators are thinking and doing in response to the introduction of these technologies. These students have also developed strategies for successfully using AI in ways that are beneficial to the effectiveness and outcomes of their educational experience. Students expressed that AI-based tools are helpful as an aid to learning in their current form but have hesitations because AI can provide misinformation and, in many cases, does not have specific information related to individual courses. As AI-based tools evolve and become more incorporated into higher education in the

future, assessing the impact on inclusion, effectiveness, and learning outcomes will be important as AI technology evolves and becomes more prevalent.

Directions for Future Study

Following the results of this study, future directions to study the impact of AI on undergraduate students could include i.) talking with professors to see how the collected student data compares with what they are experiencing, ii.) getting more information on student use from other types of students that are not in STEM, and iii.) demographic research on students to understand if AI is impacting students of different backgrounds. One of the limitations of the research was that students may not have been truthful about the different ways that they have been using AI. Gathering information from how professors are seeing student AI use could provide a more complete narrative of how AI has been impacting higher education. Additionally, by asking different types of students who are not in MCDB or the field of STEM the same questions, we could potentially find different answers to the research question that should be taken under consideration as part of the larger picture. Lastly, gathering demographic data on students and how different backgrounds correspond with AI use in college could provide needed insight for a proper response from educators and universities in the future in making sure that as AI tools get better, diversity and inclusion are not negatively impacted.

Acknowledgments

and Honors Council Representative. I would like to express my gratitude to Dr. Maciej Walczek for his role as my Outside Reader and for being an outstanding former chemistry professor. I would also like to acknowledge Drs. Christy Fillman, Jennifer Martin, Nancy Guild, Kristin Moore, Michael Stowell, Tin Tin Su, and Maureen Bjerke for their assistance with helping to advertise the interviews and survey among MCDB students. I am extremely grateful to everyone who made this research project possible.

References

Bartlett, T. (2023). *A Study Found That AI Could Ace MIT. Three MIT Students Beg to Differ.* https://www.chronicle.com/article/a-study-found-that-ai-could-ace-mit-three-mit-students-beg-to-differ?utm_source=Iterable&utm_medium=email&utm_campaign=campaign_7214412_nl_Academe-Today_date_20230710&cid=at&source=ams&sourceid=

Baule, S., & Baule, S. (2023, May 16). *Will advances in AI force a push to oral exams? - eCampus News*. https://www.ecampusnews.com/teaching-learning/2023/05/16/advances-in-ai-oral-exams/?utm_campaign=eCN%20Audience%20Development&utm_medium=email&_hsmi=260611786&_hsenc=p2ANqtz-8Izq-aElAlEGjux6gqsB1Ih9MCFiOTGCYTYZxd-cTPvdK8SV1EcP04jXa83JLAoNXmNoUo98wFNUi-kN8jP-r23bCzJRDdrY7HFCwKwQ0Z34CEMG4&utm_content=260611512&utm_source=hs_email

Bertram Gallant, T. (2017). Academic Integrity as a Teaching & Learning Issue: From Theory to

    Practice. *Theory Into Practice*, *56*(2), 88–94.

    https://doi.org/10.1080/00405841.2017.1308173

Bodnick, M. (2023, July 26). *Opinion | GPT-4 Can Already Pass Freshman Year at Harvard*.

    The Chronicle of Higher Education. https://www.chronicle.com/article/gpt-4-can-

    already-pass-freshman-year-at-harvard

Chen, B. (2023, June 30). *On Tech: A.I.: Turn A.I. into your study pal.* https://messaging-

    custom-

    newsletters.nytimes.com/dynamic/render?campaign_id=158&emc=edit_ot_20230630&in

    stance_id=96426&nl=on-tech%3A-

    a.i.&productCode=OT&regi_id=563764&segment_id=138087&te=1&uri=nyt%3A%2F

    %2Fnewsletter%2F5963c97c-6e80-526d-ae3a-

    b872b2bb7877&user_id=1e1ad7b22bfd0dd3ca61831bbec2ceda

CU Boulder. (2024, February 16). *3 ways AI is shaping the work world*. Career Services.

    https://www.colorado.edu/career/2024/02/16/3-ways-ai-shaping-work-world

Flanagin, A., Bibbins-Domingo, K., & Berkwits, M. (2023). *Nonhuman "Authors" and*

    Implications for the Integrity of Scientific Publication and Medical Knowledge | Health

    Informatics | JAMA | JAMA Network. https://jamanetwork.com/journals/jama/article-

    abstract/2801170

Gordon, C. (n.d.). *How Are Educators Reacting To Chat GPT?* Forbes. Retrieved February 9,

    2024, from https://www.forbes.com/sites/cindygordon/2023/04/30/how-are-educators-

    reacting-to-chat-gpt/

Hadi Mogavi, R., Deng, C., Kim, J., Zhou, P., Kwon, Y. D., Metwally, A., Tlili, A., Bassanelli,

    S., Bucchiarone, A., Gujar, S., Nacke, L., & Hui, P. (2023). *Exploring User Perspectives*

    on ChatGPT: Applications, Perceptions, and Implications for AI-Integrated Education.

    https://doi.org/10.13140/RG.2.2.15524.86401/1

IBM. (2024). *What are large language models? | IBM*. https://www.ibm.com/topics/large-

    language-models

Johns Hopkins Editorial. (2023, February 2). *Be gone, bot: Don't use AI to cheat your way*

    through college. The Johns Hopkins News-Letter.

    https://www.jhunewsletter.com/article/2023/02/be-gone-bot-dont-use-ai-to-cheat-your-

    way-through-college

Khan Academy. (2024). *Khanmigo Education AI Guide | Khan Academy*.

    https://www.khanacademy.org/khan-labs

Khan, S. (2023). *Sal Khan's 2023 TED Talk: AI in the classroom can transform education—*

    Khan Academy Blog. https://blog.khanacademy.org/sal-khans-2023-ted-talk-ai-in-the-

    classroom-can-transform-education/

Kichizo Terry, O. (2023, May 12). *Opinion | I'm a Student. You Have No Idea How Much We're*

    Using ChatGPT. The Chronicle of Higher Education.

    https://www.chronicle.com/article/im-a-student-you-have-no-idea-how-much-were-

    using-chatgpt

Kidd, C., & Birhane, A. (2023, June 22). *How AI can distort human beliefs | Science*.

    https://www.science.org/doi/10.1126/science.adi0248

Lauer, M., Constant, S., & Wernimont, A. (2023, June 23). *Using AI in Peer Review Is a Breach*

    of Confidentiality – NIH Extramural Nexus.

https://nexus.od.nih.gov/all/2023/06/23/using-ai-in-peer-review-is-a-breach-of-

confidentiality/

Metz, C., & Weise, K. (2023, May 1). *When AI Chatbots Hallucinate—The New York Times*.

https://www.nytimes.com/2023/05/01/business/ai-chatbots-hallucination.html

Mollick, E. (2023, September 24). *AI as Personal Tutor*. Harvard Business Publishing.

https://hbsp.harvard.edu/inspiring-minds/ai-as-personal-tutor

Moor, M., Banerjee, O., Abad, Z. S. H., Krumholz, H. M., Leskovec, J., Topol, E. J., &

Rajpurkar, P. (2023). Foundation models for generalist medical artificial intelligence.

Nature, *616*(7956), 259–265. https://doi.org/10.1038/s41586-023-05881-4

NIH. (2023, June 23). *NOT-OD-23-149: The Use of Generative Artificial Intelligence*

Technologies is Prohibited for the NIH Peer Review Process.

https://grants.nih.gov/grants/guide/notice-files/NOT-OD-23-149.html

NSF, AGS, & GEO. (2023, December 19). *NSF/AGS Update Mid-December 2023—All About*

AI. https://www.nsf.gov/news/news_summ.jsp?cntn_id=308808

Open AI. (2024). *ChatGPT* (March 2024 version) [Large Language Model].
https://chat.openai.com/chat

Open AI. (2023). *Improving mathematical reasoning with process supervision*.

https://openai.com/research/improving-mathematical-reasoning-with-process-supervision

Oxford Centre For Teaching. (2024). *IncludED: A guide to designing inclusive assessments*.

https://ctl.ox.ac.uk/included-designing-inclusive-assessments

Peter Lee, Carey Goldberg, & Isaac Kohane. (2023). *The AI Revolution in Medicine: GPT-4 and*

Beyond.

Pricing. (n.d.). Retrieved March 31, 2024, from https://openai.com/pricing

Roberts, M. (2023, December 12). *Opinion | AI is forcing teachers to confront an existential question*. Washington Post. https://www.washingtonpost.com/opinions/2023/12/12/ai-chatgpt-universities-learning/

RStudio Team (2020). RStudio: Integrated Development for R. RStudio, PBC, Boston, MA URL http://www.rstudio.com/.

Singer, N. (2023, December 13). Cheating Fears Over Chatbots Were Overblown, New Research Suggests. *The New York Times*.

https://www.nytimes.com/2023/12/13/technology/chatbot-cheating-schools-students.html

Stanford, Spector, C., & California 94305. (2023, October 31). *What do AI chatbots really mean for students and cheating?* Stanford Graduate School of Education.

https://ed.stanford.edu/news/what-do-ai-chatbots-really-mean-students-and-cheating

Svurluga, S., & Natanson. (2023, June 1). *All the unexpected ways ChatGPT is infiltrating students' lives*. Washington Post.

https://www.washingtonpost.com/education/2023/06/01/students-chatgpt-ai-tools/

Trepanier, L. (2023, March 29). *How AI Could Save Liberal Education | RealClearBooks*.

https://www.realclearbooks.com/articles/2023/03/29/how_ai_could_save_liberal_education_890101.html

UDL. (2024). *UDL: Optimize relevance, value, and authenticity*.

https://udlguidelines.cast.org/engagement/recruiting-interest/relevance-value-authenticity

University of Colorado. (2023, December 7). *3 things to know about AI and the Honor Code*.

New Student & Family Programs. https://www.colorado.edu/orientation/2023/12/07/3-things-know-about-ai-and-honor-code

Westfall, C. (n.d.). *Educators Battle Plagiarism As 89% Of Students Admit To Using OpenAI's ChatGPT For Homework*. Forbes. Retrieved April 1, 2024, from

https://www.forbes.com/sites/chriswestfall/2023/01/28/educators-battle-plagiarism-as-89-of-students-admit-to-using-open-ais-chatgpt-for-homework/

Zhang, B., Shi, H., & Wang, H. (2023). Machine Learning and AI in Cancer Prognosis, Prediction, and Treatment Selection: A Critical Approach. *Journal of Multidisciplinary Healthcare*, *16*, 1779–1791. https://doi.org/10.2147/JMDH.S410301