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Working Towards GenAI Literacy: Assessing First-Year Engineering Students' Attitudes towards, Trust in, and Ethical Opinions of ChatGPT

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Working towards GenAI literacy: Assessing first-year engineering students' attitudes towards, trust in, and ethical opinions of ChatGPT

Abstract

Generative artificial intelligence (GenAI) can be used by engineering students to improve their learning, but it also can be used in unethical or inappropriate ways that might reduce professional competence. This study investigated student opinions about ChatGPT, a popular GenAI tool, to determine a starting point for AI literacy instruction. Results revealed general positive attitudes towards GenAI, inflated trust of its outputs, and a wide variability of ethical opinions. Students with more experience using ChatGPT were more likely than students with little or no experience to think that using ChatGPT for engineering school and professional tasks is ethical. The prevalence of students using GenAI tools, along with their optimism in GenAI outputs, indicates that there is an immediate and pressing need for AI literacy instruction in first-year engineering programs.

Introduction

Generative artificial intelligence (GenAI) is increasingly used in both academic and professional settings, including engineering and engineering school. With GenAI, users can prompt large language models (LLMs) that have been trained on existing data to generate text, images, and other media with similar characteristics. Used appropriately and ethically, GenAI could support engineering students in their problem-solving, ideation, design, and learning [1]. But students may use GenAI software inappropriately, possibly leading to intentional or unintentional academic dishonesty, inaccurate source citations, or reduced competence in essential skills needed in engineering [2].

ChatGPT, developed by Open AI and launched in November 2022 [3], is one of the most popular and accessible LLM chatbots on the market today. ChatGPT in its current state is particularly good at providing context-based answers to questions, writing, editing, and coding [4], [5]. However, some of its limitations include potential bias in its training data, a lack of up-to-date knowledge, and generating made-up or "hallucinated" information including source citations [6].

Due to the accessibility and usefulness of GenAI products, engineering students need to acquire literacy in AI technology, which includes (a) understanding basic functions of AI, (b) using and applying AI in a variety of contexts, (c) evaluating and creating AI applications, and (d) understanding ethical considerations related to AI including fairness, accountability, transparency, and safety [7]. In addition, it is important for educators to understand how engineering students approach GenAI technologies so that instruction can meet their needs. Of particular concern are first-year students' incoming attitudes towards, trust in, and ethical opinions of GenAI, because these factors will impact how students engage this technology while beginning to learn engineering content and skills.

Literature Review

Positive outcomes of using GenAI in the classroom include stronger academic performance [8], [9], [10] and a better understanding of the accuracy of GenAI and the usefulness of its outputs [11]. However, GenAI may contribute to cognitive offloading [12], which may create gaps in learning essential engineering knowledge. Students need to be able to understand how and when to use GenAI tools such as ChatGPT effectively and ethically in different contexts, such as for homework, assessments, and in their work as professional engineers.

Recent studies reveal varying levels of awareness and use of GenAI tools among students [13], [14], but in many cases, an overall positive attitude toward GenAI [15], [16], [17]. Despite concerns about accuracy, plagiarism, and its impact on their future careers [16], students generally welcome opportunities to use GenAI intentionally in their coursework to prepare them for the profession [18]. This trend is similar among professional engineers who report that AI has had a positive impact on their work and feel optimistic about the future [19]. Students have reported that they use ChatGPT because it's free, fast, and provides the most accurate answers compared to its competitors [20], which aligns with the factors that have influenced the early adoption of AI technology, including ease of use and compatibility with one's values [21].

Several cognitive and affective factors such as self-confidence and enjoyment play a significant role in students' attitudes toward using ChatGPT in the learning process [22]. It is also likely that trust in GenAI will impact students' decisions as to whether and how to use GenAI. A recent survey of computer science students found that trust in GenAI varied, though students in lower-level courses trusted the outputs of GenAI more than those in advanced courses [23]. Another study of Masters engineering students' perceptions of GenAI found that more experience led them to question its reliability and consider its limitations [24].

Students generally recognize that using GenAI unethically is a form of plagiarism [25], but given the limitations of AI plagiarism detection software, it is still unclear to what extent students plagiarize with ChatGPT [26]. In addition, it is not always clear when a use of GenAI is unethical (e.g., using it to double-check an already-formed answer). Societal norms are considered a precursor to the ethical decision-making process, during which moderating factors such as an individual's moral capacity and a situational issue contribute to retrospective learning that may impact an individual's judgement, intention, and subsequent behavior [27]. In the case of GenAI, the societal norms are still evolving, and thus individual factors as well as prescribed contextual factors will play a bigger role in decision-making.

The nascency of accessible GenAI and related literature reveals a need to both understand and improve engineering students' AI literacy, including student perspectives and ethical decision-making. Very few studies have looked at the engineering student population, and even fewer have looked at first-year students. These students have the least experience in engineering and are thus the least capable of evaluating GenAI outputs using existing knowledge. Teaching them to question and test GenAI output will be necessary. In addition, collecting empirical data about

first-year engineering students' opinions of GenAI is a good first step in developing appropriate AI literacy curricula.

Current Study

The current project assesses incoming first-year engineering students' general attitudes towards, trust in, and ethical opinions of ChatGPT. It is part of a larger project in which ChatGPT assignments were integrated into a first-semester engineering course. Students were surveyed at the beginning and end of the semester, but this paper focuses on student responses in the first survey.

Our research questions were as follows:

> RQ1. What are incoming first-year engineering students' attitudes towards ChatGPT, trust in its responses, and ethical beliefs regarding its use?

> RQ2. Does students' prior experience with ChatGPT correlate with their attitudes, trust, and/or ethical opinions?

Results establish a valuable baseline for understanding the attitudes and ethical perspectives of first-year engineering students toward AI, establishing a starting point for the incorporation of GenAI literacy into engineering curricula.

Methodology

This study was approved as exempt by the authors' Institutional Review Board.

Participants

Participants included all students enrolled in the first-semester introductory engineering course at the University of Louisville in Fall 2023 who responded to all survey items ($N = 441$) and whose responses indicated active participation. Data was removed from the study if a student did not respond to the prior experience question ($N = 3$), did not respond to the ethics questions ($N = 1$), or gave the same response to all the trust and ethics questions ($N = 7$). The survey response rate was 92.8% (class size $N = 487$).

Materials

The survey asked about students' (a) prior experience using ChatGPT, (b) general attitudes towards ChatGPT, (c) trust in ChatGPT-produced information across different prompts, and (d) ethical opinions about using ChatGPT for engineering school tasks and professional tasks. The survey included a preamble that informed students that their participation indicated consent for their responses to be used in research. There was also a brief description of the survey and of ChatGPT, as follows:

"This survey is about ChatGPT, the recently-developed artificial intelligence (AI) chatbot that responds to user prompts with human-like responses. It was trained on a large dataset of many sources and can respond to many types of questions."

The general attitudes items were adapted from Joyce and Kirakowski's General Internet Attitudes Scale [28], with response options on a 5-point Likert scale (1 – *Strongly Disagree*, 2 – *Slightly Agree*, 3 – *No Opinion*, 4 – *Slightly Agree*, 5 – *Strongly Agree*). The scale included four components:

- Social Benefit (6 items, Cronbach's α = .852) – the perception of positive influence that ChatGPT may have on society and the social benefits it could create, e.g., "ChatGPT makes a positive contribution towards society."
- Affect (9 items, Cronbach's α = .887) – an experience of feeling or emotion related to ChatGPT [29]. This scale in particular measured negative affect or negative emotions about ChatGPT, e.g., "I feel intimidated by ChatGPT." This component included eight negative items and one positive item that was reverse coded for analysis.
- Exhilaration (3 items, Cronbach's α = .782) – the excitement that students experience when they use or think about using ChatGPT, e.g., "The thought of using ChatGPT is exciting to me."
- Detriment (3 items, Cronbach's α = .661) – the perception of negative effects of ChatGPT on an individual level as well as a societal level, e.g., "Using ChatGPT is harmful to people."

The trust and ethics items (fully listed in the results section) were written by the research team for this study. Each trust question was framed as an objective judgement, as follows: "What is the likelihood, on a scale of 1-100 (where 1 is extremely unlikely and 100 is extremely likely), that ChatGPT will return a correct answer to the following prompt?" The ChatGPT prompts were based on planned applications in the first-year engineering course as well as potential applications in the engineering profession. Researchers intentionally selected tasks for which ChatGPT was unlikely to return a correct answer as well as tasks for which ChatGPT-3.5 was likely to return a correct answer, based on preliminary testing. One item was included as a manipulation check.

Each ethics question began with "It is ethical to" and response options were on a 5-pt Likert Scale from 1 - *Strongly Disagree* to 5 – *Strongly Agree* (similar to the attitudes questions). The ethics questions asked about potential uses in school and the engineering profession (e.g., "It is ethical to figure out difficult engineering homework problems.")

Procedures

The survey was administered in class on September 20 and 21, 2023 (in week 5 of the semester) via Blackboard®, the campus-wide learning management software. At the time, ChatGPT 3.5 was available to the public for free. ChatGPT 4.0 was also available with a paid subscription.

Instructors gave enough time in class for all willing participants to complete the survey, watching until all students appeared to have completed the survey (approximately 12 minutes).

Data was collected from Blackboard and student identifying information was removed. Deidentified data was then imported into IBM® SPSS for statistical analysis.

Scale reliabilities and averages were calculated for the general attitude components. An average was also computed for overall trust, without the inclusion of the manipulation check. Responses to the ethics questions were compressed into three categories: Disagree, No Opinion, and Agree for analysis and visualization.

Descriptive statistics were calculated for each variable, and bivariate correlations were calculated between prior experience and the other variables. A Bonferroni correction was applied to account for these multiple, exploratory analyses ($p_{Bonferroni}$ = .05/7 = .00714).

Results

First-year engineering students' prior experience in, attitudes towards, trust in, and ethical beliefs regarding the use of ChatGPT (RQ1) are reported in the Descriptive Results section below. Correlations between prior experience and attitudes, trust, and beliefs (RQ2) are reported in the following section.

Descriptive Results

Prior Experience

Students entering the first semester of engineering school in Fall 2023 had a range of levels of prior experience with ChatGPT (see Table 1).

Table 1

Prior Experience Results for "How much experience have you had interacting with ChatGPT?"

Response	N	%
None	137	31.1
Minimal (I've tried it a few times)	160	36.3
Moderate (I've tried it several times with a purpose in mind)	115	26.1
Expert level (I've used it regularly for specific tasks)	29	6.6

Attitudes

General attitudes varied widely across the student population. The mean values (Social benefit, $M = 3.26$, $SD = .78$; Affect, $M = 2.41$, $SD = .80$; Detriment, $M = 3.11$, $SD = .81$; and Exhilaration $M = 2.88$, $SD = .89$) reveal a slightly positive attitude toward ChatGPT overall, although again, the range of results indicates that opinions varied widely. Kolmogorov-Smirnov (K-S) tests indicated non-normal distributions, but these tests are known to detect very small deviations when applied to a large dataset. The K-S statistics values were low (.079, .064, .097, and .117 respectively for the individual components), and the histograms (shown in Figure 1) as well as the skewness and kurtosis values appear close to normal.

Figure 1

Distribution of students' attitudes towards ChatGPT.
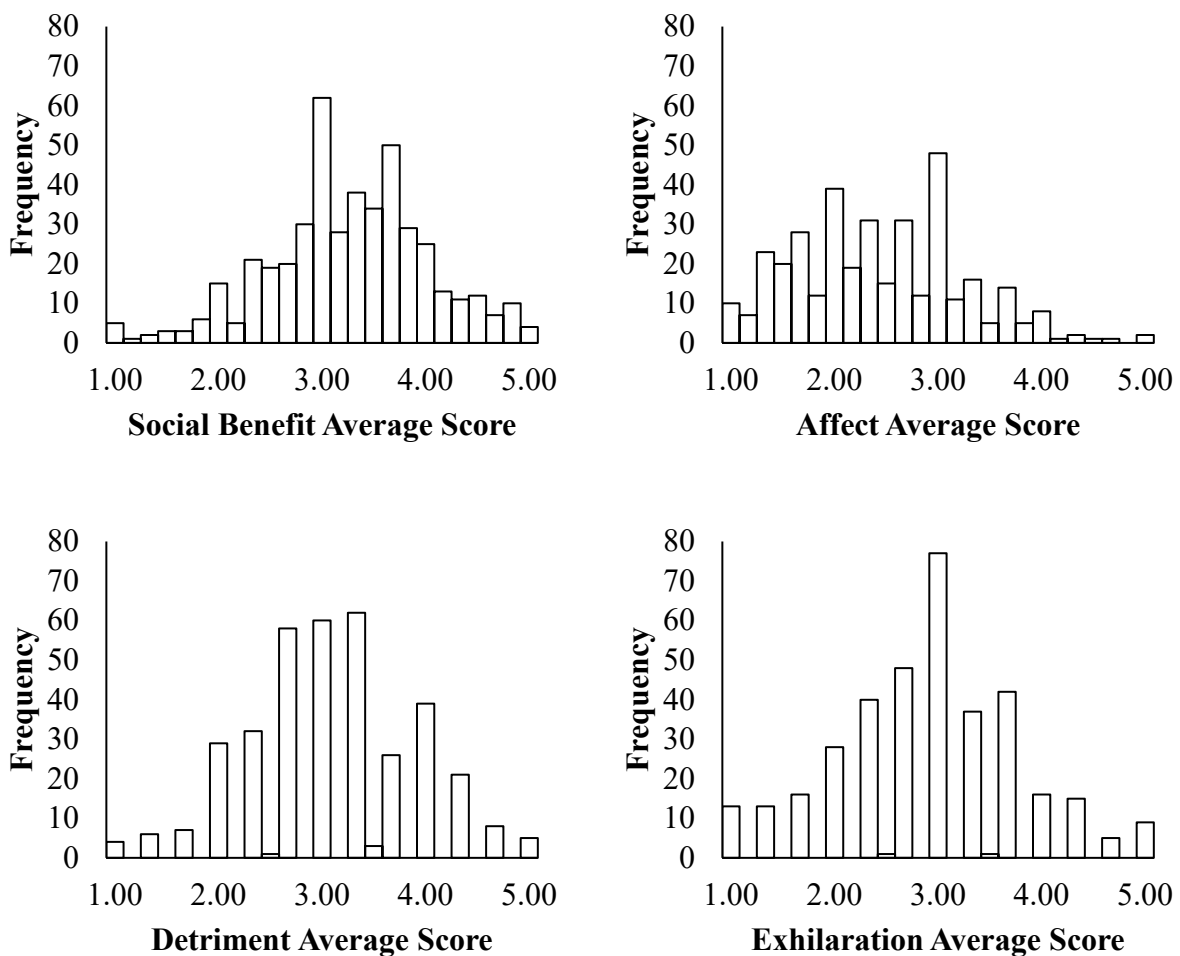
Trust

Average trust values ($M = 79.0$, $SD = 16.5$) indicated that students were generally inclined to trust the output of ChatGPT. The lowest mean trust value for any individual item was 61% that asked ChatGPT to write an essay including references (see Table 2).

Table 2

Trust in Generative AI items and response statistics.

Prompt	Mean	SD
What is the formula for calculating the circumference of a circle based on the radius?	94.08	15.934
When did I wake up this morning?*	9.17	18.233
List some recent engineering solutions to the grand challenge of engineering "making solar energy economical."	64.47	29.895
Describe the grand challenge of engineering "making solar energy economical" with references.	61.06	29.725
Write a python program of a menu with three functions: Function 1, Function 2, and Exit. Have the menu continue to execute in a loop until user selects the Exit function.	66.70	27.779
What was the exchange rate between the dollar and the euro in 2006?	89.75	19.663
Write a program to calculate the distance between two latitude and longitude points.	75.39	25.797
What is the distance between these two coordinates? (522222,10), (5222291, 49023)	87.21	19.498
Solve this system of equations: 10x + y = 26 3x + 2y = 8	88.17	20.876
Solve this system of equations: 10x + y – 2a + b = 26 3x +2y + a + 2b = 8 -x + 10y + a + 2b = 8 2x – 3y – 2a + b = -4	83.55	23.605
What is the friction coefficient for sandpaper?	77.61	26.719
Explain how to use the Unit Circle for estimating sine and cosine values.	83.16	21.273

Note. The starred item was a manipulation check to determine whether students were attending to the survey questions.

Ethics

Ethical opinions varied more than general attitudes and trust in ChatGPT's capabilities. As shown in Table 3, most students found two uses of ChatGPT to be unethical (to complete entire engineering homework assignments, or to complete entire engineering projects). Overall, average student responses tended to fall below the midpoint of the scale indicating that more students thought the activities were more unethical than ethical. The large standard deviations, however, indicate a wide range of opinions.

Table 3

Ethics with Generative AI Items and Response Statistics

Statement	M	SD
It is ethical to use ChatGPT to complete entire engineering homework assignments.	1.48	0.881
It is ethical to use ChatGPT to figure out difficult engineering homework problems.	2.87	1.172
It is ethical to use ChatGPT to answer engineering exam problems.	1.59	0.917
It is ethical to use ChatGPT to complete entire engineering projects.	1.63	0.964
It is ethical to use ChatGPT to figure out difficult professional engineering problems.	3.03	1.230
It is ethical to use ChatGPT to brainstorm before solving engineering homework problems.	3.82	1.067
It is ethical to use ChatGPT to write programming code for engineering course assignments.	2.19	1.168
It is ethical to use ChatGPT to write programming code in the engineering workplace.	2.75	1.277
It is ethical to use ChatGPT to edit professional reports and papers.	2.90	1.324
It is important to verify the information provided by ChatGPT.	4.80	0.604

Correlations between Prior Experience and Attitudes, Trust, and Ethical Opinions

Prior experience was significantly correlated with all four general attitude components as well as the selected ethics questions. Average trust was not significantly correlated after the Bonferroni correction for multiple analyses. All correlation and significance values are listed in Table 4.

Table 4

Correlations Between Prior Experience and General Attitude, Average Trust, and Ethical
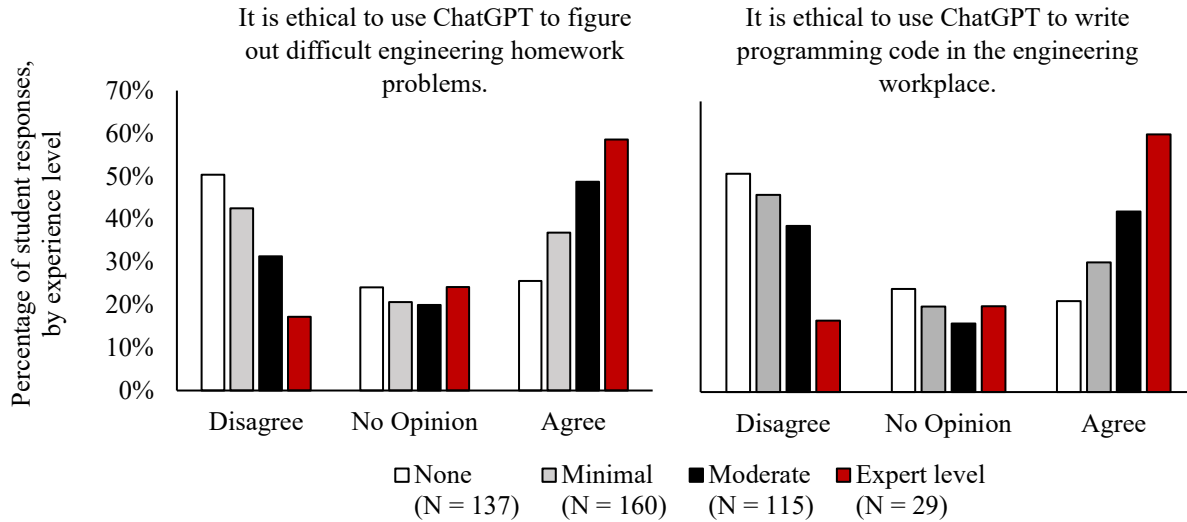Opinions of ChatGPT

Scale	Subscale	Correlation	p
General Attitudes	Social Benefit	.348	<.001*
	Affect	-.411	<.001*
	Detriment	-.216	<.001*
	Exhilaration	.339	<.001*
Trust	Average across all items	.102	.030
Ethics	Figure out difficult engineering homework problems	.261	<.001*
	Write programming code in the engineering workplace	.257	<.001*

Note. The asterisks show significance after a Bonferroni correction.

To further investigate the correlation between prior experience and ethical opinions, we grouped
the 5-point Likert scale into three categories (Disagree, No Opinion, and Agree), and plotted
frequency of student responses based on their prior knowledge. Figure 2 shows the clear increase
in beliefs that use of ChatGPT is ethical among students with higher levels of experience. In
addition, these charts reveal that a relatively consistent percentage of students are undecided or
unsure about the ethics of using ChatGPT, across all levels of experience.

Figure 2

The distribution of student responses to two ethics questions, grouped by students' prior experience with ChatGPT.

Discussion

Overall, opinions about ChatGPT varied widely across the first-year engineering student sample at the University of Louisville in Fall 2023. Given that ChatGPT is still a relatively new technology, students' varied opinions were expected, and our results support other findings from recent literature. The percentage of students who had tried ChatGPT was 69%, which was nearly double that of Spring 2023 (35%, as reported in [30]) revealing a rapid increase in use in the engineering student population. The popularity of ChatGPT reemphasizes the importance and timeliness of work towards GenAI literacy.

On average, there was a slight positive attitude towards ChatGPT. Affect (a measure of negative emotion) and detriment scores fell below the midpoint of the scale, and social benefit and exhilaration scores fell above the midpoint. However, as shown in the histograms in Figure 1, opinions were widely variable, with many students on both positive and negative sides of the scales. Only Affect had a significant positive skew, indicating that although some students did feel very negative emotions about ChatGPT, many more felt positive emotions.

In addition, students' trust in ChatGPT to give correct answers was relatively high. All trust questions had averages above 60%, indicating that the student body believed that ChatGPT was more than 60% likely to respond to each prompt correctly, even the prompts selected by instructors for which ChatGPT was unlikely to respond correctly. There was some variation, in that the students believed that ChatGPT would be more likely to accurately solve simple math problems than to give a correct answer for engineering design problems. There was also more

uncertainty about whether it could write essays and code, despite writing being a strength of LLMs. But students' overall high trust indicates that they are not fully aware of its limitations. It is important to note that trust questions were answered by all students, regardless of experience, meaning that some students had not yet had the opportunity to see the limitations of ChatGPT. It is the hope that student expectations would become more accurate with experience and instruction.

In terms of ethical opinions, students predominantly felt that it was unethical to use ChatGPT for exams and entire homework assignments or engineering projects ($Ms < 2$). In these cases, students clearly perceived the applications of GenAI to violate existing academic standards.

The responses to other, less clear ethical choices had the greatest variability. These items were: using ChatGPT to

      (a) write programming code for engineering course assignments,
      (b) write programming code in the engineering workplace,
      (c) edit professional reports and papers,
      (d) figure out difficult professional engineering problems, and
      (e) figure out difficult engineering homework problems.

For these questions, the student response average was close to the midpoint of the scale, but the large standard deviation represents wide variability. Some students strongly agree that these actions are ethical, whereas others strongly disagree. These results reflect the lack of standardized communication from leaders and educators about this technology. The call to action for educators is therefore to clearly state the rules around using GenAI in the classroom as well as in the workplace.

Interestingly, although still highly variable across students, the mean response to the use case of brainstorming before solving engineering homework problems was positive ($M = 3.8$). This result suggests that students value using ChatGPT as a tool to support learning and problem solving as opposed to completing work.

Lastly, experience was correlated with students' ethical opinions. Those with little to no experience felt that it would be unethical to use ChatGPT in many contexts, and the few students who reported themselves to have had expert-level experience (used ChatGPT regularly with specific purposes in mind) felt that it was ethical. This correlation is logical, because students who think that using ChatGPT is unethical are less likely to use it frequently. This result differed from a previous study, however, where more experienced students were more critical of GenAI, which suggests that first-year students may be misguided about its capabilities [24]. Any number of students who think it's ethical may be likely to use it without additional guidance.

All results indicate that more instruction is needed in the classroom. Instructors should provide clear guidelines for how students can and cannot use GenAI for their homework, assignments, and assessments.

Limitations

This study is limited to a student sample at one large, midwestern university. Furthermore, student demographics were not included in the survey, so differences in race/ethnicity, gender, or socioeconomic status could not be included in this analysis. However, this work is important to understand our student population as we design instruction. The survey itself also had limitations. It is possible that student experience with GenAI was not accurately measured because only one question addressed experience, and it was specifically about ChatGPT. In addition, the survey did not query how GenAI had been used (e.g., for homework assignments). Lastly, one big limitation of this study is that it was not causal, and therefore the direction of the relationship between experience and attitudes is unclear.

Conclusions & Future Work

This study investigated student opinions about ChatGPT, a popular GenAI tool. Results showed that students' opinions were widespread, with some optimistic, positive, and activity using GenAI whereas others were negative and did not think it should be used in any use case. In general, results reveal a great need for instruction on limitations and both unacceptable and acceptable use cases. AI literacy would help engineering students become able to use new technologies ethically and appropriately for learning. Future work will test whether course integration will change students' attitudes and opinions.

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