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Work-in-Progress: Student perceptions and usage of generative AI in second-year chemical engineering design exercises

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Introduction

Generative AI (Gen. AI) systems have recently become widely and easily accessible following the launch of systems such as ChatGPT in late 2022. One topic of interest is how students are using these tools and the educational impacts of their use [1]. Researchers have sought to understand student use and perception of Gen. AI through a variety of means including surveys and case studies [2], [3], [4], [5]. Weber *et al.* surveyed 760 respondents at an R1 university including students and faculty on their perception of Large Language Models (LLMs) [2]. Students believed that LLMs would significantly impact their ability to quickly access information, however many students also had concerns about the reliability of results LLMs provide. There was a difference in perception and adoption between students earlier in their undergraduate degrees and students later in their undergraduate degrees or in graduate studies, with students later in their degrees more rapidly integrating LLMs into their learning. Breese *et al.* surveyed 110 students at a university in the western United States on their perceptions of AI and its impact on society, mainly focusing on first and second-year students [4]. They found that perceptions were similar to previous studies from other countries in that students generally viewed AI positively, while also harboring some concerns. This study focuses on Gen. AI perceptions and usage in a second-year chemical engineering fundamentals and design course at a large research intensive Canadian public university.

Context

The course is a second-year chemical engineering course focusing on physical chemistry fundamentals as well as an introduction to process design. At the institution students complete a general first year and then in the second year start coursework in their discipline of interest. The course covers topics including reaction characterization, vapour-liquid phase equilibrium, energy balances and unsteady-state balances. During the same term students are taking a material and energy balances course and this content is also relied upon for the design project that students undertake. For the course design project, students prepare six short reports throughout the term of 2-3 pages each, which include additional calculations or figures such as flow diagrams. The students are also responsible for a final presentation and a final report which incorporates feedback on their six short reports. The project is coordinated with the technical communications course that students are taking simultaneously and project deliverables are submitted to both courses for feedback. Further details on the course and project context can be found in previous publications [6], [7].

Methods

A survey was announced and made available to students in the last week of the course and left open for two weeks following the end of the course during the examination period. The instructor explained the purpose of the survey both in class and through course announcements on the learning management system. No incentive was provided to students filling in the survey.

The survey was anonymous, with no way of tracking respondents. The study was reviewed and approved by the institutional research ethics board, ID # H24-03237. The list of questions provided in the survey as well as closed-ended question answer choices are provided in an appendix at the end of this publication. The survey was adapted from a previous study focusing on Gen. AI usage in capstone design courses [8].

36 responses were received of which 32 appeared to be fully completed. The 4 incomplete responses were removed from the analysis as they did not provide sufficient data for analysis. The total class size was 122 students, meaning a response rate of 26% (32/122). Responses did not appear to be duplicated for any of the 32 responses received (none were identical), however there were no measures taken to prevent someone from responding multiple times to the survey.

Results and Discussion

Of the 32 responses 18 noted that they or their teams had used Gen. AI in developing their design projects, with the remaining 14 students indicating they had not used Gen AI in their projects. Of the 18 students using Gen. AI, the cited uses were in document editing (11), problem solving (11), literature review (6), presentation creation (4), coding (4) and understanding course material (1). Note that all of the five "other" comments were coded into these categories if they were deemed to fit into them and the student had not already selected the relevant category. The "understanding course material" topic was added as it did not appear to fit into an original category.

Based on each of the common uses in the survey that students selected, students were presented with a Likert scale questions on the extent that Gen. AI tools improved their ability to perform a given task. All students were also asked a question on whether Gen. AI use improved their ability to critically evaluate information. Results from these questions are provided in Table 1. One notable result is that students who used the Gen. AI tool for coding all strongly agreed with its ability to assist their work. However, the sample size is small, with just four students using Gen. AI for this purpose. Previous literature has also suggested that Gen. AI, and specifically LLMs are particularly adept at assisting with coding tasks although this may be detrimental to learning [9], [10]. Results from other uses were mixed, although in general more students agreed there was some benefit from Gen. AI use. Given comments provided by students it appears that almost all have specific target applications where they are more comfortable using Gen. AI. Some students noted that Gen. AI is helpful in the early research stage or for idea generation, whereas others used it as a writing aid or to clarify particular questions that they had on course content. Some students noted it was a last resort rather than an initial solution and said they used it similarly to a search engine.

Table 1: Student perceptions on Gen. AI assistance in performing certain tasks

To what extent do you agree with the following statements? "Generative AI Tools improved my ability to..."	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
conduct an effective literature review	1	1	2	0	1
edit documents	3	6	1	1	0
generate content	0	0	0	0	0
prepare presentations	0	2	0	1	0
problem solve	4	5	1	1	0
code	4	0	0	0	0
critically evaluate information	0	10	6	0	2

In terms of Gen. AI tool usage all students using Gen AI reported using some form of Chat GPT, with 17 reporting usage of Chat GPT, and 5 reporting usage of GPT 4.0. In terms of other Gen. AI tools, 2 students reported using Microsoft Copilot, 1 student reported using Mistral and 1 reported using Gemini developed by Google.

All students were asked about their concerns when using Gen. AI tools. The frequency of concerns cited by students having used and not used Gen. AI is presented in Table 2. Note that not all concern prompts were provided to both groups and in the case of a group not receiving a prompt an “N/A” is shown. Both groups most frequently had concerns around low quality responses and academic integrity issues. An AI policy was circulated stating students were free to use any tools they wished but that students were responsible for the accuracy of the work they submitted, and this policy was mirrored in the communications course. In general based on the responses students seemed to have a healthy amount of skepticism in terms of Gen. AI usage. One noted difference between groups, is that none of those using AI reported an issue in terms of not knowing what prompts to use.

Table 2: Concerns from students in using Gen. AI tools

Which of the following considerations, if any, have you encountered when using generative AI tools	Used Gen. AI (n=18)	Did not use Gen. AI (n=14)
Low quality not suitable for project submission	10	12
Academic integrity	8	12
Not reliable	N/A	8
The AI tool using improper citations (e.g. fabricated citations, incorrect citations, or missing citations)	7	N/A
Not knowing what effective prompts to use (i.e. being too specific or too general in prompting and receiving a poor output)	0	6
Privacy (i.e. sharing confidential information)	2	3
Resistance from other members (i.e. not all members agreed on using Gen AI for assignments)	3	N/A
Equity concerns	1	1
Not knowing which AI tool to use	N/A	2

The results in this study in terms of students' perceptions are congruent with previous studies, which have noted student concerns around Gen. AI use in terms of accuracy and reliability[2], [4]. Further studies will aim to introduce techniques for effective and critical Gen. AI usage and further elucidate how students are using the tools using qualitative methods such as interviews to provide a richer data set.

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[Blinded references to be added]

Appendix: Survey questions

1. Have you or your team used any generative AI tools (ChatGPT, GPT4, Copilot, Gemini, Bard, ChatSonic, Perplexity, etc.) for any of the course project deliverables?
    - Yes (if selected, presented questions 2 to 5, followed by question 7)
    - No (if selected, presented question 6 followed by question 7)
2. Please describe the specific ways in which you or your group used generative AI for your project-related work (Choose all that apply)
    - Literature review
    - Document editing
    - Content generation
    - Presentation creation
    - Problem-solving (eg. solve a problem, check a solution, ...)
    - Coding (eg. computer code to perform a certain task)
    - Other [Please specify]
3. To what extent do you agree with the following statements? "Generative AI Tools improved my ability to..."
    - ...conduct an effective literature review
    - ...efficiently edit documents
    - ...generate quality content
    - ...prepare presentations
    - ...problem solve
    - ...code
    - ...critically evaluate the information I consume, read, or obtain

    Five response options were offered: Strongly agree, Somewhat agree, Neither agree nor disagree, Somewhat disagree, Strongly disagree
4. Which of the following considerations, if any, have you encountered when using generative AI tools in your assignments? (Choose all that apply)
    - Resistance from other members (i.e. not all members agreed on using Gen. AI for assignments)
    - Low quality not suitable for project submission
    - Privacy (i.e. sharing confidential information)
    - Equity concerns
    - Academic integrity
    - Not knowing what effective prompts to use (i.e. being too specific or too general in prompting and receiving a poor output)
    - The AI tool using improper citations (e.g. fabricated citations, incorrect citations, or missing citations)
    - Other (please describe)
5. Select the generative AI tool/s you have used for this course project. (select all that apply)
    - ChatGPT
    - GPT4
    - Copilot (Microsoft)
    - Gemini (formerly Bard)

- ChatSonic
- Perplexity
- Claude
- DALL-E
- Other(s) (please specify)

6. Please describe why you did not use any generative AI tools?
    - Not reliable
    - Low quality, not suitable for project work
    - Privacy (i.e. sharing confidential information)
    - Academic integrity
    - Not knowing what effective prompts to use (i.e. being too specific or too general in prompting and receiving a poor output)
    - Not knowing which AI tool to use
    - Equity concerns
    - Other (Please describe)
7. In the space below, please add any additional comments you have about the use of generative AI tools in your course project and/or clarification for any answer you provided in this survey.