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Work-in-Progress: Fostering Student Support and Professional Development in an Introductory Chemical Engineering Seminar Course

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ABSTRACT:

Lower-division introductory courses provide students with a valuable foundation for future success. In this Work-in-Progress paper, we discuss the development of a lower-division, seminar-based course for chemical engineering students and assess its impact. Students face social and professional challenges when entering college due to the significant adjustment from high school or community college. Additionally, Generative Artificial Intelligence (GenAI) tools present a new challenge to lower-division engineering education, as students have varying levels of experience and familiarity with using them appropriately as educational tools. The course was structured to address these challenges through weekly lectures on diverse topics, helping students adjust to the university's learning environment while exposing them to campus resources and professional development opportunities.

Preliminary survey results show that students responded positively to the course, finding the presentations useful for their learning experience. A comparison of pre- and post-course surveys revealed that students had gained significantly improved understanding of potential career paths in chemical engineering, developed peer connections, and become familiar with the university's academic resources. Survey results also show that students obtained a better understanding of how to use GenAI tools ethically and effectively. Finally, students provided suggestions for future course improvements as also discussed in this paper.

Introduction:

Integrating lower-division introductory courses into engineering programs offers significant benefits for students [1]. Currently, early chemical engineering curricula often consist of large, general courses managed by mathematics, physics, and chemistry departments. A primary challenge of this structure is that entering students may lack an understanding of the specific opportunities offered by their institution and the post-graduate pathways available in their field [2]. Furthermore, Generative Artificial Intelligence (GenAI) introduces a modern complexity; students enter with varying experience levels and often lack guidance on how to use these tools ethically to support their learning [3].

The transition to college-level programs also presents academic and social hurdles [4]. Students must adjust to increased rigor and the requirement to self-regulate their studies, often without a peer group for community support. Those facing these challenges may become discouraged, leading to a loss of motivation and potential withdrawal from the major [5, 6]. Additionally, navigating the path to employment is increasingly difficult, as students must identify competitive internship or research opportunities early in their academic careers.

This seminar-based course was designed to directly address these challenges by orienting incoming students to program-specific opportunities and post-graduate pathways, building a peer learning community to ease the academic and social transition, and providing early exposure to professional development resources. Additionally, the course establishes a consistent foundation in GenAI literacy by ensuring all students receive equal instruction on ethical usage and departmental policies. This Work-in-Progress manuscript reports on the development, implementation, and early impact of this introduction to chemical engineering course.

Curriculum Framework and Development:

This study analyzes a major required 1-unit course for incoming chemical engineering students at a large public R1 institution. The representation of the students in this study is reflective of the institution being designated as a Hispanic-Serving Institution (HSI) and an Asian American and Native American Pacific Islander-Serving Institution (AANAPISI). The course was integrated as a curriculum requirement in 2021, as sophomore-level courses did not have the capacity to include the same content. Currently, the class format comprises 10 seminars, each addressing a different topic. To expose students to diverse professional pathways, speakers were selected from varied backgrounds, including the course instructor, upper-division undergraduate students, graduate students, and chemical engineering alumni currently working in industry. The curriculum topics (listed below) were selected to introduce students to their academic community and guide them in preparing for successful future careers.

- Introduction to Chemical Engineering
- American Institute of Chemical Engineers (AICHE)
- Guest Speaker: Water Resource Management
- Guest Speaker: Entrepreneurship
- Guest Speaker Machine Learning and Application to ChemE
- Chemical Engineering Curriculum Overview
- Careers in Chemical Engineering
- Division of Career Pathways
- Office of Outreach, Access and Inclusion
- Academic and Professional Integrity in Engineering (GenAI)

Additionally, two modules on artificial intelligence (AI) were integrated into the course to help prepare students for the growing use of AI in engineering. One module was developed to focus on how to ethically use GenAI and considerations to have when using it as an academic learning tool. Another module was developed to demonstrate the application of machine learning to a chemical engineering application.

Methods:

Students completed anonymous pre- and post-course surveys at the beginning and the end of the Fall term in 2025 to evaluate the course's impact on their experience. The surveys integrated questions from a literature review of similar seminar-based lower-division courses [1, 7] with additional questions developed by the research team. The surveys asked students about their personal motivations, views, backgrounds, and future goals as chemical engineering students. Also, students reported their views on generative AI (GenAI) tools and their personal usage of these technologies. Moreover, in the post-survey, students assessed the impact of course lectures on their learning and suggested potential improvements.

Learning outcomes were presented as statements, with students indicating their level of agreement using a 5-point Likert scale. Responses ranged from 5 (most favorable—most important to learning, strongly agree, or very trustworthy) to 1 (least favorable—least important to learning, strongly disagree, or most untrustworthy). Some questions also included short-answer responses. This study was approved by the university's Institutional Review Board.

Results:

In the pre-course survey, students were asked to discuss their motivations for pursuing chemical engineering to help the instructional team better understand what drives them. Students selected all applicable motivations, revealing that they were primarily drawn to chemical engineering because of their interest in design (103/152, 67.8%), hands-on learning (93/152, 61.2%), and financial considerations (86/152, 56.6%). Many current course modules aligned with these student motivations. For example, hands-on projects promoted by the AIChE student chapter, and undergraduate research opportunities and career pathways were discussed during lectures. This exposure helped students learn how to leverage opportunities for their future careers while developing technical skills across a diverse range of experiences.

Students responded positively overall to the course lectures. When asked to rate the importance of each lecture to their learning, students rated the course modules between "somewhat important" and "very important" (average Likert scale ratings between 3 and 5), as displayed in Table 1. These ratings indicate that the course successfully introduced students to a wide variety of topics related to their professional, academic, and social growth.

Table 1. Student ratings of the importance of each course lecture topic to their learning (5-point Likert scale).

Learning Outcome	Introduction to the Department of Chemical and Biomolecular Engineering	Introduction to the Chemical Engineering Curriculum	AIChE Student Club and Project Presentation	Career Pathways for Chemical Engineers	Presentation from Career Center
Student Assessed Importance to Learning Experience (Mean ± STD)	4.02 ± 0.82	4.23 ± 0.74	4.05 ± 0.87	4.34 ± 0.71	3.81 ± 1.00
Learning Outcome	**Industry/Alumni Guest Speakers**	**Presentation from Office of Outreach, Access and Inclusion**	**Undergraduate Research Opportunities in Chemical Engineering**	**Introduction to Machine Learning**	**Academic/Professional Integrity and GenAI in Engineering**
Student Assessed Importance to Learning Experience (Mean ± STD)	3.99 ± 0.86	3.65 ± 0.97	4.23 ± 0.81	3.68 ± 0.99	3.70 ± 1.01

To evaluate the course's effectiveness in building student community and enhancing understanding of professional development, five survey statements from both pre-course and post-course surveys were analyzed using T-tests within an ANOVA framework to calculate p-values. Figure 1 presents the mean and standard deviation of student responses on a 5-point scale (5 = strongly agree, 1 = strongly disagree). Results revealed statistically significant improvements in targeted areas. Post-course, students reported increased knowledge of chemical engineering career opportunities, job market requirements, and clearer post-graduation goals, aligning with the course's objective to help students plan their futures and explore opportunities within their major. Students also reported forming effective peer study groups and gaining awareness of academic support resources, fulfilling the course's community-building goals.

Furthermore, to better understand students' views, use and knowledge of GenAI, five statements were assessed in the pre- and post-course survey to rate their level of agreement to the following statements, a Likert scale of 1 being very unlikely/very untrustworthy/strongly disagree to 5 being very likely/very trustworthy/strongly agree. Figure 2 displayed the mean and standard deviation of student responses. The numerical values of the mean and standard deviation in Figures 1 and 2 were displayed supplementally in Table 2.

Student responses revealed statistically significant differences ($p < 0.05$) between pre- and post-surveys in three areas. More students reported planning to use GenAI tools for academic work, viewing GenAI as more trustworthy for academic and engineering coursework (as a learning tool), and having the necessary resources and knowledge to use these tools effectively. However, no significant change was observed in students' trust of GenAI for general usage. Notably, average responses for trustworthiness statements remained between "Moderately untrustworthy" and "Neither trustworthy nor untrustworthy," indicating that students maintain a cautious approach to GenAI tools. This aligned with the course's objective of encouraging responsible GenAI usage than blind adoption. Lecture demonstrations emphasized that while GenAI tools might not provide correct information, they could effectively guide problem-solving approaches. Overall, the course successfully improved students' GenAI literacy and promoted responsible tool usage.

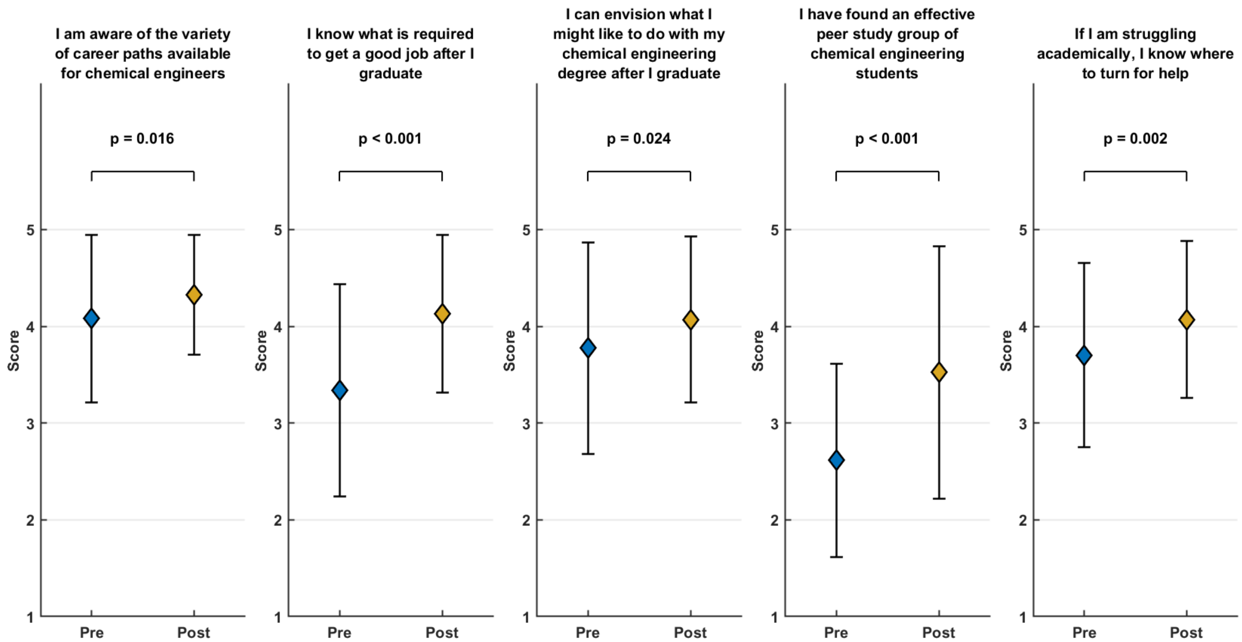

Figure 1. Comparison of mean (with standard deviation) of student agreement to statements regarding their career path (statements 1-3) and academic community (statements 4-5) in pre- and post-survey. Statistically significant differences were observed for all statements ($p < 0.05$).

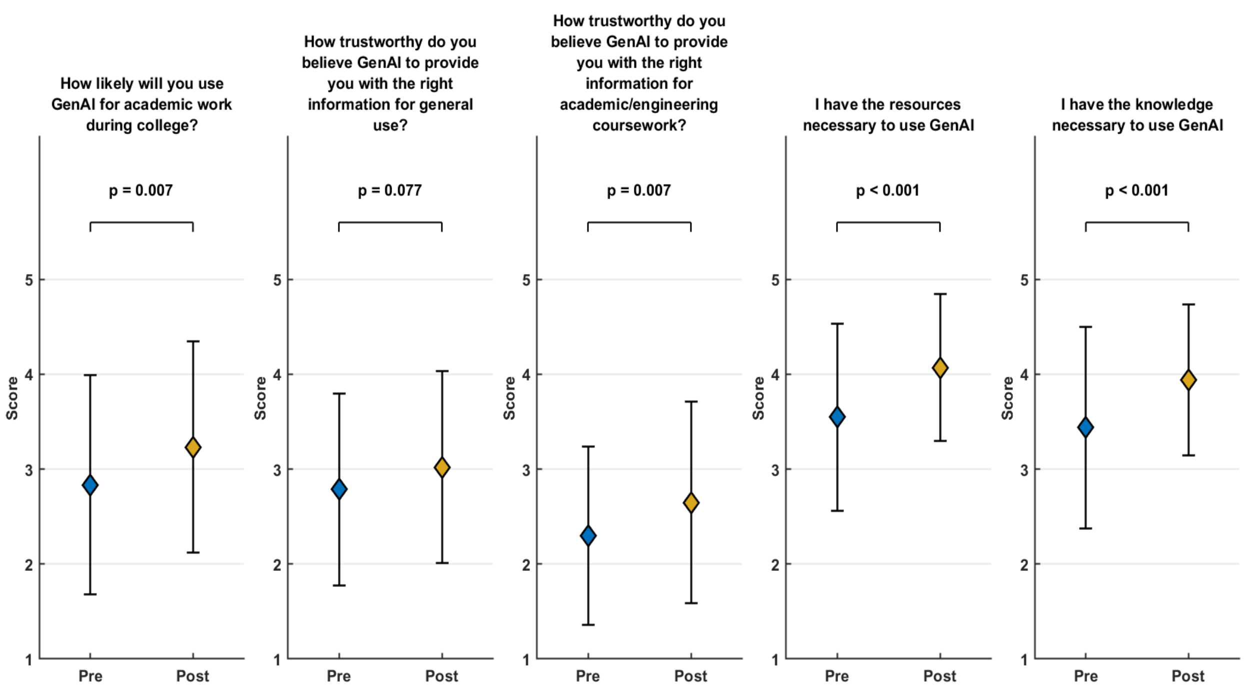

Figure 2. Comparison of mean (with standard deviation) of student response on their view and confidence of using GenAI in pre- and post-survey. Statistically significant differences were demonstrated with p-value < 0.05.

Time	I am aware of the variety of career paths available for chemical engineers		I know what is required to get a good job after I graduate		I can envision what I might like to do with my chemical engineering degree after I graduate	
	Mean ± STD	p-value	Mean ± STD	p-value	Mean ± STD	p-value
Pre-Survey, n = 151	4.08 ± 0.87	0.016	3.34 ± 1.09	< 0.001	3.77 ± 1.09	0.024
Post-Survey, n = 99	4.32 ± 0.62		4.13 ± 0.82		4.07 ± 0.86	

Time	I have found an effective peer study group of chemical engineering students		If I am struggling academically, I know where to turn for help	
	Mean ± STD	p-value	Mean ± STD	p-value
Pre-Survey, n = 151	2.62 ± 0.99	<0.001	3.70 ± 0.95	0.002
Post-Survey, n = 99	3.53 ± 1.30		4.07 ± 0.81	

Time	How likely will you use GenAI for academic work during college?		How trustworthy do you believe GenAI to provide you with the right information for general use?		How trustworthy do you believe GenAI to provide you with the right information for academic/engineering coursework?	
	Mean ± STD	p-value	Mean ± STD	p-value	Mean ± STD	p-value
Pre-Survey, n = 151	2.83 ± 1.56	0.007	2.79 ± 1.01	0.077	2.30 ± 0.94	0.007
Post-Survey, n = 99	3.23 ± 1.11		3.02 ± 1.01		2.65 ± 1.06	

Time	I have the resources necessary to use GenAI		I have the knowledge necessary to use GenAI	
	Mean ± STD	p-value	Mean ± STD	p-value
Pre-Survey, n = 151	3.55 ± 0.98	<0.001	3.44 ± 1.06	<0.001
Post-Survey, n = 99	4.07 ± 0.77		3.94 ± 0.79	

Table 2. Tabular display of comparison of the student perspectives on GenAI, academic community and career path from the pre-survey and post-survey. The highlighted values in green indicate $p<0.05$, demonstrating a significantly higher mean at the end of the course.

Conclusion:

In summary, analysis of the Fall 2025 survey responses revealed that while this seminar-based course effectively introduced students to chemical engineering and potential career options, students commonly requested more active and hands-on learning. The current format successfully exposes students to diverse perspectives and the ethical use of generative AI; however, many students expressed a desire for more engaging activities to address limited peer interaction and occasional disengagement. To improve the course's future iterations, project-based learning utilizing GenAI tools will be integrated to enhance motivation and provide practical experience while maintaining core objectives such as building community and promoting professional development. Overall, the course successfully met its objectives and served as a meaningful foundation for incoming chemical engineering students as they began their transition into university life.

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Appendix - Course Survey:

Survey Questions

What factors influenced your decision to major in engineering? (Select all that apply)

☐ Interest in design/understanding how things work

☐ Financial

☐ Mentor influence

☐ Familial influence

☐ Pre-college experience/coursework

☐ Desire to help society

☐ Technically challenging major

☐ Interest in hands-on/lab-based learning

☐ Other: ____________________________

Please explain your answer (optional):

How likely will you use GenAI for academic work during college?

○ Very unlikely

○ Moderately unlikely

○ Neither likely nor unlikely

○ Moderately likely

○ Very likely

How trustworthy do you believe GenAI to provide you with the right information for general use?

○ Very untrustworthy

○ Moderately untrustworthy

○ Neither trustworthy nor untrustworthy

○ Moderately trustworthy

○ Very trustworthy

How trustworthy do you believe GenAI to provide you with the right information for academic/engineering coursework?

○ Very untrustworthy

○ Moderately untrustworthy

○ Neither trustworthy nor untrustworthy

○ Moderately trustworthy

○ Very trustworthy

Please indicate the extent to which you agree or disagree with the following statements:

I have the resources necessary to use GenAI

○ Strongly disagree

○ Disagree

○ Neither agree nor disagree

○ Agree

○ Strongly agree

I have the knowledge necessary to use GenAI

○ Strongly disagree

○ Disagree

○ Neither agree nor disagree

○ Agree

○ Strongly agree

Please indicate the extent to which you agree or disagree with the following statements. *

Statement	**Strongly Disagree**	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
I am aware of the variety of career paths available for chemical engineers	○	○	○	○	○
I know what is required to get a good job after I graduate	○	○	○	○	○
I can envision what I might like to do with my chemical engineering degree after I graduate	○	○	○	○	○
I have found an effective peer study group of chemical engineering students	○	○	○	○	○
If I am struggling academically, I know where to turn for help	○	○	○	○	○

When thinking about the course, how important were the following lectures/presentations to your course experience?

Presentation / Lecture	Very unimportant	Unimportant	Somewhat important	Important	Very important
Introduction to the Dept. of Chemical and Biomolecular Engineering at UCI	○	○	○	○	○
Introduction to the Chemical Engineering Curriculum	○	○	○	○	○
AIChE Student Club and Project Presentation	○	○	○	○	○
Career Pathways for Chemical Engineers	○	○	○	○	○
Industry/Alumni Guest Speakers	○	○	○	○	○
Presentation from Office of Outreach, Access and Inclusion	○	○	○	○	○

Undergraduate Research Opportunities in Chemical Engineering	◯	◯	◯	◯	◯
Academic/Professional Integrity and GenAI in Engineering	◯	◯	◯	◯	◯
Introduction to Machine Learning	◯	◯	◯	◯	◯
Presentation from Career Center	◯	◯	◯	◯	◯