Career Readiness: Integrating NACE Career Competencies in engineering courses

Prof. Ryan C Cooper, University of Connecticut

Professor Ryan C. Cooper is an Assistant Professor-in-Residence at the University of Connecticut in the Mechanical Engineering Department. Professor Cooper teaches a number of core mechanical and manufacturing courses.

Career Readiness in the classroom: Integrating NACE Career Competencies

Abstract

This study investigates the early outcomes of incorporating the National Association of Colleges and Employers (NACE) Career Competencies framework into engineering courses. More than three quarters of engineering students are seeking career advancement or career changes with engineering degrees. The integration of NACE Career Competencies helps translate ABET student outcomes into practicable career readiness strategies. The courses used projects and guided reflection students to practice eight career competencies: Career and Self Development, Communication, Critical Thinking, Equity and Inclusion, Leadership, Professionalism, Teamwork, and Technology. Preliminary observations from student reflections and advising interviews suggest students are intrinsically motivated to connect course exercises to career competencies. This study provides a valuable foundation for ongoing investigations into the potential benefits of incorporating career competencies in engaging engineering students and building lifelong learners.

Introduction

Career skills are one of the key learning outcomes students hope to gain during their academic careers. The narrative many university programs rely on is that getting a degree will lead to better work outcomes[1]. As faculty, we are the second most likely source of career advice for students[1]. By discussing career skills in the classroom, we can create more equal opportunities for students that may not have existing professional networks from their family and friends. Specifically addressing perceived career barriers to first generation college students[2].

Connecting classroom concepts to lived experience is crucial in creating neuron paths to reinforce learning[3]. John Dewey was an influential philosopher and educator that pushed the idea of education as experience[4]. Dewey's philosophy of experience in education now has strong empirical evidence of support. In a study on remembering soccer scores, participants that were already familiar with the sport and its players were able to remember new scores with higher accuracy than those with little to no knowledge about soccer[5]. Medical student exam scores increase when notes are provided by instructors and students are required to connect the concepts[6,7]. The practice of connecting information leads to better academic performance and better learning experiences.

As faculty, we can provide connecting examples, but students must practice connections on their

own. It is better for student learning if instructors do not create all of the learning connections[8]. Students can struggle to connect course topics and recognize underlying concepts because they are still new to the field of inquiry[9]. As instructors, we can help students build connections by creating opportunities to connect material to lived experience and professional goals.

One of the most common objectives for undergraduate students is to pursue career goals. Surveying 2378 bachelor's students, 73% cite job payment and skills are the reason for their degree as opposed to the 64% that are seeking personal fulfillment from the program[1]. In any given classroom, there will around 2 out of three students that have general interest in topics, but 3 out of 4 students are actively seeking career advancement skills. By aligning student outcomes with skills that advance students' careers, we can create intrinsic motivation in the classroom.

Relevant career skills are defined in this study by the National Academy of Colleges and Employers (NACE) called career competencies:

- Career and Self development: Proactively develop oneself and one's career through continual personal and professional learning, awareness of one's strengths and weaknesses, navigation of career opportunities, and networking to build relationships within and without one's organization
- Communication: Clearly and effectively exchange information, ideas, facts, and perspectives with persons inside and outside of an organization.
- Critical Thinking: Identify and respond to needs based upon an understanding of situational context and logical analysis of relevant information.
- Equity and Inclusion: Demonstrate the awareness, attitude, knowledge, and skills required to equitably engage and include people from different local and global cultures. Engage in anti-racist practices that actively challenge the systems, structures, and policies of racism
- Leadership: Recognize and capitalize on personal and team strengths to achieve organizational goals.
- Professionalism: Knowing work environments differ greatly, understand and demonstrate effective work habits, and act in the interest of the larger community and workplace.
- Teamwork: Build and maintain collaborative relationships to work effectively toward common goals, while appreciating diverse viewpoints and shared responsibilities.
- Technology: Understand and leverage technologies ethically to enhance efficiencies, complete tasks, and accomplish goals.

These career competencies can map directly to the Accreditation Board for Engineering and Technology (ABET) student outcomes[10]:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social,

environmental, and economic factors.

3. an ability to communicate effectively with a range of audiences.
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

This direct mapping presents an opportunity to create intrinsic motivation in students. Engineering courses have to document and assess the ABET learning outcomes to remain accredited. Typically, this work is invisible to students and continuous improvement processes do not actively incorporate student voices. The main benefit of this exercise is to establish vocabulary that is consistent between administrative (ABET) goals, faculty goals (motivation of students), and student goals (career competencies).

Methods

In this approach, the student learning outcomes were mapped to career competencies and communicated to students in Mechanical Engineering Computational Mechanics and Civil Engineering Dynamics. Students were asked to provide feedback in week 8 and week 15 in a 15-week semester. Career-related feedback was optional in week 15. The mapping between student outcomes and career competencies is organized in Table 1. Some of the ABET student outcomes and NACE career competencies map directly, e.g. Communication, while others might use a combination of outcomes and experiences. e.g. outcome 6 could include technology and critical thinking and communication, but it was mapped to just technology. Leadership, although very important, cannot be assessed in most courses so it is not included as a student outcome; if it is not directly assessed its difficult to track its effectiveness.

I used text vectorizing and k-means clustering to identify topics described by students in the mid-semester survey.

The optional response in week 15 was collected to understand the student voice in identifying assignments that align with career competencies and mapped those directly to ABET student outcomes.

Results and Discussion

The mid-semester results reveal that students were able to connect classroom assignments and activities across all career competencies. On average, students identified 5-6 career competencies

Table 1: Map of ABET student outcomes to NACE career competencies.

ABET outcome	Career Competency
1. identify, formulate, and solve engineering problems	Critical Thinking
2. apply engineering design...that meet specified needs with consideration of public health, safety, and welfare	Professionalism
3. Communicate effectively	Communication
4. recognize ethical and professional responsibilities	Equity and Inclusion
5. function effectively on a team	Teamwork
6. develop and conduct appropriate experimentation...interpret data, and use engineering judgement	Technology
7. Acquire and apply new knowledge	Career and Self Development
not directly assessed	Leadership

that they practiced during studying, projects, and homeworks. I do not directly assess leadership and its not directly covered by ABET student outcomes, but 26% of students still connected this career competency to the course as seen in Fig. 1. Fig. 1 demonstrates that students were able to connect course content to their experiences in preparing for engineering careers. In Table 2, students shared anecdotes of specific skills they used. The majority of students mentioned improving critical thinking through "problem solving" and teamwork/communication in "working with others to improve assignments", 25% and 27% respectively.

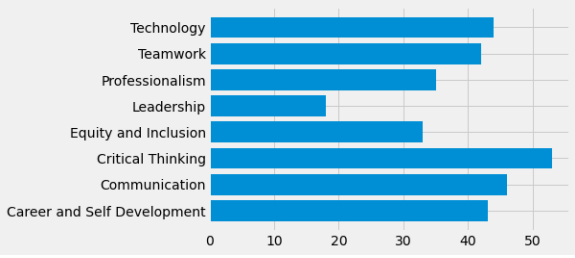
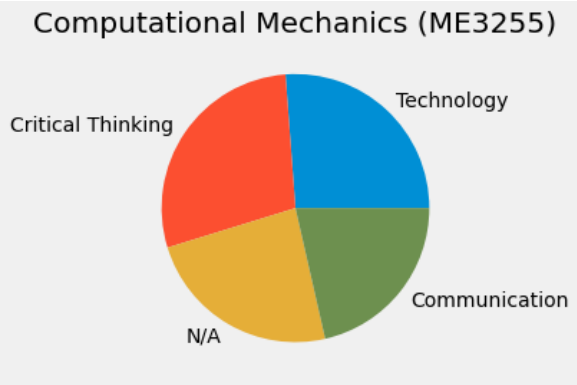


Figure 1: Mid semester connection results for students. A total of 143 students were asked to connect class to career competencies. On average students connected 5-6 competencies to course activities, assignments, and projects.

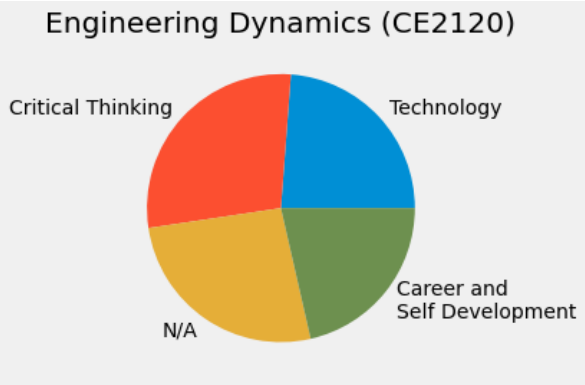
At the end of the semester, students were asked to voluntarily connect one assignment to a career competency. In Fig. 2, two classes are compared where different competencies were foci. In both

Table 2: Mid semester clustered free responses for students to describe 'Can you share an example of when you practiced or improved one of these career competencies in the course (this response would be great to share in an interview/job fair/networking event)?'

response group	number of responses	percent
general self development	16	8%
improved workflow with technology	33	16%
communicated technical issues	48	24%
developed better problem solving	51	25%
work with others to improve assignments	55	27%



(a) Junior/Senior level computational course.



(b) Sophomore/Junior level dynamics course

Figure 2: End of semester optional connection exercise. Students that responded included a pdf of an assignment, anecdote on how it demonstrated the career competency, and the connection to a career competency.

courses more than 75% of the students submitted an assignment and connected it to a career competency. This result is directly in line with current career data that 73% of students cite job payment and skills as a primary reason to enroll in a bachelor program[1].

Conclusions

The initial results described in this paper suggest that students are intrisically motivated to connect their classroom experience to career competencies. The course assignments, activities, and projects are all still aligned with ABET student outcomes, but because they have been mapped to NACE career competencies students are shown direct connections between course outcomes and career outcomes. The main benefit of this exercise is to establish vocabulary that is consistent between administrative (ABET) goals, faculty goals (motivation of students), and student goals (career competencies).

This data collection process could enable students to continuously provide feedback on assignment alignment with career competencies. Here, the data demonstrates different alignment in two classes, but if more courses were contained in the study, programs could monitor the perception of students on career competency alignment. As changes are made to the curriculum,

prerequisites, and even instructor improvements, departments could monitor the breadth of coverage across career competencies. Because career competencies are mapped to ABET student outcomes, departments would have continuous data collection to document alignment and continuous improvement of courses.

References

[1] The state of higher education in 2023, gallup & lumina, 2023.

[2] Teru Toyokawa and Chelsie DeWald. Perceived career barriers and career decidedness of first-generation college students. *The Career Development Quarterly*, 68(4):332–347, 2020.

[3] James E Zull. *The art of changing the brain: Enriching the practice of teaching by exploring the biology of learning*. Stylus Publishing, LLC, 2020.

[4] John Dewey. *Experience and education*. 1986.

[5] Peter E Morris, Michael M Gruneberg, Robert N Sykes, and Anna Merrick. Football knowledge and the acquisition of new results. *British Journal of Psychology*, 72(4):479–483, 1981.

[6] Anneh Mohammad Gharravi. Impact of instructor-provided notes on the learning and exam performance of medical students in an organ system-based medical curriculum. *Advances in Medical Education and Practice*, pages 665–672, 2018.

[7] Tara L Cornelius and Jamie Owen-DeSchryver. Differential effects of full and partial notes on learning outcomes and attendance. *Teaching of Psychology*, 35(1):6–12, 2008.

[8] Stephanie McGuire, Saundra Yancy McGuire, and Thomas Angelo. *Teach students how to learn: Strategies you can incorporate into any course to improve student metacognition, study skills, and motivation*. Routledge, 2015.

[9] Susan A Ambrose, Michael W Bridges, Michele DiPietro, Marsha C Lovett, and Marie K Norman. *How learning works: Seven research-based principles for smart teaching*. John Wiley & Sons, 2010.

[10] 2024-2025 criteria for accrediting engineering programs, abet, 2024.