

Impact of Mentoring and Skills Sessions on Student Professional Preparation

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Introduction

To be successful in their chosen careers, engineers require both technical expertise and complementary skills like the ability to communicate effectively, to both lead and contribute to teams, and to manage interpersonal dynamics and potential conflicts. ABET, the primary accrediting body for engineering programs in the U.S., includes many of these skills the current student outcomes for engineering programs, shown in Table 1¹. While the specific wording of the ABET outcomes changes periodically, they have included non-technical components since a major revision in 2000. At that time, Shuman² provided an overview of the new outcomes as well as potential methods for teaching and assessing.

Table 1: Current ABET student outcomes for engineering programs¹.

an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	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.
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.	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
an ability to communicate effectively with a range of audiences.	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
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.	

Outside the accreditation process, employers of engineering graduates regularly provide their perspective regarding the importance of skills beyond math and science for career success. Sometimes referred to as ‘soft’ skills or ‘professional skills’ these traits are also referred to in the literature as ‘transversal competencies’³. In 2005, Martin et al. reported on a study with a small

group of chemical engineering graduates in South Africa who self-assessed their preparation in both technical expertise and transversal competencies after entering the professional workplace. Skills like teamwork, leadership, and management were reported as generally weaker than other skills³. Ramadi and co-workers noted significant gaps between expectations from engineering managers and the skills of new engineering graduates, particularly in communication, time management, and continuous learning⁴. Craps et al. brought together professionals from human resource departments as well as practicing engineers to outline key traits and competencies based on specific job roles within engineering⁵. Mohan et al. implemented a professional skills seminar at the graduate level based on observations and feedback related to gaps in transversal competencies in new graduate students⁶. Cruz and co-workers provide an overview of recent work to assess the implementation of transversal competencies into engineering education with the goal of making definitions and assessment methods more uniform⁷.

Most transversal competencies involve cultivating and understanding of human behavior – time management (understanding yourself), teamwork (understanding yourself and others), leadership (understanding yourself and others), etc. Mentoring can be an effective technique to help less experienced individuals understand where their competency gaps lie and how those gaps could be overcome. A variety of studies are available in the literature with respect to the impact of mentoring programs on the development of future professionals, including future engineers⁸⁻¹⁴. Research shows that mentoring programs hold great promise, but that setting expectations for both student protégés and mentors is critical for overall program success and individual participant impact. Eller et al. report results from a study of mentoring across multiple institutions showing that key components of an effective mentoring relationship (regardless of the discipline) include open communication, accessibility, mutual trust and respect, setting goals and challenges, both independence and collaboration, and an exchange of knowledge¹².

The remainder of this paper describes the implementation of a program that integrates skills sessions focused on transversal competencies with mentoring by engineering and applied sciences alumni to improve students' knowledge, confidence, and expertise as future professionals. Included are student responses regarding the value of the program after one semester of participation.

Methods

The Western Michigan University (WMU) College of Engineering and Applied Sciences (CEAS) undertook creation of the Professional Skills Program (PSP) with the following goals:

- Increase student protégé confidence in their chosen major/profession
- Increase student protégé knowledge of their chosen major/profession
- Prepare protégés for their chosen profession by expanding their toolkit of professional skills
- Broaden the professional network of protégés
- Improve protégé academic and professional success
- Increase mentor connections to the college

The PSP comprises two components – one-on-one mentoring of current students in the college by alumni and six professional skills sessions held approximately monthly throughout the academic year. A prior iteration of the program was focused solely on mentoring¹⁵; skills sessions were added this year with the goal of attracting additional student interest and increasing the overall value for program participants. Students who successfully complete the program (defined as year-long interactions with their assigned mentor and attending at least three of the skills program sessions over the course of the year) receive a letter of acknowledgement from the dean of the college. The Marquette Mentors Program¹⁶ was a significant source of inspiration in the design of the mentoring component of the program, including expectations and training for both mentors and students.

Starting in late spring 2023, applications were solicited from any interested students in CEAS. Interested students were asked what they hoped to gain from the program overall as well as from the mentoring experience specifically. Additionally, students were asked about their preferred format for meeting with their mentors (virtual vs. in-person), preferred days/times of the week for meetings, and any special statuses they felt would be helpful in finding an appropriate mentor (transfer student, international student, first-generation, veteran, underrepresented minority, etc.). In parallel, interested alumni were encouraged to volunteer as mentors. Student protégé acceptance into the program was based on both expressed interest and the availability of an appropriate mentor. Some mentors articulated an interest in focusing on protégés in specific majors and some were open to working with students from any program. Most students expressed a preference to work with mentors in their major or a closely related field. Protégés were matched with mentors based on typical availability during the week, major, and any special statuses. Over thirty students applied for the 2023-2024 Professional Skills Program. Nineteen protégés and eighteen mentors were ultimately matched. The primary reason for non-selection of students was lack of mentor availability, particularly for students in aerospace engineering and computer science, both current areas of enrollment growth.

Separate online training sessions at the start of the Fall 2023 for both the alumni mentors and the student protégés stressed the fact that the students should be the primary drivers for the mentoring relationship; mentors and protégés work together to agree on meeting schedule, format, etc., but students have the final say on topics and content based on their needs and interests. Protégés in the PSP are expected to take the lead in setting agendas for meetings with their mentor and in determining topics to be discussed. Mentors and protégés are expected to interact at least twice per month with at least one of the interactions being ‘live’ (in-person or via phone call or teleconferencing). Appropriate length of meetings was left up to each protégé / mentor pair. Following an introductory email putting each protégé in contact with their mentor by the author, the mentoring process was left largely up to the protégés and mentors except for a November email check-in to make sure the process was working smoothly.

The topics for the skills sessions during the 2023-2024 academic year are listed in Table 2. Topics were intentionally organized with fall sessions being more focused on individual skills and spring sessions being more focused on interpersonal/group skills.

Table 2: PSP skills session topics for 2023-2024.

Fall 2023	Spring 2024
Critical Thinking	Teamwork
Professional Communication	Interpersonal Conflict
Time Management	Leadership

For the Fall 2023 PSP sessions, the first, Critical Thinking, was delivered in-person by the author. The other two sessions were delivered remotely by CEAS alumni over WebEx with the author and another college representative (the Chief Development Officer) in attendance. Each session lasted approximately one hour. Virtual sessions were recorded and students who were not able to attend live were given the option to view them later. For the Critical Thinking session, materials used were made available for participants to review, but the presentation and discussion of the session were not recorded.

At the end of the Fall 2023 semester, all PSP student participants were invited to complete a short survey regarding their experience in the program to date. Questions asked about their level of engagement with each of the skills sessions, their perceived value of each session, the value of their mentoring interactions, and overall feedback regarding the program. Survey responses were a mix of Likert ratings and open-ended input. Seven PSP participants responded, a response rate of 36.8%.

Results and Discussion

Applicants to the 2023-2024 Professional Skills Program cited a number of reasons for their interest. These included networking or forming connections with industry professionals, gaining insights to help with securing internships, cooperative education placements, or full-time jobs, and receiving general career advice. Applicants also identified potential areas of interest with regards to skills sessions. The most commonly cited was working on a team, followed by issues of leadership and management as well as communication and conflict resolution. Overall, there seemed to be good alignment between student expectations for the program and the goals of the college in facilitating the program.

Protégés represented a variety of demographics, were drawn from programs across the college and were at various levels of degree progression during the Fall 2023 semester. Seven protégés were female (36.8%) and 12 were male. Five were international students (26.3%) and 11 reported their race/ethnicity as ‘white’ (57.9%). Undergraduate majors represented in the group included aerospace engineering (2), chemical engineering (1), civil engineering (1), computer engineering (1), computer science (1), electrical engineering (1), engineering management technology (2), industrial and entrepreneurial engineering (5), mechanical engineering (4). One student was a first-year, first semester student. Four were classified as sophomores, two were juniors, and 11 were seniors. One protégé was a doctoral student in computer science.

Of the protégés who responded to the Fall 2023 survey, four were female (57.1%), five were white (71.4%), and they represented the aerospace engineering, chemical engineering, industrial and entrepreneurial engineering, and mechanical engineering programs.

Table 3 shows the number of participants in each of the Fall 2023 skills sessions. Viewing of the recorded sessions was not monitored. Only the ‘live’ numbers were measured directly. Other data is based on student feedback via the end-of-semester survey. Every protégé attended at least one session live during the fall semester with the average number of sessions attended being 2.3. Nine of the nineteen protégés attended all three sessions live (47.4%).

Table 3: Fall 2023 PSP skills session participation

Skills Session	Attended Live	Viewed Later	Unknown
Critical Thinking	14	1	4
Professional Communication	14	1	4
Time Management	15	2	2

Of the seven Fall 2023 survey respondents, five indicated that they had interacted live with their mentor multiple times over the course of the semester. All of these students rated the value of their mentoring experience at four or five (out of five) with an average of 4.5 (five being significant value). Open-ended responses highlighted the value of specific insights and advice provided by their mentor as well as general motivation provided by the mentoring interactions. One respondent had not yet interacted with their mentor when the author performed a mid-November check-in with both mentors and protégés. This appeared to be the result of a miscommunication between protégé and mentor. Once this was cleared up, they were able to meet live once prior to the end of the fall semester and the protégé ranked the value at five out of five based on their discussion of goals and potential future career paths. The seventh respondent was not able to connect with their mentor due to personal time constraints and a lag in responses from the mentor. As a result, the protégé requested to drop-out from the mentoring portion of the program and continue to attend the skills sessions.

Table 4 shows the average values reported for each of the skills sessions with respect to both engagement and perceived value. Likert scale responses ranged from one to five with one representing no engagement/value and five representing significant engagement/value.

Table 4: Protégé perceptions of engagement and value of Fall 2023 skills sessions.

Skills Session	Avg Engagement (Median / Mode)	Avg Value (Median / Mode)	# Attending (Live)
Critical Thinking	3.7 (3.5 / 3)	3.9 (4 / 3)	7 (7)
Professional Communication	3.8 (3.5 / 3)	3.8 (3 / 3)	5 (4)
Time Management	3.4 (3 / 3)	3.4 (3 / 3)	7 (5)

Results in Table 4 show similar levels of engagement and perceived value for all sessions with slightly lower values for the third session, Time Management. Due to the small sample size, any differences may not be statistically significant. One takeaway is that there does not seem to be an inherent difference in engagement or perceived value based on modality (Critical Thinking was presented in-person in a discussion/workshop format and Professional Communication and Time Management were presented via WebEx in a presentation/discussion format). Similarly, attendance (Table 3) was consistent for both in-person and virtual sessions.

Protégés were also asked how likely they would be to recommend participation in the Professional Skills Program to other students in CEAS. The average response was 4.1 out of five, indicating that most students would recommend participating in the program to their peers. When asked for details regarding the basis of their choice to recommend (or not), the mentoring experience was highlighted by four respondents. The skills sessions were highlighted by two respondents and interactions with fellow students were highlighted by one. The respondent who was not able to connect with their mentor rated likelihood of recommending the program at two out of five, citing both the mentoring issues and a general disappointment with the structure and content of the skills sessions.

Summary and Future Work

Through the midpoint of the academic year, participants in the CEAS Professional Skills Program at Western Michigan University report generally favorable experiences. The vast majority of participants are actively engaged with their mentor and with the skills program sessions. In addition to value for program participants, the CEAS Professional Skills Program has provided a vehicle to engage with alumni as both mentors and skills session facilitators. The latter has allowed participants to learn from professionals beyond the bounds of campus or the typical classroom. However, it also means ceding control with respect to structure and content of the sessions. The three fall session presenters (including the author) each had their own structure and approach. While there is nothing inherently wrong with this, it creates a somewhat less coherent feel than if the format and delivery of each session was consistent.

Participants in the CEAS Professional Skills Program will be invited to participate in a second survey at the end of the Spring 2024 semester. In addition to questions similar to the fall survey, the next version will also be asked about overall impressions of the program, whether it met their needs and expectations, areas in which they perceive the most growth as a result in participating in the program, and suggestions for future improvements.

For future iterations of the PSP, one potential modification will be to explicitly integrate discussions about engineering in a global marketplace into one or more of the skills sessions. The importance of a global competency for engineering success has been suggested by a number of authors including Lohmann et al.¹⁷. Alumni with experience in engineering collaborations across international borders will be solicited to share their experiences with participants along with suggestions about how best to prepare for succeeding in a global profession.

References

- [1] Criteria for Accrediting Engineering Programs 2024-2025. ABET. <https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2024-2025/>, accessed January 28, 2024.
- [2] Shuman, L., et al. (2005). "The ABET "Professional Skills" - Can They Be Taught? Can They Be Assessed?" *Journal of Engineering Education* **94**(1): 41-55.
- [3] Martin, R., et al. (2005). "Engineering graduates' perceptions of how well they were prepared for work in industry." *European Journal of Engineering Education* **30**(2): 167-180.
- [4] Ramadi, E., et al. (2016). "Engineering graduates' skill sets in the MENA region: a gap analysis of industry expectations and satisfaction." *European Journal of Engineering Education* **41**(1): 34-52.
- [5] Craps, S., et al. (2021). "Different roles, different demands. A competency-based professional roles model for early career engineers, validated in industry and higher education." *European Journal of Engineering Education* **47**(1): 144-163.
- [6] Mohan, A., et al. (2010). "Professional Skills in the Engineering Curriculum." *IEEE Transactions on Education* **53**(4): 562-571.
- [7] Cruz, M. L., et al. (2020). "Evaluation of competency methods in engineering education: a systematic review." *European Journal of Engineering Education* **45**(5): 729-757.
- [8] Skrzypek, C., et al. (2019). "Mentoring Connections: Implementing a Student–Alumni Mentor Program in Social Work." *Journal of Social Work Education* **55**(3): 449-459.
- [9] Skrzypek, C., et al. (2020). "Formalizing Alumni Mentoring in Social Work Education: Lessons Learned From a Three-Year Program Evaluation." *Journal of Social Work Education*. DOI: 10.1080/10437797.2020.1817820.
- [10] Crisp G. and I. Cruz. (2009). "Mentoring College Students: A Critical Review of the Literature Between 1990 and 2007." *Research in Higher Education* **50**: 525-545. DOI 10.1007/s11162-009-9130-2.
- [11] Jacobi, M. (1991). "Mentoring and Undergraduate Academic Success: A Literature Review." *Review of Educational Research* **61**(4): 505-532.
- [12] Eller, L.S., E.L. Lev, and A. Feurer. (2014). "Key components of an effective mentoring relationship: A qualitative study." *Nurse Education Today* **34**: 815-820.
- [13] Dollinger, M., S. Arkoudis, and S. Marangell. (2019). "University alumni mentoring programs: a win-win?" *Journal of Higher Education Policy and Management* **41**(4): 375-389. DOI: 10.1080/1360080X.2019.1617657.
- [14] Baier, S.T., B.S. Markman, and F.M. Pernice-Duca. (2016). "Intent to Persist in College Freshmen: The Role of Self-Efficacy and Mentorship." *Journal of College Student Development* **57**(5): 614-619.
- [15] Cavalli, Matthew and A. Grice. (2023). Impact of Mentoring on Student Success. Proceedings of the 2023 ASEE North Central Section Conference. Morgantown, WV.
- [16] Marquette Mentors, <https://alumni.marquette.edu/marquette-mentors>, accessed February 27, 2024.
- [17] Lohmann, J. R., et al. (2006). "Defining, developing and assessing global competence in engineers." *European Journal of Engineering Education* **31**(1): 119-131.