Work in Progress: Transforming the Freshman Engineering Experience through Peer-Mentorship and Professional Competency Workshops

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Work in Progress: Transforming the Freshman Engineering Experience through Peer-Mentorship and Professional Competency Workshops

Introduction

This work-in-progress paper describes the research initiative to enhance a first-year engineering courses by incorporating peer-mentorship and professional competency workshops. The engineering profession keeps positively evolving, which consequently creates a need for improving current teaching and learning methods to holistically educate future engineers. In Engineering education, we are still in a state of transformation intended to define the most appropriate approaches to educating future engineers. The emerging challenges and demands in engineering fields require future professionals to have a broader skillset including technical knowledge, professional competencies, leadership identities, and autonomy. However, engineering faculty faced major challenges trying to include alternative, yet essential professional skills in their curricula, while balancing the demands for increasing technical content. At the University of Texas at El Paso, the introduction of the Leadership and Engineering Education department created a strategic education environment to innovate and prepare engineering students to succeed professionally as autonomous and critically thinking engineers and leaders [1].

Introductory university courses, regardless of the academic major, could play a significant role in solidifying the career preparedness, academic motivation, persistence, and foundational professional skills of undergraduate students to satisfactorily navigate their academic programs and professional careers [2] [3]. Given the evidence-based research on the impact of interventions that support undergraduate students' persistence and academic success, the curriculum design of an introductory course in Leadership and Engineering Education program was modified in this study. This study reports the impact of professional competency workshops and peer-to-peer mentorship to transform the first-year experience of our engineering students.

The Center for Research in Engineering and Technology Education (CREaTE) in conjunction with the Engineering Leadership and Innovation department from the University of Texas at El Paso are spearheading this research initiative. The STEMShine grant is a driving financial force that propels the CREaTE team to conduct this research initiative. As the study continues this research represents a collaborative merger, at the intersection of interdisciplinary research, through its unique blend of various levels of institutional support and grant funding.

Importance of professional competencies in engineering education

National agencies and organizations including the Accreditation Board for Engineering and Technology, National Academy of Engineering, National Science Foundation, American Society of Engineering Education and among other constituents have stressed the importance of developing the new generation of engineers with skills appropriate to function in a global engineering profession. The list of professional competencies essential for future engineers is enormous and every competency is critical, which can include communication skills [4, 5]; critical thinking [6, 7]; computer skills [8]; time management [9], leadership [10, 11], and among

others. However, including educational activities to exercise every professional competency in a single class curriculum could be overwhelming for faculty and students. Without forgetting the importance of the fundamental technical content of an engineering curriculum, faculty must strategically revamp the curriculum to also exercise professional competencies as part of the students' learning experience [10]. For first-year engineering students, our study proposed to investigate the inclusion of communication, resume building, motivation and time management, and campus involvement. These professional skills and activities were considered essential to transform the transition of our students from high school to their first experience in an engineering program.

The impact of peer mentoring on first-year engineering experience

The implementation of a peer mentoring component was deemed necessary to facilitate a support system for our first-year freshman engineering students enrolled in our Leadership and Engineering Education class. Several studies have shown that peer mentoring can contribute to successful transitions from high school to college [12], [13], as well as to increase student retention, motivation, and success in engineering programs [14], [15], [16], [17]. Holt and Berwise [18], results indicate that, mentored students' grades improved significantly and correlated well with the perceived emotional, academic, and role model support they received from their mentors. Additional alternative benefits from peer-mentoring were reported as mentees gaining insight into courses, received tips and advice on how to better navigate the university system [19], and felt more comfortable and less intimidated talking to peer mentors than faculty [20]. Peer mentoring offers many advantages including flexibility, inclusiveness, knowledge sharing, interdependence, networking, a safe environment, skills development, personal growth, and friendships [17]. The inclusion of professional competency workshops coupled with a peer-to-peer mentoring framework is considered to enrich the engineering experience through a supportive and personalized learning environment.

Objectives and scope of work

The goal of this study is to investigate an engineering education model that can help to transform the first-year experience of engineering students and impact their career preparedness, academic motivation, persistence, and professional competencies. The primary objective of this work-in-progress paper is to report the preliminary findings from incorporating professional and academic development workshops into the curriculum of an introductory engineering class. In addition, this paper discusses the importance of a peer-to-peer mentorship program, specifically focusing on utilizing the course teaching assistants (TAs) as role models and mentors. The students' demographic data, the development workshop topics and content, and the impact and overall effectiveness of the interventions implemented in this study are discussed. The research project explores the implications of future iterations that integrate the lessons learned from this analysis and propose the next steps to ensure a replicable positive impact on the students.

Methodology

Overview of Introductory Engineering Course

At the University of Texas at El Paso, first year engineering students had to take an introductory course as part of the engineering curricula. The UNIV 1301 "Critical Inquiry" intends to support the acclimation of freshmen students to their college journey. However, this course was designed

with a general curriculum for students from all majors. Nevertheless, this introductory university course was considered appropriate to provide first-year engineering students with learning experiences that could impact not only their college journeys but also their preparedness for academic and professional careers in engineering. As such, faculty from the Leadership and Engineering Education department have been investigating promising strategies to adapt the curriculum design for the UNIV 1301 course and provide entering engineering students with the experiential learning and professional skills required for a future career in engineering. More details about initial efforts to transform the curriculum design of the introductory engineering course can be found in [1] and [3].

Now the introductory engineering class is known as the Engineering Leadership (EL) 1301 and has the following course description:

> *"Through the new introductory engineering course, students will gain a foundation of knowledge of innovation, technological and leadership advancement in modern society, develop principles of personal, professional and social responsibility for living in a diverse world, and advance intellectual and practical skills that are essential for all learning."*

The major changes in the new curriculum design were the core learning objectives, which were defined as follows:

1) Critical Thinking. Students will be taught engineering design thinking and mathematical problem-solving skills. Students will be prompted to explain their reasoning when working through engineering problems and ask critical questions about the role of engineers in society, innovation, and leadership practices.
2) Empirical and Quantitative Skills. Students will explore the visualization and analysis of numerical data to evaluate innovative alternatives and use observable facts resulting in informed conclusions. Engineering development propositions will include business analytics, accounting and reliability functions, and engineering systems.
3) Teamwork Competencies. Students will practice the value of teamwork, which is common in engineering environments. Students will understand that teamwork promotes:
    a. Development of an ethical mindset and ability to seek assistance to get the job done.
    b. Collaborative skills, experience, and knowledge to solve challenging problems.
    c. Credibility of solutions derived from multiple perspectives.
    d. Learning from and professional development for team members.
    e. Better communication, trust, support, and a positive working environment.
4) Communication: Students will exercise their communication skills in oral and written forms. Students will learn to practice empathetic and respectful communication during discussion sessions, student collaborations, and team project presentations.
5) Social Responsibility. Students will learn about the social responsibility of the engineering profession in terms of the commitment to place, public safety, and interest, ahead of all considerations. Students will value intercultural competence, civic responsibility, and the ability to engage effectively in regional, national, and global communities.
6) Personal Responsibility. Students will develop the ability to connect choices, actions, and consequences to the ethical decision-making responsibilities of engineers. Students will become aware of the different roles their profession and personal life will play in additional

responsibilities such as environmental, human rights, philanthropic, social justice, and economic areas.

Description of Intervention components

As it pertains to this paper, four professional development workshops were designed and implemented in 2022 to investigate their contributions to meeting the learning objectives of the new EL 1301 course. The EL 1301 course was taught by a faculty from the Leadership and Engineering Education department. Apart from the curricula of the EL 1301 course, the professional development workshops were embedded in the course. Research assistants for CREaTE facilitated the professional workshops. The overarching goal of the workshop integration into the course is to bridge the gap between theoretical knowledge and practical application of the knowledge. Table 1 provides an overview of each workshop including descriptions and key concepts.

Table 1. Overview of Professional Development Workshops.

Workshop	Descriptions	Key Concepts
Communication	This workshop addresses the need for engineers to be able to communicate complex thoughts and ideas to diverse stakeholders and customers. Through interactive sessions and real-world exercises, students grow their communication skills, and learn how to manage conflict resolution within teams.	• Effective Communication • Conflict Management • Team Collaboration • Professional Presentation Skills • Cultural Communication • Effective Listening • Building Tailored Messages • Feedback and Improvement
Resume Writing	This workshop highlights the need to develop a resume that fits the industry expectations while also standing out to employers, scholarship boards, and other resume reviewers. The focus is on crafting a tailored resume that turns academic achievements into marketable skills to showcase technical and business acumen.	• Tailoring resumes for specific jobs • Format and Structure • Action Verbs • Professional Experience • Resume Review and Editing • Personal Brand in Resumes • Employer Expectations • Continuous Improvement
Motivation and Time Management	This workshop focuses on identifying students' various motivation styles and providing strategies to hone those styles into time management practices that are sustainable for the student. The aim is to empower students by building effective and viable time management habits that will continue past their academic journey.	• Understanding Motivation • Effective Goal Setting • Proactive Time Management • Mindfulness in Time Management • Integration of Motivation into Daily Habits • Utilizing Technology to Stay Accountable • Positive Habits
Get Involved on Campus	This workshop encourages students to get involved and engaged with student organizations, emphasizing the importance of extracurricular	• Benefits of Student Involvement • Identifying Student Organizations • Networking • Leadership Opportunities

	involvement to support their transition into the professional world.	• Community Service • Unique Resources Access

The professional development workshop content was one component of this intervention to promote student success; the other component consisted of a peer-to-peer mentorship program. This mentorship program was led by the teaching assistants (TAs) of the EL 1301 course. The TAs functioned a dual role of facilitating course activities and supporting students in their professional development through mentoring sessions. The TAs (hereafter referred to as "peer mentors"), who have previously taken the course, provide firsthand course experience and their college journey. The mentorship sessions extend beyond academic issues and stretch into career planning tips, internship/scholarship searching, promoting and modeling the professional development workshop learning, and fostering an overall supportive learning environment.

Demographics

The CREaTE team administered a pre- and post-semester survey at the conclusion of the course. The introductory engineering course consisted of three different class sections. In total, 93 students enrolled in the introductory engineering course. From the students enrolled in the course, 74 students completed the survey at the end of the course. Approximately 81% of the students surveyed identify as Hispanic/Latino, 10% identified Bi-Racial/Bi-Ethnic, and 4% identified as White, 3% identified as Native American, 1% identified as Black, and 1% identified as Middle Eastern. Approximately, 66% of students surveyed as male, 31% identified as women, and 3% identified as other.

Results

Resume Writing Workshop

Prior to the course, approximately 55% of the students in the course had a resume, and after the course, approximately 98% of the students had a resume. To evaluate the effectiveness of the resume writing workshop, students rated their confidence level in developing a strong resume utilizing the 5-point scale (refer to the communication workshop section). The survey data shows that prior to the course the average confidence level was 2.51 and after the course the average student confidence level was 3.93. The 56.5% increase in the confidence level of the students means that not only did virtually all students emerge from the course with a resume, but they also feel more confident in their skills to construct one effectively.

Communication Workshop

As part of the communication workshop, students were asked to rate their confidence levels in communicating effectively in various scenarios. The survey question consisted of a 5-point rating scale with 1 representing "Not Confident at all" and 5 representing "Extremely Confident." Table 2 summarizes the students' feedback regarding confidence level in communication. The pre- and post-course survey results are compared and shown in percent change. All scenarios show a positive increase from the pre-course to post-course confidence levels, seen in Table 2.

Motivation and Time Management Workshop

To evaluate the effectiveness of the motivation and time management workshop, Table 3 displays the average pre- and post-course confidence level of each time management activity and

motivational statement as well as the average increase in percentage change across confidence level. There was an average increase in confidence level of 25.9% for all the activities.

Table 2. Summary of Students' Confidence Levels from Communication Workshop

Scenarios	Confidence Levels		
	Pre-Course	**Post-Course**	**Change (%)**
In group/team projects	3.22	4.20	30.4
With individual peers/classmates	3.39	4.13	21.8
With faculty/instructors	3.15	4.15	31.7
With professionals in the students' field	2.67	3.64	36.3
Presenting project information/results to others	2.88	4.04	40.2
Giving constructive feedback to peers/team members	3.01	3.97	31.8

Table 3. Summary of Confidence Levels from Time Management and Motivation Workshop

	Confidence Levels		
Scenarios	**Pre-Course**	**Post-Course**	**Change (%)**
Balancing your time between school, work, family, leisure, etc.	2.55	3.59	40.7
Prioritizing tasks/to do lists	2.90	3.73	28.6
Evaluating urgent tasks	3.29	4.02	22.1
Goal setting	3.05	4.04	32.3
Finding your routine to manage your time	2.66	3.72	39.8
Motivation Workshop - Area Surveyed			
Student was/is motivated towards his/her studies	3.66	4.51	23.2
Student expected/expects to do well in future course	3.82	4.39	14.9
Student was/is motivated to continue in STEM	4.02	4.66	15.9

Get Involved Workshop

According to the survey, approximately 5% of students were already involved on campus, and 39% of students not already involved on campus wanted to get involved on campus prior to the course. After the course, approximately 32% of students were involved on campus, and 97% of students not involved on campus wanted to get involved on campus. There is a significant number of students expressing desire to get involved on campus, yet a portion of the student had yet to translate that interest into involvement. To evaluate the effectiveness of the get involved on campus workshop, students were tasked with reflecting on their involvement with the student organization network as well as their involvement outside of the student organization network. Table 4 shows the number of students that joined student organizations inside and outside of the student organization network. The data highlights the drastic increase in understanding that getting involved on campus is beneficial.

Table 4. Summary of Student Participation in Student Organization Network

Organizations	**Number of students before the course**	**Number of students after the course**
Yes, She Can!	3	11
EP Honey Badgers	0	8
Bandit Game Studios	0	6
Meeple Board Game Society	0	4
Irish Bunnies	0	1
Other	1	23

Peer-to-Peer Mentorship Program

To evaluate the impact of the peer-to-peer mentorship program, students were surveyed on a variety of topics regarding their interactions with the mentor's performance. Students rated their mentors and how skilled their mentors were throughout the duration of the course. One survey question provided a 7-point scale ranging from "Not Skilled at all" (1) to "Extremely Skilled" (7) covering various mentoring skills and techniques, the data is shown in Table 5 which displays the mentors' average score for each skill and technique. Additionally, the feedback from the students reveals a high satisfaction rate with of around 54% strongly agreeing that their mentor met their expectations, about 36% of students being agreeing that their mentor met their expectations, about 7% of students expressing a neutral view of their mentor meeting their expectation, and only 3% of students expressing dissatisfaction regarding the student's expectation of their mentor. The positive feedback affirms the effectiveness of the peer-to-peer mentorship program in providing valuable support to the students.

Conclusions

The current results suggest that the workshops demonstrated positive outcomes. Notably, the communication workshop substantially impacts the inside and outside of the classroom. The peer-to-peer mentorship program, particularly utilizing teaching assistants, received extremely positive feedback, highlighting its value. However, a more streamlined structure is necessary to ensure consistency in the mentorship experience for all students. Additionally, survey content and timing must be updated to reflect the necessary information highlighted through the analysis of current data and the project's needs. This initiative by CREaTE at The University of Texas at El Paso seeks to engage, motivate, retain, and graduate better prepared under represented

minority engineers into the field. A more diverse workplace premises solutions that work for different cultural needs. It means a broader range of ideas and different perspectives that forge new ways of thinking. It means a better world.

Table 5. Students' Feedback on Effectiveness of Peer Mentorship Component.

Mentoring Skills and Techniques	**Score**
Active listening	5.94
Providing constructive feedback	5.83
Identifying and accommodating to the student's communication style	5.76
Establishing a relationship based on trust	5.94
Working with the student to set clear mentoring expectations	5.69
Aligning their expectations with yours	5.51
Helping you develop strategies to meet goals	5.88
Employing strategies to enhance your knowledge and abilities	5.94
Motivating you	6.09
Building your confidence	6.18
Stimulating your creativity	6.02
Acknowledging your successes	6.16
Helping you set career goals	5.79
Understanding their impact as a role model	6.08
Helping you acquire on-campus resources	5.90

Future Work

Moving forward, the data collection process will improve to assess the student's understanding of the material and specific areas in which it is most beneficial. Future data collected will include the student's understanding of the tangible benefits of a well-crafted resume, as well as their comfort level in identifying career-related activities to boost their resumes. Gathering specific data on time management or motivational techniques that resonate most with the students would allow for an in-depth analysis of which time management or motivational techniques would better impact students. Identifying he reasons for wanting to get involved but not getting involved yet would allow us to identify the primary reasons and provide support in helping these students identify organizations and potentially expand the student organization network. Additional data is needed regarding the teaching assistants and professors to determine if the additional responsibilities impacted the traditional teaching assistant duties More data will be collected and asses with the current state of this research project to evaluate the initial impact of the program to inform future iterations.

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