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Work in Progress: Developing a Guide to Support Engineering Student Out-of-Class Participation and Professional Learning

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WIP: Developing a Guide to Support Engineering Student Out-of-Class Participation and Professional Learning

Introduction

Many co-curricular engineering research studies have connected students' participation to specific professional (e.g., communication, teamwork [1]–[4]) and personal outcomes (e.g., identity, retention [1], [5]–[7]). This approach has established a foundation for claims that co-curricular engagement is important for engineering students' overall development but leaves questions about what drives students' engagement in these activities. This study leverages a pilot survey to explore student reasoning for engaging in co-curriculars and develop an institution-specific co-curricular engagement guide to support students' decision making about co-curriculars. The survey and ongoing engagement guide development explore the following questions: *(1) What opportunities do students participate in outside of their degree requirements? (2) What professional skills do they link to their co-curricular participation? (3) What factors do they consider when choosing what to participate in?* This work-in-progress paper discusses pilot survey results and how they will inform the ongoing guide development efforts.

Background

Literature has connected students' engagement in college activities with their development and success for many years [8], [9]. Broadly, engagement has been described as a physical and emotional investment in a task that leads to students' learning [10], [11]. In engineering, many researchers have explored the impacts of engagement outside of the classroom, commonly called co-curricular engagement [8], [9]. Within engineering co-curricular engagement studies, researchers have identified relationships between participation in specific categories of co-curricular activities (e.g., research, service learning, competition teams) and professional [1]–[4] and personal outcomes [1], [5]–[7]. To do so, researchers have developed methods that aim to identify connections between co-curricular engagement and student development or outcomes.

One of the most commonly used methods to study relationships between engagement and student development is the National Survey of Student Engagement (NSSE) [7], [12]. The NSSE looks at how and where students engage while in college and what they gain from their engagement. Specifically, the survey probes five types of information: participation in activities, what institutions require of students, perceptions of the environment related to academic success, demographic information, and estimated growth in outcomes since beginning college. Moreover, engineering education scholars have also developed methods to explore relationships between engagement and student outcomes. One example in engineering is Simmons and colleagues' [13] work to develop the Post-Secondary Survey of Student Engagement (PosSE), which looks at how a student's involvement at a university relates to their overall performance. Fisher and co-authors [1] similarly developed a framework that details many opportunities to get involved on a single campus, linking the opportunities to a set of 20 student outcomes.

Despite a wealth of knowledge on what outcomes students might gain from engagement in co-curricular activities, relatively few studies have explored what factors engineering students consider when choosing to engage in these activities [14]–[16]. Furthermore, researchers exploring the impact of engineering student engagement in co-curriculars have not yet looked at institutional context in relation to students' reasons for being engaged. As one example, literature has shown differences in the experiences of residential and commuter students [17]. Holding a commuter or

residential status for students may impact the co-curricular activities they engage in or influence why they engage at all. More broadly, the ratio of commuting to residential students at an institution may impact the overall patterns of co-curricular engagement at that institution. Thus far, much of the co-curricular literature has used general outcomes to inform their guidance for students seeking to engage in co-curriculars, but there is a clear need to consider an institution's context and students' reasoning for engagement when developing this guidance.

Study Design

The purpose of this work is to develop and iterate on an engagement guide for students interested in participating in co-curricular activities. The pilot survey portion of this study explores students' engagement and factors they consider when making engagement decisions through a compilation of survey items from multiple co-curricular engagement surveys and frameworks [12], [13], [18].

In future work of this project, findings from the pilot survey will be used to prototype the co-curricular engagement guide. To further explore engagement decisions of the student population, stakeholder interviews will be conducted and inform iterations of the engagement guide, thus improving its usability and potential adoption as a resource.

Study Context. The student population studied is an undergraduate engineering population at a mid-Atlantic research institution. Majors that students can enroll in include biomedical engineering, chemical engineering, civil and environmental engineering, electrical and computer engineering, engineering entrepreneurship, and mechanical engineering. The institution currently enrolls approximately 1,500 students across all undergraduate engineering majors. In the College of Engineering, approximately 25% of students identify as women and 11.5% come from racial or ethnic minoritized backgrounds. Approximately 67% of the university's students live off campus and 27% are reported to be first-generation students [19].

Survey Development. Three research efforts exploring student engagement informed a majority of the items included in this survey: (1) The National Survey of Student Engagement (NSSE) [12], (2) The Postsecondary Survey of Student Engagement (PosSE) [13], and (3) a survey by the University of Buffalo which tracked students' co-curricular engagement and professional development [18]. Most of the questions from the survey can be found in Appendix 1. The goal of pulling from multiple surveys was to better understand the specific co-curricular activities that students engaged in while also exploring what skills they were connecting to those activities and their reasons for participating.

One area of our survey where multiple surveys were synthesized to capture the breadth of discussions in the literature was in developing categories of co-curricular activity options. To do this, preliminary categories were pulled from other co-curricular literature [1], [13], [18], [20], [21]. The research team wrote each of the literature categories on sticky notes and grouped them into new categories on a whiteboard through a discussion. Once the groupings were established, the team discussed what to name the new categories and how to define them. Table 1 demonstrates the outcome of this process which led to the 15 categories in our survey.

In addition to the close-ended items added, three open-ended items about students' learning experiences were also incorporated to inform the development of the engagement guide. These items were pulled from the NSSE survey [12], and asked students to describe college experiences that were most significant, satisfying, and dissatisfying towards their learning.

Table 1. Categories used to classify co-curricular opportunities at the institution studied.

Category Name	Category Description	Literature Categories
Academic Competition Team	individuals who compete to show their proficiency in a subject	Academic Competition; Project Team [1]; Design Competition Team [13], [20]; Intramurals [18]; Competition & Design Teams [21]
Academic or Professional Society	provides social and professional events for a particular field/study	Academic and Professional; Professional Organization Chapter; Honorary; Departmental Group [1]; Fraternity or Sorority (Major Related) [20]; Professional Societies [21]
College Facilitated Community	within the college, facilitated by the university, and aimed at fostering community	Campus Community; Housing Community [1]; Living Learning Community [13], [20]; College Run Organizations [21]
Employment	job, on campus or off campus, not relating to the field of engineering	Job [13], [20]; Non-Technical [18]
Energy & Environmental Clubs	focuses on conserving energy /or the environment	Energy & Environment [1]; Environmental [13], [20]
Greek Life	social, associated with the university, typically has a focus in philanthropy	Greek Life [1]; Fraternity or Sorority (Social) [13], [20]
Identity Based Organizations	groups formed or defined by specific characteristics of participants	Cultural; Religious [1]; Culture, Faith, Gender, or Identity [13], [20]; Identity Based Organizations [21]
Organized Sports	athletic teams or groups, of all different skill levels with coaches that compete against others	Athletics; Martial Arts [1]; Sports [13], [20]
Performing Arts & Entertainment	creative activity performed or produced for an audience	Arts [1]; Film, Theater, & Visual Arts; Music & Dance [13], [20]
Professional Experience	real-world experience within engineering profession, typically alongside engineers in industry	Innovation & Entrepreneurship [1]; Professional Experience; Pre-professional Experience [13], [20]; Technical [18]
Research Organizations	overarching goal of gaining or producing new knowledge on a subject	Research [13], [18], [20]
Service Clubs	aimed at giving back to a community and promoting the welfare of others	Service; Advocacy [1]; Engineering Outreach Support; Military, Service, & Public Service [13], [20]; Fraternity or Sorority (Service) [13]; Service [21]
Student Clubs & Organizations	fulfill a niche in a community for student hobbies and interests	Recreation; Games and Hobbies [1]; Clubs [18]; Student Clubs & Organizations [13]
Student Government	structured group that manages campus wide events, activities, initiatives	Student Government [1]; Student Government [20]; Government [13]
Student Media	involves producing or/ working on media art such as writing, papers, painting, etc.	Media [1]; Media, Publications, & Journalism [13], [20]

Data Collection & Analysis. The survey was distributed on email listservs and through in-class recruitment in interdisciplinary engineering courses. Much of the in-class recruitment was in first year and second-year courses, leading to a majority of responses coming from underclassmen (n

= 87 participants out of a total of 107 participants). The project aims to recruit more participants in the coming semesters as the co-curricular engagement guide is developed, targeting more responses from upperclassmen by recruiting in courses they take. Of the responses received thus far, 74 individuals identified as male, 20 identified as a marginalized race or ethnicity, and 46 were commuter students (34 of which commuted from outside of the university city).

The research team has begun to explore the pilot survey data collected, which will inform the development of the first iteration of the engagement guide prototype. Survey responses were analyzed using frequency plots and relationship maps (or resource networks; Figure 1). Resource networks were used to visualize how different elements of student co-curricular experiences (e.g., co-curricular categories of engagement (C_), professional skills developed (S_), factors for engagement or disengagement (Y_ & P_), and information sources (L_)) were occurring in relation to others [22]. Resource networks display nodes that represent the experience elements probed by the survey and connecting lines that represent different combinations of those elements. The sizes of the nodes and thickness of links are proportional to the instances in the data. Patterns in these networks will inform a preliminary engagement guide design.

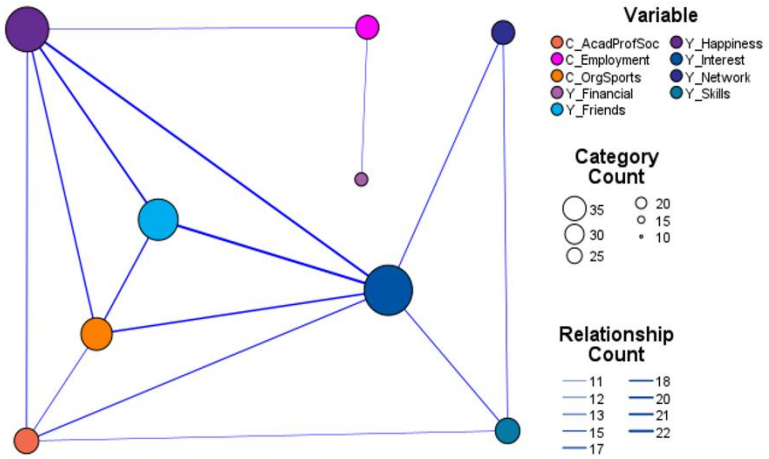

Figure 1. Example resource network.

After designing the first iteration of the engagement guide based on patterns found in the pilot survey data, the research team plans to implement stakeholder interviews with students to gain feedback and further insights into their decision-making processes and what they believe would improve the usefulness of a co-curricular engagement guide. The interviews will allow the research team to explore and test preliminary hypotheses about what factors students consider when making engagement decisions.

Preliminary Survey Results

We present preliminary patterns of common pilot survey responses in Table 2 and Figure 2.

Table 2. Common responses in sections of the survey. Participants could select multiple choices. Parenthesis indicates number of respondents.

Co-Curricular Categories Participated In	Academic or Professional Society (21)	Employment (21)		Organized Sports (25)
Activities Found Through	Emails (24)	Campus Link (27)		Friends (41)
Reasons to Engage	Technical Skills (22)	Friends (30)	Happiness (31)	Interests (34)
Reasons to Not Engage	Shyness (15)	Lack of Motivation (27)		Lack of Time (65)

The resource networks (not presented) illustrated that students' time restrictions strongly hindered their participation in co-curriculars including professional societies (n = 17), organized sports (n = 23), and non-engineering employment (n = 19). In addition, the networks showed strong

relationships among two reasons for participation (happiness (n = 11) and finances (n = 11)) and one opportunity students chose to participate in (non-engineering employment).

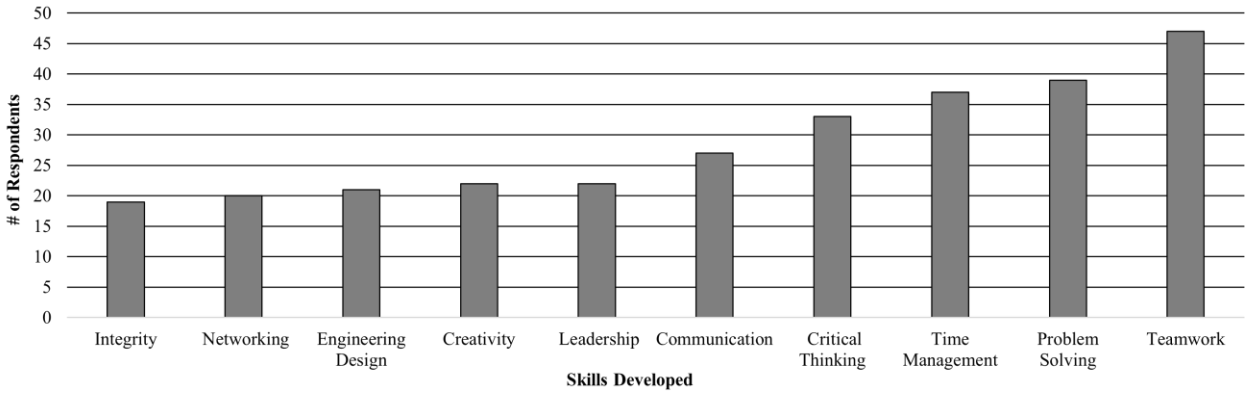

Figure 2. Frequency of responses on skills students perceived they developed. Participants could select multiple choices.

Discussion and Future Work

The patterns in this preliminary survey data will inform a prototype design of the engagement guide. While we are still working to gather data from upperclassmen perspectives, and expand the number of responses in our dataset, we believe the use of the pilot survey to gather broad engagement data has provided useful information that can inform the first iteration of the guide and be used in future stakeholder interviews. As an example, to account for students' concerns over time restrictions when selecting co-curriculars that was present in our pilot survey data, the engagement guide may provide co-curricular filters based on reported time investment or meeting times. Currently, two designs are also being considered for a professional skills filter: one that would present student-reported outcomes linked to participation, and one that would present outcomes linked by administrative members (e.g., faculty mentors) of the co-curricular activities. Stakeholder interviews will help the research team understand the decision-making process students use to interpret the data presented to them in each of these designs and determine which design has the most benefit to its intended student audience.

In addition, the resource network showed interesting relationships among happiness, finances, and non-engineering employment; while further inquiry is required to make definitive claims beyond these preliminary results, this relationship may suggest themes of financial insecurity. In response, the initial design will consider linking resources for students into the engagement guide that respond to potential financial insecurity (scholarship opportunities, food pantry, etc.), which may improve their pathway to success in college [8], [9].

By presenting this WIP at the annual conference, the research team aims to spark discussion about co-curricular engagement and better understand considerations and incentives that are prevalent in students' decision-making at other institutions. Using a combination of broad student surveys (presented in this paper) and the planned targeted stakeholder interviews in succession can support an iterative process for developing this engagement guide, thus leading to a final product that is tailored to the needs of students on one campus and will help them navigate decisions about engaging with co-curricular activities in their institutional context. Moreover, the long-term goal of this work is to share a context-conscious approach to understanding student engagement that may be transferable to other institutions.

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References
[1] D. R. Fisher, A. Bagiati, and S. Sarma, "Developing Professional Skills in Undergraduate Engineering Students Through Cocurricular Involvement," *J. Stud. Aff. Res. Pract.*, vol. 54, no. 3, pp. 286–302, Jul. 2017, doi: 10.1080/19496591.2017.1289097.
[2] G. Young, D. B. Knight, and D. R. Simmons, "Co-curricular experiences link to nontechnical skill development for African-American engineers: Communication, teamwork, professionalism, lifelong learning, and reflective behavior skills," in *2014 IEEE Frontiers in Education Conference (FIE) Proceedings*, Madrid, Spain, Oct. 2014, pp. 1–7. doi: 10.1109/FIE.2014.7044076.
[3] K. Litchfield, A. Javernick-Will, and A. Maul, "Technical and Professional Skills of Engineers Involved and Not Involved in Engineering Service: Technical and Professional Skills of Engineers in Engineering Service," *J. Eng. Educ.*, vol. 105, no. 1, pp. 70–92, Jan. 2016, doi: 10.1002/jee.20109.
[4] K. G. Wolfinbarger, R. L. Shehab, D. A. Trytten, and S. E. Walden, "The influence of engineering competition team participation on students' leadership identity development," *J. Eng. Educ.*, vol. 110, no. 4, pp. 925–948, Oct. 2021, doi: 10.1002/jee.20418.
[5] B. Burt *et al.*, "Outcomes of Engaging Engineering Undergraduates in Co-Curricular Experiences," in *2011 ASEE Annual Conference & Exposition Proceedings*, Vancouver, BC, Jun. 2011, p. 22.1132.1-22.1132.11. doi: 10.18260/1-2--18498.
[6] Simmons, Denise R., Creamer, Elizabeth G., and Yu, Rongrong, "Involvement in Out of Class Activities A Mixed Research Synthesis Comparing Outcomes of Engineering to Non-engineering Undergraduate Students," *J. STEM Educ.*, vol. 18, no. 2, pp. 10–16, 2017.
[7] S. Fiorini, L. Shepard, T. Liu, and J. Ouimet, "Using NSSE to Understand Student Success: A Multi-Year Analysis," p. 14, 2014.
[8] Mayhew, Matthew J., Pascarella, Ernest T., and Terenzini, Patrick T, *How college affects students. Volume 3, 21st century evidence that higher education works*, Second., vol. 3. San Francisco, CA: Jossey-Bass, 2016.
[9] G. D. Kuh, "Assessing What Really Matters to Student Learning *Inside The National Survey of Student Engagement*," *Change Mag. High. Learn.*, vol. 33, no. 3, pp. 10–17, May 2001, doi: 10.1080/00091380109601795.
[10] Pace, C. Robert, "Recollections and Reflections," in *Higher Education: Handbook of Teory and Research*, vol. 13, New York, NY: Agathon Press, 1998, pp. 1–34.
[11] Astin, Alexander W, "Student involvement: A developmental Theory for Higher Education," *J. Coll. Stud. Dev.*, vol. 40, no. 5, pp. 518–529, 1999.
[12] G. D. Kuh, "The national survey of student engagement: Conceptual and empirical foundations," *New Dir. Institutional Res.*, vol. 2009, no. 141, pp. 5–20, Dec. 2009, doi: 10.1002/ir.283.
[13] D. R. Simmons, Y. Ye, N. J. Hunsu, and O. O. Adesope, "Development of a Survey to Explore Out-of-Class Engagement of Engineering Students," *Int. J. Eng. Educ.*, vol. 33, no. 4, pp. 1213–1221, 2017.
[14] H. M. Mulrooney, "Exploring participation in co-curricular activities among undergraduate students," *New Dir. Teach. Phys. Sci.*, no. 12, Oct. 2017, doi: 10.29311/ndtps.v0i12.566.

[15] O. Dalrymple and D. Evangelou, “The Role of Extracurricular Activities in the Education of Engineers,” p. 7, 2006.
[16] C. Woodcock, A. Huang-Saad, S. Daly, and L. Lattuca, “The Value of Co-curricular Experiences: Perspectives of Third-year Biomedical Engineering Students,” in *2020 ASEE Virtual Annual Conference Content Access Proceedings*, Virtual On line, Jun. 2020, p. 35381. doi: 10.18260/1-2--35381.
[17] H. J. Alfano and N. B. Eduljee, “Differences in work, levels of involvement, and academic performance between residential and commuter students,” *Coll. Stud. J.*, vol. 47, no. 2, p. 334+, Jun. 2013.
[18] B. Memarian and A. Olewnik, “Comparison of a Unique Co-curricular Engagement of Engineering Students and their Self-reported Outcomes,” 2022, p. 17.
[19] Rowan Flying First First-Generation Task Force, “Annual Report 20-21,” Rowan University, 2021.
[20] D. Simmons and C. Groen, “Increasing Impact of the Hidden Curriculum: Exploring Student Outcomes from Out-of-Class Activities,” in *2018 ASEE Annual Conference & Exposition Proceedings*, Salt Lake City, Utah, Jun. 2018, p. 29935. doi: 10.18260/1-2--29935.
[21] J. Millunchick and Y. Zhou, “The Effect of Clusters of Participation in Engineering Co-curricular Activities on Student Outcomes,” in *2020 ASEE Virtual Annual Conference Content Access Proceedings*, Virtual On line, Jun. 2020, p. 35305. doi: 10.18260/1-2--35305.
[22] A. Walsh, E. Diehl, and C. Faber, “Studying the Resource Networks of First-year Engineering Students: Establishing a Data Collection Method,” in *2019 ASEE Annual Conference & Exposition Proceedings*, Tampa, Florida, Jun. 2019, p. 33321. doi: 10.18260/1-2--33321.

Appendix 1. Example Survey Questions

Please describe the most significant learning experience you have had at [School]. (open)

Please describe a satisfying learning experience while at [School]. Why was it satisfying? (open)

Please describe a dissatisfying learning experience while at [School]. Why was it dissatisfying? (open)

What co-curricular activities/organizations are you involved in? (multi-select)

Greek life
Academic/professional society
Academic competition team
Organized sports (varsity, club, intramural)
Student government
Student media (school news, school newspaper, etc)
Service clubs
Research organizations
Employment (off-campus, on-campus)
Professional Experience (interships, co-ops, etc)
College Facilitated Community
Energy & Environment clubs
Performing Arts & Entertainment
Identity Based Organizations
International Experiences
Other

How often do you participate in [fill in selected] organization?

Once
Once per semester
Once a month
Once a week
Daily

Where did you learn about or find opportunities to join the co-curricular activities that you are involved in? (multi-select)

Campuslink
Daily Mail
Emails
Social Media
Posters
Advisors or Faculty
Fairs
Friends
Other (please describe)

Why did you choose to get involved in the co-curricular activities that you did? (multi-select)

To make new friends
For your own happiness
Because it suited your interests
To become a better leader
For networking purposes
To develop technical engineering skills
For financial reasons
Service opportunity
Other (please describe)

What, if any, professional skills do you feel that your co-curricular activities have helped you to develop? (multi-select)

Critical thinking
Problem solving
Engineering design
Creativity
Computer skills
Oral written communication
Leadership skills
Teamwork
Professional ethical integrity
Networking

Time management
None
Other (please describe)

What factors prevent you from maintaining involvement or becoming involved in a co-curricular activity? (multi-select)

Lack of time
Competitive or difficult membership process
Lack of opportunities or knowledge of opportunities
Lack of motivation
Shyness
Cost
Feeling of unwelcomeness
Limited participation
Other (please describe)