Student-to-Industry Interaction in a Civil Engineering Field Course: Benefits for Education and Leadership

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The United States Air Force Academy (USAFA) is a military-focused college, where students serve in the U.S. armed forces upon graduation. The civil engineering program conducts a required three-week summer field engineering course focusing on hands-on skills that help bridge the gap between theory and practice. This course is generally taken between the sophomore and junior year, and prior to most of the other civil engineering courses. Approximately 75 students take the course annually. Most are civil engineering majors at USAFA, but approximately one-third of the students come from other military colleges and Reserve Officer Training Corps programs from around the country. The course includes field trips, lab exercises, and hands-on activities intended to give students a practical frame-of-reference that is helpful in subsequent analysis and design courses.

Most activities consist of some pre-reading, a short classroom lesson, the hands-on portion, and finally a quiz or laboratory practical exercise. Both the quizzes and practical exercises serve as low stakes assessments. Faculty develop the course materials and teach the classroom lesson, but to execute the hands-on portion, the faculty rely on approximately 25 tradespeople or "mentors." The mentors are surveyors, electricians, plumbers, carpenters, and equipment operators that also serve in the U.S. armed forces in either an active, guard, reserve, or civilian status. The mentors generally demonstrate to the students how to perform a particular skill, and then let the students perform the work. The amount of oversight and coaching the mentors provide is tailored to the nature of the activity and each individual student's needs. Industry experts also conduct several field trips for students within the course.

In addition to learning technical skills from the mentors, students learn about their future roles and responsibilities after graduation since many will be charged to lead enlisted and civilian tradespersons. The interaction in the field engineering course also offers opportunities for the students to learn what the enlisted force expects of their leaders. Student to mentor discussions take place during the hands-on activities, informally during breaks, and formally during a series of panel sessions.

In this paper, we will describe the course and the nature of the interaction between students and mentors. Student survey and interview results show that they tremendously value the interactions with mentors both as a component of their learning in the course and for their development as leaders. The approach to leverage tradespeople to teach and mentor students in a civil engineering course has been successful in motivating students to choose and persist in the civil engineering major at USAFA and could be a useful benchmark for other engineering programs.

Leadership and Teamwork Outcomes:

The mission of USAFA is to educate, train and inspire men and women to become officers of character motivated to lead the United States Air Force and Space Force in service to our Nation. As part of the means to accomplish this mission, USAFA has nine institutional outcomes that are intended to develop a diverse group of professional officers who think critically, lead with character, and serve the nation. The objective of this paper is primarily aligned with the first USAFA institutional outcome. In addition to the institutional outcome on leadership, teamwork, and organizational management, this paper discusses how the use of practitioners supports the "leadership" aspect of the fifth ABET student outcome. The seven ABET student outcomes and nine USAFA institutional outcomes are shown in Figure 1:

ABET Student Outcomes:	**USAFA Institutional Outcomes**
1.an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	***(1) Leadership, Teamwork, and Organizational Management***
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.	*(2) Ethics and Respect for Human Dignity*
3.an ability to communicate effectively with a range of audiences.	*(3) The Human Condition, Cultures, and Societies*
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.	*(4) Scientific Reasoning and the Principles of*
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.	*(5) Application of Engineering Problem-Solving Methods*
6.an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	*(6) Clear Communication*
7.an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	*(7) Critical Thinking*
	(8) National Security of the American
	(9) Warrior Ethos as Airmen and Citizens

Figure 1: ABET Student Outcomes and USAFA Institutional Outcomes

Literature Review on Utilization of Practitioners in Education:

Academic partnerships with industry provide many learning benefits that include opportunities for field trips (Welch et al. 2018), service-learning experiences (Oakes 2011), and internships (Tener 1996, Saviz et al. 2011, Weatherton 2012, Welch et al. 2018). Partnerships with industry for realistic projects in capstone courses is quite common (Akili 2010, McGinnis and Welch 2010, Aktan et al. 2011, Knikiewicz 2017, Welch et al. 2018, Stanford et al. 2020, Khalid 2022). Industry involvement helps to ensure balanced graduates who are well-balanced in the fundamentals of civil engineering (Howard 2015) and can occur with either private or public entities (Howard 2015, Knakiewicz 2017). Industry participation on advisory committees or boards helps ensure graduates are properly prepared to practice their profession upon graduation (Casey and O'Donnell 2008, Welch et al. 2018). Industry partnerships are also commonly used in engineering technology programs (Dobrowski 2008, Knakiewicz 2017), baccalaureate programs (Welch et al. 2018) and even post-bachelors, masters, and doctoral programs (Bolo and Ventura 2011, Howard 2015).

Benefits to practitioner involvement in education include keeping apprised of civil engineering practices that may be unique to a given region of the country (Akili 2007) and potential for a faculty sabbatical to build collaboration and practical experiences (Batson 2015). Industry

professionals can also augment faculty expertise in a specialty area or serve as an additional teaching resource (Detmann 2000, Welch et al. 2018).

The literature review revealed a wide range of topics associated with the utilization of practitioners in education, but it did not yield much related specifically to how those practitioners can help improve both the technical education and the leader development of students.

Field Engineering and Readiness Laboratory (FERL) Introduction:
In 1994 the Department of Civil and Environmental Engineering at USAFA initiated an innovative concept in higher education: The Field Engineering and Readiness Laboratory, more commonly referred to as FERL. FERL is a direct result of the vision and dedicated effort of Retired Brigadier General David O. Swint to improve the learning of students in this unique course. The course is described in general by Wambeke (2022) while Meade et al. (2000) describe the geotechnical activities and Kuennen and Barrett (2003) give a detailed description of the concrete beam activity.

FERL is a three semester-hour course where engineering practice and education are uniquely combined in a hands-on construction environment. Each summer, rising civil engineering juniors engage in this cornerstone of their major's curriculum, a three-week field course designed to introduce the students to their discipline and to lay a foundation for their subsequent coursework. USAFA students are joined by other students from across the United States. The students are led by seniors who have previously taken FERL, and are instructed by faculty, visiting professors, and most importantly, enlisted tradespeople from throughout the armed forces, and include members from the Active Reserve, National Guard, and civilian components. This student-centered program with practitioner mentorship is not only a unique educational experience, but a valuable leadership laboratory. The objective of this paper is to examine the utilization of practitioners (beyond faculty) focusing on tradespeople mentors in the US Air Force civil engineering learning environment.

The FERL course is centered on six learning objectives (listed below) and has nearly 20 activities that are related to the four sub disciplines of civil engineering that are included in the program (Wambeke 2022, Sloan et al. In press). Several activities are associated with surveying, roadway paving, concrete beam construction and testing, wood frame house construction, heavy equipment operations, steel bridge erection, pipe and open channel flow design, expeditionary wastewater treatment and field trips to material and processing plants in the local area. A full list of activities is included in Table 1. These activities allow the students to assume the role of technician under the watchful eyes of mentors. In the following two years of classroom academic work, students can relate their theoretical classroom education to real-life construction experience gained during FERL. The six FERL course objectives are:

1. Work in teams effectively to solve civil and environmental engineering problems.
2. Describe production, properties, behavior and uses of common construction material (soils, steel, concrete, asphalt and wood).
3. Describe various construction methods and techniques used in civil engineering.
4. Appreciate roles and responsibilities of Air Force Civil Engineers.
5. Describe broad environmental engineering concepts.

6. Describe common civil and environmental engineering field and laboratory tests.

Table 1: FERL Activities

Construction	Environmental	Geotechnical	Structural
Wood Frame Building Construction	Water Treatment Activity	Geology Field Trip	Concrete Mix Design
Intro to Surveying	Water and Wastewater Plant Field Trip	Asphalt Paving, Horizontal & Vertical Curve Layout	Concrete Beam Design and Construction
Total Station Surveying & GPS	Sprinkler Design	Site Investigation: Drill Rig, Field Classification	Steel Construction & Fabrication Shop Field Trip
Construction Site Visit	Open Channel Flow and Three Reservoir Problem	Heavy Equipment Operations	Materials Testing
Power Production Operations	Stream Sampling		Concrete Placement & Finishing (Pad)

Due to the specialty skills required and the relatively small size of the USAFA CE faculty, most of these activities would not be possible without the expertise and experience of mentors who work side by side with students. The mentors are a significant contribution to the unique value of FERL. They work with the students and demonstrate first-hand how to function on multidisciplinary teams to accomplish project goals. In addition to supplying technical expertise for the FERL projects, the mentors serve as excellent role models for the students who get to see US Air Force Non-Commissioned Officers (NCOs) in the field work environment.

Research Methods – Surveys and Interviews:

The faculty developed separate sets of survey questions for students and mentors. The surveys served three purposes. The first was to collect opinions on how FERL might be modified for future offerings as part of the department's continuous improvement process. The second was to get a sense of how student and mentor interactions related to skill and professional development. It was expected that this second purpose of administering the surveys could produce results that may resonate beyond the course and with either the USAFA or other academic institutions. The third purpose or goal of the surveys was to capture changes in student mindset, if any, towards civil engineering.

Students were presented with both pre- and post-course surveys containing some of the same questions to establish a baseline and then measure any changes due to the FERL experience. The pre-course surveys were administered the day prior to or the first day of the course, while the post-course surveys were completed two or three days prior to the last day of the course. The pre-course survey allowed a baseline to be established by gathering demographic information

such as class year, sub-discipline interest, and career interests upon graduation; while also examining why students chose the civil engineering major over other engineering degrees. The post-course survey included typical end-of-course feedback questions on how the course could be improved and greatest takeaways, but in order to capture any potential changes in the student's mindset towards civil engineering, the survey included questions examining if the program caused students to more strongly consider pursuing a career in civil engineering upon graduation. Although no course credit was awarded to students for completing the surveys, they were strongly encouraged and reminded several times to participate if willing. While more than just USAFA students took the FERL course, the student survey data included in this paper was limited to the USAFA students from the Class of 2024. Forty-five students completed pre-course survey and forty-three completed the post-course survey.

To get more insights beyond the survey responses, a sub-set of students were selected at random for interviews. The participants selected for interviews varied in ethnicity, gender, and grade point average. Participation in an interview remained voluntary and anonymous. A total of 15 individuals completed interviews, each lasting approximately 30-40 minutes long. The interview questions looked to capture the students' greatest takeaways from the program and gather any constructive feedback to improve upon the course. Questions included: Did the FERL course change how they viewed civil engineering? Did interactions with mentors help them learn skills or develop self-confidence? A full list of interview questions can be found in Appendix B.

Results:

Students responded favorably to many of the post-course survey questions. Ninety-three percent either agreed or strongly agreed that mentors helped them learn the course material (Fig 2). Several students mentioned the "hands-on" nature of FERL combined with coaching from the mentors helped with learning. When identifying their single greatest take-away from FERL, 13 students (30%) reported learning the technical skills to help them in life and in future courses. Not only were mentors helpful in developing students' technical skills, but non-technical professional development was a meaningful outcome of the student-mentor interaction during FERL. Eighty-eight percent of students either agreed or strongly agreed that the mentors helped them become better leaders (Fig 2), suggesting that the mentors had an impact on students beyond course material. In support of the drastic impression the mentors had on students, developing mentor-to-student relationships was mentioned 2.6 times more often (13 times vs. 5 times) than developing student peer-to-peer relationships as the single greatest take-away on the student post-course survey. When combining responses about the development of relationships, professional advice, and technical content, over half of the students (35 of 43, or 81%) indicated their experience with mentors was the single greatest take-away from FERL. Additionally, there was a 17% increase in the number of students who either agreed or strongly agreed that they "knew the classmates in their major well" after FERL, which supports observations from interviews that students value developing interpersonal relationships with their peers.

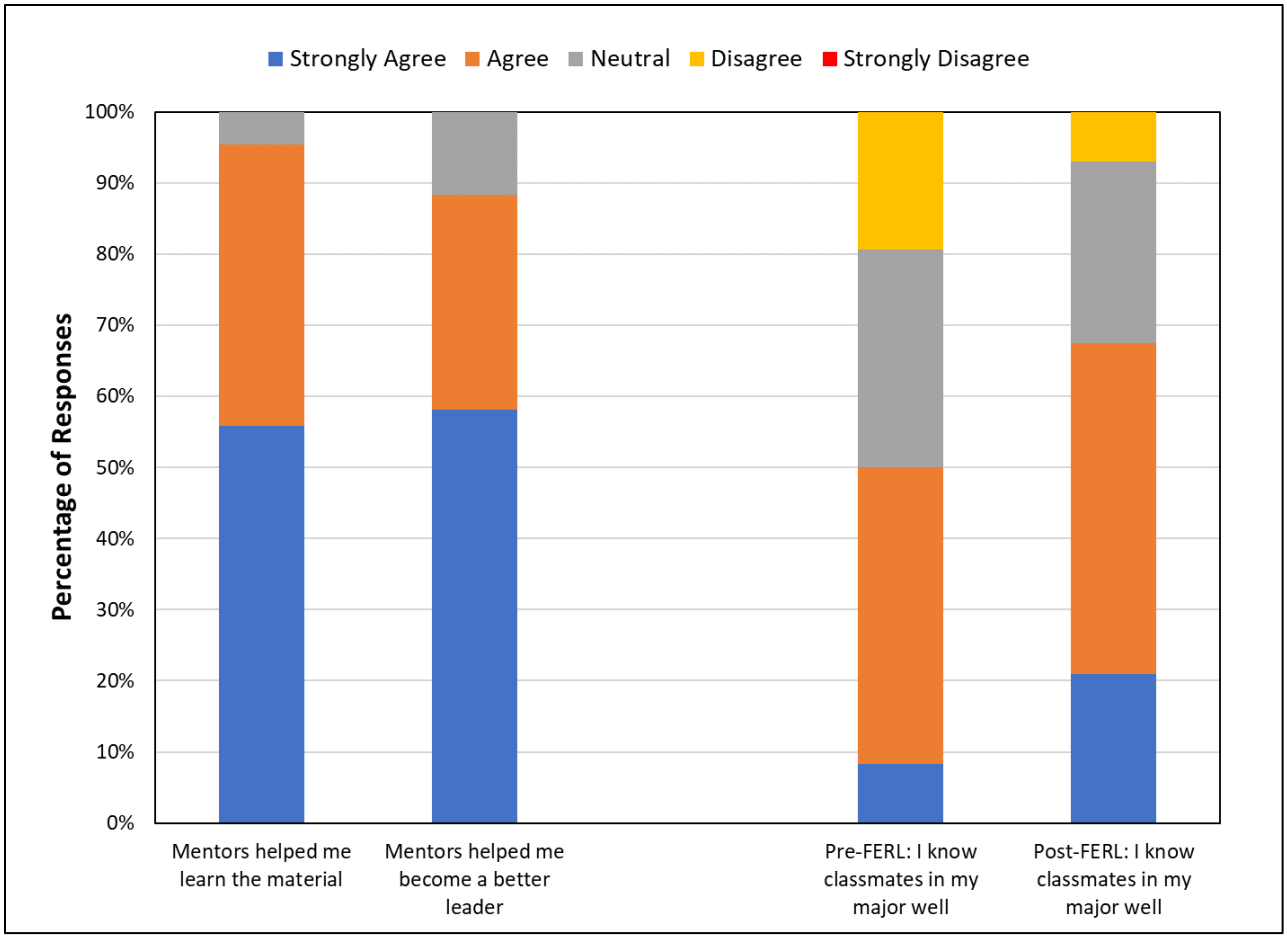

Figure 2: Student Survey Responses

Four themes emerged from the results of the interviews, all of which are related to how the FERL course provides a unique opportunity for students to work with faculty, mentors, and other students, to gain knowledge and experience that will help them succeed in future roles as military officers. Those four themes were: The Value of Developing Interpersonal Relationships with Peers, Interactions with Tradespeople and a Glimpse into life in the Air Force, Hands-on Experience, and Getting to Know Faculty. What follows explicates the themes that emerged from this study.

The Value of Developing Interpersonal Relationships with Peers

Every FERL participant interviewed indicated that the FERL course was instrumental in providing an environment where CE majors could get to know each other on a different level that what often occurs in classes during the regular academic year, which literature has shown (Lopes, et al., 2015) supports the development of social and interpersonal skills that are important both during the educational process and in one's post-graduate career experiences. Given that the course is residential, that participants often work in teams, and there are opportunities for interpersonal interactions via structured extracurricular activities, students indicated that the resulting strengthened interpersonal relationships had multiple positive impacts; the sense that one is in the company of others as they progress through the major which

aids the ability to persist. Even though most of the students reported that they did not question their ability to be successful in the major, they mentioned that interpersonal relationships among colleagues was a factor that they very much appreciated, and that would be a very positive aspect of their experience in the major.

Interactions with Tradespeople and a Glimpse into life in the Air Force

Every student interviewed found great value in being able to work closely with tradespeople mentors. Students note several aspects that enhanced their FERL experiences: being able to observe how the members lead in such a way as to promote engagement on the part of those they supervise, a glimpse of what civil engineering is like in the field, and how they, as future officers approach their relationship and interactions with tradespeople such that mutual respect, cooperation, and achievement of work objectives are most effectively achieved.

Hands-On Experience

Hands-on learning is an important part of engineering education (Hernandez-de-Menendez, et al., 2019). It allows students to gain practical experience in the field and to work with their peers and mentors (Crawley, et al., 2007). It involves working closely with faculty, getting to know colleagues, and creating a community that can be beneficial for the student's future. Through hands-on learning, students gain hands-on knowledge and skills that they will use in the Air Force, as they also learn how to communicate effectively, problem solve, and develop leadership skills.

A residential summer course, such as FERL turns out to be a great way for civil engineering students to learn-by-doing and get hands-on experience in the field. The students who were part of this study very much appreciated the opportunity to have a hands-on civil engineering experience. They found great value in being able to not only see, but to participate in engineering projects as practitioners. The students interviewed did not express concern about the alignment of their choice of CE as a major with their Air Force career objectives, thus the FERL course was not presented as a factor as to whether or not they would pursue civil engineering as a career. However, interviewees generally noted that their participation in the FERL course prompted an increased appreciation that they had made the right choice declaring CE as a major and combining hands on experience and working with fellow students and mentors, they report that they have developed skills that will help them succeed in their future careers.

Getting to Know Faculty

Participants in the study greatly appreciated the opportunity to get to know some of their faculty during the FERL course in ways that the Fall and Spring semesters don’t often allow due to the constraints and course structures. The students also recognized the importance of having an opportunity to work with mentors and faculty members who are also experienced civil engineers. Study participants report that this allows them to gain valuable insight into the field and develop a better understanding of how it works.

The benefits of getting to know faculty were not limited to the FERL course itself. The pedagogy of the FERL course, given its hands-on approach, residential setting, working closely with faculty and mentors on a daily basis, and informal opportunities for interactions with faculty, facilitated relationship building that would transfer into the regular academic year.

Summary / Conclusion:

The FERL course within the USAFA civil engineering program provides a valuable opportunity for students to learn technical material, but also to develop teamwork and leadership attributes supporting ABET SO #5 and an Institutional Outcome. The student interviewees reported that the FERL course was one of the best experiences to date as part of their education at USAFA. They did not isolate a single activity of FERL that made it a special and beneficial experience, however students tremendously valued the discussions and relationships they formed with the practitioners and the benefits they expect from it following graduation early in their professional career. Additionally, there were very few comments about what might be added to, or subtracted from, the FERL course to make for a better educational experience. Interviewees did not report that the FERL experience, in any way, detracted from their decision to major in civil engineering. Although not explicitly captured in the surveys or interviews, the authors feel the FERL experience is one of the major reasons students persist in the program. Typically, only one or two of the 40-50 civil engineering major juniors decide to not continue in the program. The authors feel the themes, together, may represent why this is so: the hands-on nature of the course, the opportunity to work closely with and learn from tradespeople who served as mentors for the FERL program, and the strengthened interpersonal relationships with fellow majors that contribute positively to the overall positive experience in the major. The authors feel the methodology used in FERL to leverage tradespeople to teach and mentor students has been successful in motivating students to choose and persist in the USAFA civil engineering program, and the approach could be a useful benchmark for other engineering programs.

References:

ABET. (2021, January 22). *Criteria for Accrediting Engineering Programs, 2019 – 2020.* https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2019-2020/.

Abrica, E. J., Lane, T. B., Zobac, S., & Collins, E. (2022). Sense of belonging and community building within a STEM intervention program: A focus on Latino male undergraduates' experiences. *Journal of Hispanic Higher Education*, *21*(2), 228-242.

Akili, W. (2007, June), *A Practitioner ? Faculty Collaboration In Teaching Civil Engineering Design* Paper presented at 2007 Annual Conference & Exposition, Honolulu, Hawaii. 10.18260/1-2--2100

Akili, W. (2010, June), *Project Oriented Capstone Design In Civil Engineering: Linkages With Industry To Enhance The Practice* Paper presented at 2010 Annual Conference & Exposition, Louisville, Kentucky. 10.18260/1-2—16855

Aktan, H. M., & Polasek, J. S., & Phillips, K. J. (2011, June), *Industry University Partnership in Senior Capstone Design Course* Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--18153

Barger, M., & Lesiecki, M., & Simington, R., & Carreras, M., & Gilbert, R., & Sandburg, N., & Hoff, A. (2007, June), *Community College Industry Partnership To Develop An Automated Training Platform* Paper presented at 2007 Annual Conference & Exposition, Honolulu, Hawaii. 10.18260/1-2—2253

Batson, R. G. (2015, June), *Sabbatical Leaves with Industry - Three Experiences* Paper presented at 2015 ASEE Annual Conference & Exposition, Seattle, Washington. 10.18260/p.24688

Bollo, M. E., & Ventura, C. E. (2011, June), *A Model for the Post-Bachelor's Degree Education of Structural Engineers Through a Collaboration Between Industry and Academia* Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--17348

Casey, M., & O'Donnell, E. (2008, June), *Models For Direct Industry Support Of Us Civil Engineering Programs* Paper presented at 2008 Annual Conference & Exposition, Pittsburgh, Pennsylvania. 10.18260/1-2--3317

Crawley, E., Malmqvist, J., Ostlund, S., Brodeur, D., & Edstrom, K. (2007). Rethinking engineering education. *The CDIO approach*, *302*(2), 60-62.c

Dettman, M. A. (2000, June), *Industrial Partnerships At Western Kentucky University* Paper presented at 2000 Annual Conference, St. Louis, Missouri. 10.18260/1-2--8453

Dobrowski, T. (2008, June), *Building Industry Relationships* Paper presented at 2008 Annual Conference & Exposition, Pittsburgh, Pennsylvania. 10.18260/1-2--3797

Foltz, L. G., Gannon, S., & Kirschmann, S. L. (2014). Factors that contribute to the persistence of minority students in STEM Fields. *Planning for Higher Education*, *42*(4), 1-13.

Hernández-de-Menéndez, M., Vallejo Guevara, A., Tudón Martínez, J. C., Hernández Alcántara, D., & Morales-Menendez, R. (2019). Active learning in engineering education. A review of fundamentals, best practices and experiences. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, *13*, 909-922.

Howard, I. L. (2015, June), *Engagement of Practitioners to Produce Balanced and Fundamentally Well-Grounded Civil Engineers* Paper presented at 2015 ASEE Annual Conference & Exposition, Seattle, Washington. 10.18260/p.23941

Khalid, A. (2022, August), *Inter-Disciplinary Senior Design Projects with Industry Partnership - A Pilot Study* Paper presented at 2022 ASEE Annual Conference & Exposition, Minneapolis, MN. https://peer.asee.org/40488

Knakiewicz, B. (2017, June), *A methodology for civil engineering technology senior capstone projects with public, private, and federal agency collaboration to assist underserved communities* Paper presented at 2017 ASEE Annual Conference & Exposition, Columbus, Ohio. 10.18260/1-2—27478

Kuennen, S. & Barrett, A. (2003). Construct first, design later – A hands-on learning experience in reinforced concrete. *Proceedings of the 2003 American Society for Engineering Education Annual Conference and Exposition*. DOI: 10.18260/1-2—11574

Lopes, D. C., Gerolamo, M. C., Del Prette, Z. A. P., Musetti, M. A., & Del Prette, A. L. M. I. R. (2015). Social skills: A key factor for engineering students to develop interpersonal skills. *International journal of engineering education*, *31*(1), 405-413.

McGinnis, M., & Welch, R. (2010, June), *Capstones With An Industry Model* Paper presented at 2010 Annual Conference & Exposition, Louisville, Kentucky. 10.18260/1-2--16899

Meade, R.B., Fiori, C.M., and Malone, M.S. (2000). “Experiential preparation for the classroom.” Proceedings of Geo-Denver 2000. https://ascelibrary.org/doi/10.1061/40522%28297%291

Oakes, W. C. (2011, June), *Service-Learning Partnerships: Improving Education and Addressing Community Needs* Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2--18406

Pearson Weatherton, Y., & Chen, V. C. P., & Mattingly, S. P., & Rogers, K., & Sattler, M. L. (2012, June), *Sustainable Engineering Internships: Creation and Assessment* Paper presented at 2012 ASEE Annual Conference & Exposition, San Antonio, Texas. 10.18260/1-2--21976

Saviz, C. M., & Fernandez, A. A., & Basha, E. A., & Ellis, A. P., & Hammarstrom, K., & Leon, F., & Hildebrand, J. B., & Ton, S. (2011, June), *Engineering Internships in Social Entrepreneurship: Developing Partnerships and Student Perspectives* Paper presented at 2011 ASEE Annual Conference & Exposition, Vancouver, BC. 10.18260/1-2—17877

Sloan, J.A., Beauregard, M.S., and Russell, M.M. (in press). “High impact practices in the civil engineering major at the United States Air Force Academy.” Book Chapter accepted for *High Impact Practices in Higher Education: International Perspectives*. Sengupta, E and Blessinger, P. Eds. Emerald Group, U.K

Stanford, M. S., & Sloan, J., & Pocock, J. B., & Russell, M. M. (2020, June), *A Construction Management Competition as the Basis of a Capstone Culminating Event* Paper presented at 2020 ASEE Virtual Annual Conference Content Access, Virtual On line. https://peer.asee.org/33987

Strayhorn, T. L. (2018). *College students’ sense of belonging: A key to educational success for all students*. Routledge.

Wambeke, B. (2022, August), *Construct First, Design Later – Evolution over the past 25 years* Paper presented at 2022 ASEE Annual Conference & Exposition, Minneapolis, MN. https://peer.asee.org/41158

Welch, R. W., & Rabb, R. J., & Bower, K. C. (2018, June), *Industry Partnerships Assist Programs for Accreditation* Paper presented at 2018 ASEE Annual Conference & Exposition , Salt Lake City, Utah. 10.18260/1-2—30657

Appendix A: Survey Questions for Students

Pre-course Student Survey Questions:

1) For civil engineering majors, when did you declare civil engineering (CE) as your major?
   a) Fall semester freshman year
   b) Spring semester freshman year
   c) Fall semester sophomore year
   d) Spring semester sophomore year
   e) For civil engineering majors, why did you choose civil engineering as your major?
   f) For civil engineering majors, what other majors, if any, did you consider?
2) Did you hear about FERL prior to declaring your major?
3) On a scale of 1-5, rate how you agree with the following statements.
   1 - Strongly disagree, 2 – Disagree, 3 - Neither disagree nor agree, 4 – Agree, 5 - Strongly agree
   a) I plan to pursue the Civil Engineering career field in the Air Force.
   b) I plan to pursue another non-flying career field in the Air Force.
   c) I plan to pursue a flying career field in the Air Force.
   d) I know my classmates in my major well.
4) What are you most looking forward to in FERL?
5) Rank your level of interest in the following CE sub-disciplines 1-n.
   1=most interested, 2=second most interested and so on.
   a) Structures
   b) Construction
   c) Environmental
   d) Geotech

Post-course Student Survey Questions:

1) What is your greatest takeaway from your FERL experience?
2) What is one aspect or activity the program should continue to include in FERL?
3) What is one aspect or activity that you would recommend removing or changing?
4) On a scale of 1-5, rate how you agree with the following statements.
   1 - Strongly disagree, 2 – Disagree, 3 - Neither disagree nor agree, 4 – Agree, 5 - Strongly agree
   a) I plan to pursue the CE AFSC in the Air Force.
   b) FERL has made me more strongly consider CE as an AF career choice.
   c) I know my classmates in my major well.
   d) The enlisted mentors helped me learn the course material.
   e) The enlisted mentors helped me develop into a better teammate, leader, and mentor.
5) Rank your level of interest in the following CE sub-disciplines 1-n where 1=most interested, 2=second most interested and so on.
   a) Structures
   b) Construction
   c) Environmental
   d) Geotech
6) What's the one thing about FERL that makes it such a special and beneficial experience, and why?

Appendix B: Interview Questions for Students

Interview Questions for Students:

1) Do you plan to pursue the CE AFSC in the Air Force?
2) How has FERL influenced you to consider CE as an AF career choice?
3) How did FERL impact how well you know your classmates in the CE major?
4) How did the enlisted mentors help you learn the course material?
5) How did the enlisted mentors help you develop into a better teammate, leader, and mentor?
6) What specific aspects of your FERL experience solidified or strengthened your interest in pursuing CE? Explain.
7) What specific aspects of your FERL experience detracted from your interest in CE? (e.g. you think it should be removed or changed) Explain.
8) What would you add to the FERL course that was not part of the curriculum you experienced? Explain your rationale.
9) How would you describe your experience as a member of the FERL course? (e.g. to what extent did you feel accepted, included, that you belonged, etc.) Can you tell me about a specific time when you MOST felt included?
10) Share a couple of examples of how your relationship with the mentors impacted your performance as a FERL participant.
11) Share a couple of examples of how your relationship with the mentors impacted the perception of your ability to complete an engineering degree.
12) What aspects of your FERL experience, if you had had them in your 4 degree year, would you say, would have sparked your interest in engineering or solidified your interest before declaring?
13) What aspects of your FERL experience, if you had had them in your 4 degree year, would you say might have helped you know or understand better what you would be signing up for as a CE major?
14) What sub-disciplines within civil engineering are you most interested in pursuing further study?
15) What's the one thing about FERL that makes it such a special and beneficial experience, and why?