A Phenomenographic Analysis of Three Real-World Experiences in Clemson University's Industrial Engineering Program

Abstract

As a first step in our efforts to assess the impact of an Industrial Engineering (IE) curriculum on the students, we recently completed a qualitative study of 7 senior majors one week before their graduation. Using phenomenographic methodology, our goal was to explore how students perceived their experiences with the curriculum and how they view its impact on their future careers. In the course of this work, the students offered specific, unprompted comments comparing three activities that were intended to provide real world experiences, namely co-op, capstone course and undergraduate research. Inductive, grounded theory analysis of this aspect of the student interviews revealed that while co-op, capstone course, and undergraduate research had a significant impact on their experience as majors, students viewed each one in substantially different ways. In addition to describing the students' perceptions of their experiences, we also provide implications for using real-world activities in STEM education.

Keywords: Situated learning, cooperative studies, internships, capstone courses, undergraduate research, engineering

1. Introduction

Real-world examples and activities are frequently used by science, technology, engineering, and mathematics (STEM) instructors to engage students by connecting with their life experiences. In a classroom setting, typically, the goal is to help students learn some of the more important and/or abstract concepts of the discipline. Bringing the real world into other aspects of the curriculum can also prepare students for their future careers and expose them to scientists' methods of inquiry and to communities of practice (CoP). Common examples of real-world engagement in the college curriculum include undergraduate research (UR), professional internships, and inquiry-based methods of instruction. When instructors deem an aspect of the curriculum as "authentic practice", it is often based on the instructors' or CoP's definitions and perspectives. However, real-world activities are most effective if they are also *relevant from the* *learner's standpoint* (Bhattacharyya, 2010). Personal relevance, like knowledge, is achieved through the individual's construction of meaning for the material and the activities (Bhattacharyya, 2008; Driscoll, 2005).

Similar to other engineering curricula, the Industrial Engineering Program at Clemson University offers three activities designed to provide students with real-world experiences: work experience in the form of cooperative assignments and internships, a capstone design course, and undergraduate research. Cooperative assignments (co-ops) and internships intend to ease the transition between the classroom and the workforce. University sponsored co-ops typically require a multi-semester commitment during which students spend some semesters engaged in paid career-related, learning experiences. Like other co-op programs, it is intended that this program give meaning to academic work while allowing students to develop interpersonal skills (Cates & Jones, 1999). While not required, co-ops are strongly encouraged by the Department. Unlike the longer-term commitment associated with co-ops, internships tend to be limited to one semester or a summer; however throughout the rest of the paper we refer to both of these work experiences as co-ops.

A second part of the curriculum that is intended to provide students with authentic practice is the senior capstone design course, which is intended for students in their final semester of undergraduate study. The capstone course focuses on the execution of a semester-long design project performed in teams for industrial- and service-sector clients. Thus, even though this activity occurs within the confines of a formal course, the projects that are a part of the capstone course are not simulated exercises of the real world since students work on real projects with real expectations. Undergraduate research in the Department is an intensive, discovery-oriented approach to learning under the mentorship of a faculty member or advanced graduate student. It represents one of the alternatives available to satisfy a degree requirement, i.e., it can be chosen as a technical elective. A typical research experience spans at least two semesters, with participants working in groups with other peers.

2. Motivation for Study

There is a relatively, large and growing body of research that has attempted to assess the outcomes of student participation in the real-world curriculum activities described above. Summarized in Table 1, this work describes a wide range of cognitive and affective benefits for STEM students.

Table 1: Summary of research on effects of real-world experiences on students

Experience	Documented Benefits
Cooperative Education	• Higher GPA's and starting salaries (Blair, Millea, & Hammer, 2004; Fletcher, 1989; Gardner, Nixon, & Motschenbacker, 1992; Lindenmeyer, 1967; Schuurman *et al.*, 2008). • The quantity of co-op correlates positively with starting salary after college (Blair, Millea, & Hammer, 2004; Gardner, Nixon, & Motschenbacker, 1992; Schuurman *et al.*, 2008). • Students who co-op find jobs faster and obtain promotions and advancements faster once employed than students who do not co-op (Fletcher, 1989; Schuurman *et al.*, 2008; Wessels, 1996). • Students are able to gain a realistic expectation of the real-world (Fletcher, 1989). • Increased "soft skills" that are deemed critical for industry success including communication and teamwork skills (Gardner, Nixon, & Motschenbacker, 1992). • Increased self-confidence, responsibility and maturity (Cates & Jones, 1999; Gardner, Nixon, & Motschenbacker, 1992). • Students learned problem solving skills in real-world settings and learned about applying the engineering process to solve problems (Pierrakos, Borrego, & Lo, 2008a). • Co-op experiences allow students to clarify or validate career goals (Pierrakos, Borrego, & Lo, 2008a).
Capstone Course	• Instill teamwork, communication, and project management abilities that include prioritization, planning, organization, and resource allocation (Davis, 2001; Kremer & Burnette, 2008; McKenzie *et al.*, 2004; Pierrakos, Lo, & Borrego, 2007). • Teaches students to produce quality designs, test and defend their product's performance, and make decisions based on broad criteria (Davis, 2001). • Senior design gives educators a chance to discuss character attributes including honesty and integrity, work ethic, loyalty, and accountability due to the team and project nature of the courses (Kremer & Burnette, 2008). • Senior design allows students to design and conduct experiments to creatively solve problems (McKenzie *et al.*, 2004). • Students rank personal and professional skill gains higher than technical outcomes (Pierrakos, Lo, & Borrego, 2007).

Undergraduate Research	• Increased research skills, productivity, and interest (Kremer & Bringle, 1990). • Enabled students to meet problem –solving, analytical, and experimentation skills (Pierrakos, Borrego, & Lo, 2008b). • Afford personal and professional growth and development, self-understanding, and allows students to find themselves as a young scientist (Hunter, Laursen, & Seymour, 2006; Seymour *et al*., 2004). • Increase undergraduate understanding, confidence, and self-awareness (Russell, 2005; Russell, Hancock, & McCullough, 2007; Seymour *et al*., 2004). • Students are able to make connections between bodies of knowledge, apply their prior knowledge and reflect on their thinking (Seymour *et al*., 2004). • Increased oral communication skills (Kardash, 2000; Pierrakos, Borrego, & Lo, 2008b; Seymour *et al*., 2004). • Allow undergraduates to become part of community of practice which affects their careers (Seymour *et al*., 2004). • Help clarify student interest in STEM careers (Russell, 2005; Russell, Hancock, & McCullough, 2007). • Participants are accepted to higher education programs faster than non-participants (Kremer & Bringle, 1990). • Increase anticipation of higher education degrees or research as a career choice (Kremer & Bringle, 1990; Russell, 2005; Russell, Hancock, & McCullough, 2007; Seymour *et al*., 2004). • Such experiences validate student plans to attend graduate school (Pierrakos, Borrego, & Lo, 2008b).

Understandably, most of the previous studies focused on specific outcomes. Although a few researchers analyzed students' perceptions of these experiences, to our knowledge, no studies investigated students' perceptions of real-world experiences in relation to each other. We recently completed the first phase of an assessment of the impacts of the Industrial Engineering curriculum. In the course of this work, we elucidated some of the factors that affect the personal relevance that students can use to classify real-world activities. We believe that these outcomes offer an important step in understanding how individuals construct personal meaning for elements of a curriculum. We report some of the significant findings of this research and discuss implications for training STEM students at the tertiary level.

3. Methodology

The data we report in this paper were gathered during the course of a study guided by the following questions:

- What are students' perceptions of their experiences as Industrial Engineering majors at Clemson University?
- According to the students, which activities in the curriculum have the greatest impact on them?

The word "perceptions" was purposely added to the first question as it would have been impossible to investigate all of the students' experiences over 4-plus years of study. As to the second question, we wanted to see if there was one part of the curriculum the students felt helped (or will help) them the most as they pursue future endeavors in Industrial Engineering. In particular we wanted to compare newly instituted undergraduate research experiences, with more traditional and longstanding alternatives such as senior design and co-ops.

Since our goal was to understand the industrial engineering experience from the students' viewpoint, we deliberately did not want to approach this research with preconceived theories regarding the students' experiences. Thus, we felt a qualitative approach was the appropriate method of data collection and analysis, since it would give voice to the students and, therefore, help us fulfill our research goals.

Data were collected and analyzed through the lens of phenomenography, which Marton (1994) describes as "… the empirical study of the limited number of qualitatively different ways in which various phenomena in, and aspects of, the world around us are experienced, conceptualized, understood, perceived, and apprehended." Phenomenography was a powerful theoretical framework for this study because it could be used to probe the students' conceptualizations of their experiences. Furthermore, we had no reason to believe that these students would all have a singular conceptualization, which is the reason for not choosing phenomenology.

Due to the in-depth nature of the data collection process, qualitative studies typically involve few subjects. Thus, to ensure that the data contain the information relevant to the research goals, participants are *purposefully sampled* (Patton, 2002). We used criterion purposeful sampling in this project; all the participants were Industrial Engineering majors at Clemson University, who had fulfilled all of their graduation requirements by the time of data collection, which was the week between the end of their final term and the University's Spring Commencement Exercises. Participants were recruited through an IE faculty member and were interviewed after their exit interviews with the Department Chair. An incentive of a $10 gift card was provided for the students to participate. A total of 7 individuals – 4 female and 3 male – volunteered for this study. The 7 individuals comprise roughly, 30% of the entire graduating class for that year. The female-to-male ratio of our sample is nominally greater than that of the overall graduating class (43% female); and, as such, may represent a potential limitation in the data.

The students participated in a single audiotaped, semi-structured interview lasting approximately 30 to 45 minutes. This allowed the interviewer to focus on the key points of the study but also to ensure that the participants' voices were captured during the interviews. The interview guide is shown in Figure 1. Given that the goal of this study was to understand the participants' experiences, we purposely did not ask them any questions that could be considered as "leading", and is the reason that most of the interview questions are so open-ended. In the program from which we recruited the participants, all of the advanced electives carry a 400-level course designation. Investigating the students' choices for these courses would, therefore, offer important insights into their perceptions of the curriculum and the field. It is important to note that both the capstone and undergraduate research courses are at the 400-level.

All of the interviews were conducted by the same individual. The interviewer is not a member of the Department of Industrial Engineering although he is a faculty member at the University, and all participants were made aware of this fact. Moreover, he neither had prior interaction with any of the research participants nor any experience with any field of engineering. The interviewer noted key observations during the interviews and added any insights regarding the interview in post-interview notes. These constituted the field notes.

Figure 1: Interview Protocol

- *When did you decide to major in industrial engineering (IE)? What factors led to your decision?*
- *To you, what does it mean to be an industrial engineer? What do professional industrial engineers do? What experiences have promoted to your current understanding?*
- *Which 400-level courses did you take? When did you take them? On what basis did you choose your courses? Looking back, are you satisfied with your choices?*
- *Can you describe the content of your 400-level courses? What was your overall impression of the work? What do you think you got out of it that will help you after graduation?*
- *Did your work in the 400-level courses help you with other IE courses? How about courses outside of your major? In what ways did the 400-level courses affect these other courses?*
- *How would you characterize your interactions with the IE faculty? Have they changed over time? Why or why not?*
- *What do you plan on doing after graduation? What factors contributed to your decision?*

All of the interviews were transcribed verbatim. The interview transcripts and field notes were repeatedly examined on an individual basis by all three researchers – 1 chemical education researcher and 2 industrial engineers – to find trends in the data. The research team met to discuss their findings. The result of that meeting was that only codes that all observed or unanimously agreed upon were used in the next phase of analysis. A total of 39 codes resulted from this process of open coding (Patton, 2002). Again on an individual basis, each researcher took the 39 codes from the previous step and grouped related codes into larger categories. The researchers met again and only categories that all of the team members observed or unanimously agreed upon were kept as data. A total of 8 categories resulted from this process of axial coding (Patton, 2002). Finally, as a team, the researchers reviewed all of the categories and developed assertions that described the overall data. This paper focuses on only one of these assertions because it offers insight into how all curricula can impact students, not just those in engineering or other STEM fields.

4. Results and Discussion

As noted in the introduction the co-op, capstone, and undergraduate research are the 3 primary elements of the IE curriculum by which students can get advanced, real-life learning and professional experiences. Although the interviews were designed to be broad enough to get the students impressions regarding their entire undergraduate experiences, the students spontaneously focused on co-op, capstone, and research. *While all three had significant, positive impacts on their experience as majors, students viewed each one of these activities in substantially different ways*, as summarized in Table 2. Furthermore, *none* of the students considered the capstone course as a real-world experience, even though all but one of them felt that it was a significant learning experience. It is important to remind the reader that these results represent the students' *conceptualizations* of their experiences. As such, there may be some apparent incongruities between these beliefs and an external or objective reality.

In describing how the students viewed each component of the curriculum, we will quote the students directly from the interview transcripts to support our claims. These are offered without alteration in grammar and/or syntax. To protect student confidentiality, each participant was given a pseudonym, and any identifying words or phrases were altered. These alterations are indicated in square brackets. Finally, square brackets in quotes are also used for any annotations made by the authors.

4.1 Co-op Experience

The students felt that the primary learning outcome of the co-op experience was to help them learn about the professional world, as tersely described by Mary, who had experience with co-op, UR, and senior capstone:

"But I feel like the co-op prepared me more professionally like to graduate and get a job."

Table 2: Summary of student perceptions of real-world activities

Activity	Student perception	Emerging Interview Observations
Co-op Experience	Preparation for a professional career as an IE	• Teaches how classroom concepts are applied to the real-world • Teaches soft skills • Helps students define what they like/dislike within the IE discipline • Projects tend to be short-sighted, addressing the symptoms of a problem rather than focusing on the process of problem solving
Capstone Course	Just another course	• Lack of personal decision-making powers. Follows a very structured (one-size fits-all) approach with prescribed methods and assignments • Assignments are seemingly unrelated to the project goal • Projects seem unrealistic despite having a real-world client • Many students were unhappy
Undergraduate Research Experience	A unique experience which is beneficial, especially in preparation for graduate school	• A sense of ownership, since the experience is customized and elected • Students understood that "failing" was part of the process; however, this was viewed as a challenge which motivated rather than impeded success • Allowed students to develop personal and collegial relationship with mentors

One of the most significant ways in which co-ops prepared students professionally was that it helped students identify areas of the field they liked or disliked. Consider the following comment from Beverly:

> "But then I think outside of the typical industrial engineering goal, a lot of IEs are managers. Every boss I had at my co-op, his boss's boss's boss is an industrial engineer. Which is awesome. And also I think it's just expanding into so many industries. I don't want to ever step foot into another manufacturing plant. Like I want to be able to go into the service industry or the healthcare industry or I think anything in that way. And so I think it's really neat that you can do so much with it."

These results are highly consistent with previous work cited in Table 1. Interestingly, however, the students felt that the co-op environment was not a good one for learning the "intellectual" skills needed to be an industrial engineer. Beverly, who had the most co-op experience of all the participants, explains:

> "Co-oping was a lot different than working on a research project. At work it was kind of how motivated I was as to what they let me do. I had to prove myself. And once I proved myself I got a lot of work. But nothing was ever for an extended amount of time. Like I never had a project that lasted for a long time. It was almost like when I was talking about the fighting fires earlier, everything was always a fire and everything always had to be done right away. Whereas when we do research we want to like actually solve like the root cause of the problem. Where when I was co-oping, it was like anything to cover it up or -- yeah, anything to cover it or just like temporarily fix it."

Like Beverly**,** the other students felt that the work environment was there to get things done, whereas the undergraduate research environment was for them to learn. This disparity will be revisited below.

Even though the students didn't perceive the co-op environment as one to foster their intellectual growth, it seemed to help change some of their attitudes towards how they approached course work afterwards. Consider the following comment in which Jason describes his return to the classroom:

> "Oh, definitely. [Referring to the effects of co-op on course work.] It's a more systematic approach. You actually understand why you're learning it. For instance I took a safety course after my co-op and I didn't really do a whole lot with safety when I was on the co-op, but I feel that I could have, having known this information, worked with the safety end of things."

In the least, the co-op experience provided Jason with motivation to be more engaged in his class because the work experience had helped him develop meaning for the material taught in that course. According to Ausebel's theory of meaningful learning, construction of meaning, or personal relevance, is a key and necessary step for deep knowledge construction (Driscoll, 2005). Schuurman *et al.* (2008) have shown that co-op students tend to have higher GPAs than their non-co-op counterparts. Perhaps, this sense of meaning is one explanation for Gardner and co-workers' (Gardner, Nixon, & Motschenbacker, 1992) prior observation that students who participate in co-ops tend to experience increased self-confidence.

4.2 Capstone Course

Students felt that this course gave them the opportunity to work in teams and allowed them to practice and implement methods learned in courses, as Sandra describes:

> "Well, one thing definitely is the projects that I worked on, I've been able to use in interviews trying to get new jobs. That kind of shows them some of the work that I've done, which is nice, having something to show that you've done. But also like working in groups, especially in [senior capstone course], it was kind of a good learning experience, how to deal with that like team aspect of things and people strengths and weaknesses and things that really bother you and your own kind of the negative things that you might bring to a group so that you can know to put them in check and when they're getting out of hand and how to deal with those."

Like Sandra the other students benefited from the senior capstone experience. However, they did not see this course as a real-world activity on par with undergraduate research or co-op, as is explained by Brittany:

> "I think in the case of senior design, you're following the syllabus and the course structure of your professor. You're not really working for your client still. You know, like you're -- you still have to write papers the way your professor wants you to. You still have to make your presentation the way your professor wants you to. Like you're not using your company's tools so to say like luckily I got to work for [name of company A] and the tool that the department [referring to IE department] uses is a [name of analysis tool]. So it was just perfect that I was working for [name of company A] and I got to use a [name of analysis tool]. There were other groups working for [name of company B] and [name of company C]. They have to use [name of analysis tool] too. Like I think that in a senior design class it's so -- it's structured to a point that it's not realistic anymore. And I know that the clients you're working for, I think it would be great if they used your solutions and things like that."

This passage suggests that “real” clients do not necessarily make students perceive the activity as real world. It seems that students perceive real-world problems as those for which there is a genuine need for a solution, *i.e.*, the primary goal is not a grade. As such, students perceived that the capstone course was not as valuable an experience as either their co-op or research experiences in preparation for a career as an IE. The capstone course has an assigned project, prescribed methodologies and fixed deadlines, which the students often feel are not the most suitable to the project. Even though the students dealt with companies, many of which did have genuine needs for solutions to existing problems, the overwhelming sentiment is that this is another course, not an example of authentic practice, and that all of the other activities had fixed deadlines.

We believe there are two primary reasons for these differences: sense of uniqueness and sense of ownership. In the mandatory capstone course, two teams work on the same project, and while pairs of projects are not designed to be similar, students often perceive them to be similar because of the generic solution process. On the other hand, for both co-op and undergraduate research, each of the experiences is distinct. In addition, students are selected to participate based on an application process. Thus the students recognize these as being unique experiences and feel special for participating in them. Also, the students perceived that only co-op and undergraduate research involved solving original problems, which resulted in a greater sense of responsibility. These assertions were eloquently captured by Mary:

> “Yeah. I think the difference comes in is with [undergraduate research] or with co-op, it’s more of a decision that you make personally. And with [senior capstone course] it’s more of you don’t really have a choice. It’s a class that you have to take regardless. So I think that’s where it comes in. And with [senior capstone course] it’s still a class so it’s

still structured. You still have things that you have to complete as part of your academic requirements. With co-op and [UR], it's kind of the same, but not really. Co-op is different because you don't have papers to write. You don't have, you don't have classroom things. And with [undergraduate research], depending on your project, it just kind of varies from project to project. … I don't know. I think it's more personal, more of an accomplishment for myself to say that I did this with little to no direction, opposed to I did this and so did everyone else. I think it separates you a little more, like when you do [undergraduate research] you're kind of making a conscious decision to step outside that box of comfort. And with [senior capstone course], like I said, everybody is going through it together, so you have that support system that you can fall back on. Like everybody is going through it. Everybody's having to write these papers. Everybody's doing this. With [undergraduate research], it's kind of like nobody really knows, but once you overcome the obstacle, it feels a whole lot better. It's like, yes, I made it. It's a better feeling when it's over, I think, for me anyway."

4.3 Undergraduate Research

UR was the activity that students found most fulfilling, especially as a learning experience. Interestingly, it was also the most demanding of the three activities since it involved open-ended questions and appropriate methodologies were not obvious. Consider the following comment from Joel:

"The biggest difference [of UR from co-op and senior capstone] I would say is when you're out there doing a project, nobody sits there and tells you, you know, or nobody knows, hey, you need to do [name of method] on this problem and that'll make things go way faster. And then you just have to figure out how to use the [name of method]. So I

> would say the hardest -- the biggest difference is that -- is being able to figure out which tool you need to use."

The students viewed this ambiguity in a positive light, acknowledging that as a good part of the process. The key to these students' perceptions was their interaction with their mentors. In the co-op setting, students felt that meeting the deadline was the most important goal. In UR, however, they felt that their mentor's priority was student learning, since the time deadlines were not as rigid and the guidelines provided to complete the projects were not as well defined. Thus, the students felt that the stakes of failure were far less threatening than in the co-op environment. Altogether, this set of circumstances increased students' confidence and pride as well as enthusiasm about their work since they had the uniqueness and the ownership that was lacking in the senior capstone course. These sentiments are summed up by Brittany:

> "Thesis [referring to UR] ranks first, internship second, senior design last. Again, with the thesis, it was my own work. It was -- it's funny because I guess Dr.[name of mentor] was up to it the whole time. She didn't want to like hold my hand during this whole process. The sense of accomplishment you get after doing something like that is great. Like it's my story to tell. No one else can take it from me. Like no one helped me on this."

4.4 General Discussion

As mentioned in the introduction, instructors and curriculum designers encourage students to engage in a variety of activities, which, from the standpoint of the instructors, are meant to provide students with real-world experience. There are primarily three methods with which faculty in the Industrial Engineering Department propose to achieve this goal: co-operative internships with companies; undergraduate research; and the senior capstone course.

The faculty certainly does not expect that students will acquire the same skills from each, but they also see these as congruous activities with similar requirements, such as meeting deadlines, etc. The students, however, perceived the similar characteristics very differently. For example, both undergraduate research and capstone required the submission of papers. Yet, the students viewed this as a burdensome exercise in the context of the capstone experience.

One could argue that these discrepancies were caused by poor instruction in the capstone course. However, as Sandra's comment clearly shows, capstone course was a positive experience for her and her classmates. Furthermore, the students' perceptions of co-ops and research were from multiple sources, especially since students spend a total of 3 semesters with up to 3 different companies during the co-ops. The data suggest, therefore, a reason other than an instructor effect.

5. Implications

In reflecting upon these results, it is interesting to view them in light of the students' reasons for choosing Industrial Engineering as their major. Like many engineering programs, Clemson's requires all its first-year students to attend a course in which presentations are made by faculty from each area of engineering. The goal is to help students choose their major based on their understanding of each specialty. However, all but one of the participants in this study chose Industrial Engineering for one reason: it is people-oriented. When further probed the students clearly remembered that they were drawn to this major primarily for this reason; not based on the type of work they would be doing. This was true even of Joel whose father is an industrial engineer:

> "Well, actually when I came in I wanted to be -- I thought I wanted to be a mechanical engineer. And after we went on all the different plant tours and we kind of learned what all the different kind of engineers did, I'm really more of a people person than not, I guess. And the stuff that it looked like the IEs would be doing, it looked like it was a lot more people oriented than most of the other engineering fields which appealed to me. Also, my dad is an IE so I guess that's probably one reason why it naturally appealed to me."

The impact that the "people-oriented" nature of the field made on the students cannot be minimized since these data were collected from graduating seniors, at least 4 years after they attended these presentations.

In addition to their desire to work with people, another aspect of their personalities that the students emphasized was individuality. For example, one of their motivations for pursuing co-ops and UR was that they were not for "everyone." Thus, the activities that the students valued most naturally appealed to the students' personalities and their desire to help people and make things better.

The students' insights, therefore, provide STEM instructors important guidelines for designing real-world activities. Based on our data, incorporating "real-world-like" activities within a traditional classroom structure does not necessarily make the activity real-world in the minds of the students. Our data suggest that it is important to understand the attributes of real-world activities that a group of students value before designing a curriculum. Doing so increases the likelihood that the students will find that authentic practice relevant. However, an important but difficult implementation issue is to create genuine experiences for the student and to create opportunities for students to have unique experiences. Thus instructors and departments must strike a delicate balance between providing sufficient instruction and structure to enable students to learn, but not too much as to inhibit their creativity and sense of ownership.

6. Conclusion

In this study we have explored the perceptions that industrial engineering graduates have about three real-world activities: co-ops, the capstone course, and undergraduate research. While there is validity and merit to offering different "real-world" experiences in that they may benefit students in distinct ways by providing different levels of complexity, safety and ownership, some of the intended benefits of these programs are similar. For example, some of the intended outcomes shared among all three experiences are: to promote communication and teamwork, provide genuine learning experiences to deepen understanding, to introduce students to the life of an engineering professional, and to create opportunities for students to apply skills and knowledge learned in the classroom (Pierrakos et al. 2007, 2008a, 2008b). Interestingly, our data clearly show that students are able to perceive the differences between each one of these curricular activities and, therefore, likely derive different sets and levels of benefits from each. We acknowledge that the observations were collected for a very small program so that even with purposeful sampling it is difficult to make generalizations to other programs. However, these initial findings are interesting and, in our opinion, merit conducting a similar and larger study in other departments for comparison.

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