Scaffolding reflection across the design curriculum: Triangulating Student, Alumni, and Faculty Perspectives of the Role of Design within an Engineering Science Program

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1.0 Introduction

Higher education institutions regularly make significant investments to promote a high-quality undergraduate experience [1]. Curriculum design in higher education is localized, and standardization of higher education curricula mainly targets meeting specific accreditation bodies' requirements [2]. As such, little relational emphasis is placed on how the planned curriculum is enacted by instructors and experienced by students [3].

With the rise of mass education systems, universities have had to restructure and invest in curriculum changes that produce graduates with professions and the skilled workforce required by the emerging knowledge-based economy [4]. Despite their substantive attention to curriculum and instruction, post-secondary educational institutes have come under scrutiny regarding their program structures, course sequences and responsiveness to societal and industry needs. Post-secondary educational institutes spend a large portion of their resources on curriculum development, and the sequence of courses in a program has been the subject of scrutiny. Many have argued that the curriculum should reflect industry linkages and create work-ready graduates with lifelong learning competencies at the end of their program [5]. Moreover, emerging trends in active learning and student-centred instruction have placed further pressure on universities to examine their course offerings and sequences.

In the context of engineering education, graduate engineers need to effectively balance two very different thought paradigms: design thinking and analytic thinking. Design, usually taught across a program, has been explicitly highlighted as a competency and experience that undergraduate engineers need to achieve [6]. Most engineering programs have included design across the curriculum - moving away from the bookend fashion in the past [7]. These design courses, strategically strewn across the undergraduate program, help students experience design thinking frequently and provide a space for curriculum innovation. The design courses can be thought of as part of a learning progression in which students develop their professional identity through epistemic activities, social networks, and sense-making.

However, most engineering students see few connections across the sequence of design courses and their technical experiences while being exposed to different perspectives on the field [8]. Therefore, more research and engineering education partnerships are needed to examine programs' coherence around central disciplinary competencies such as critical thinking, collaboration, and design. Another critical factor in student engagement, retention, and preparation for the workplace is the development of students' professional identity. To better support students' professional identity development, we must understand what motives, values, and experiences across the curriculum contribute to its construction.

This study reports on our recent interactions with instructors, alumni, and students of an Engineering Science program. The data was collected through interviews and focus groups that allowed us to understand how each group of participants understood the role of engineering
design education. The data analysis showed us that to have a nuanced understanding of the purpose of design courses, we need to ask students to reflect on how they connect their design experiences to their professional identity through reflective writing assignments. We present a reflective framework to understand how students make meaning and seek coherence through sequences of design courses using a collective knowledge construction approach. The purpose of these reflective activities will bring evidence forward to curriculum integrators and instructors on how students are making sense of the unique experiences of engineering design within the curriculum [9].

2.0 Literature Review

Here, we review literature concerned with how learning occurs within a particular discipline, such as engineering. Any understanding of learning should also be informed by how epistemic expectations influence curriculum design, such as by informing learning progression and design course sequences in the context of this study. Finally, the literature review looks at how coherence in the curriculum is conceptualized, evaluated, and achieved.

2.1 Epistemic knowledge

Generic skills, such as critical thinking and problem solving, are important for deep learning and are used to organize the curriculum and can be taught independently of traditional subjects. However, cognitive science literature considers deep learning differently. This school of thought is less concerned with pedagogy and generic skills as the starting point for learning and more concerned with how cognitive advancements are derived from domain-specific content knowledge leading to abstract thinking. This is not to say that skills and competencies are unnecessary, but in this argument, these skills emerge as by-products of the growth in understanding domain-dependent and domain-specific epistemic knowledge [10]. In other words, the ability to transfer knowledge and problem-solve emerges from domain-specific contexts, not generic ones [11].

For example, learning to design in undergraduate engineering is a higher-order mentality that brings in art abilities and scientific inquiry, all of which are "chaotic and seldomly mathematically elegant" [12]. Engineering design, as stated by Dym et al. [13], is: "a systematic, intelligent process in which designers generate, evaluate, and specify concepts for devices, systems or processes whose form and function achieve clients' objectives or users' needs while satisfying a specified set of constraints". This definition presents design as a deep learning process that depends on the systematic, intelligent generation of design concepts and the understanding of disciplinary specifications that make it possible to realize these concepts.

Deep learning involves coming to understand and utilize the relationship between concepts and procedural knowledge by applying conceptual knowledge in new contexts [14] [15]. Fullan et al. [16] suggest deep learning is exemplified by a strong sense of identity around a purpose or passion, creativity and mastery in relation to a valued pursuit, and connectedness with the world and others. The more the curriculum design, teaching methods, and learning activities reflect the conceptual knowledge structures, the more likely it is to understand the increasing complexity of the knowledge [11]. For example, Erickson [3] argues that transfer and synergistic thinking only
occur as a result of engaging in conceptual thinking; concepts are the mechanism which enables humans to 'transfer understandings to multiple concrete examples [to] develop brain schemata for insightfully seeing patterns and connections between new knowledge and prior knowledge,' moreover 'synergistic thinking requires the interaction of factual knowledge and concepts.'

2.2 Learning within a Discipline

Donald [17], in her book on learning within disciplines, examines the thinking processes employed in different disciplines and how they lead to the desired intellectual development of students. She describes the learning environment each discipline offers, elaborates on the knowledge and higher-order thinking processes that are deemed necessary within a discipline and, lastly, how these processes are cultivated in the student's learning and reasoning. She describes engineering programs as reflecting an active response to the global demand for technological changes. Professors, researchers, and students function in practical and pragmatic contexts. The thinking processes instilled in engineering students reflect the goals of engineers, which is to develop products and product-oriented mechanisms. Problems are compartmentalized into simpler blocks, and design courses aid students in being intuitive that the problem needs to be solved. Also, through design experiences, students learn group dynamics as they must learn to rely on each other's expertise.

2.3 Epistemic Fluency

Every academic discipline characterizes problems differently, and their solutions typically require distinctive kinds of knowledge [18]. These characteristic patterns of actions for effective inquiry have been referred to as epistemic games [19] [20]. Design courses in the engineering curriculum help novice community members identify and practice their discipline's epistemic games. Through instruction, emphasis on specific topics, and weightage on assessments, instructors show students the types of knowledge and dispositions valued in the profession. The capability to recognize these patterns of knowledge and action is known as epistemic fluency [18].

Fluency in one's profession requires students to have a deep understanding of the nature and demands of their profession [21]. This expectation then falls upon educators to know how to design and manage a learning environment that offers reliable forms of assessment that support the students’ developing career identity.

2.4 Learning Progressions

Shavelson and Kurpius [22] described learning progressions as a sequence of successively more complex ways of reasoning about a set of ideas. These sequences depend on instruction and interactions with students' prior knowledge and in constructing new knowledge. The goal is to move learners from being a novice to an expert through extensive experience and practice. The authors alerted that learning progressions are hypothetical and inferential and that there was no one correct order of progression. They emphasized that learning in succession evolves with changes happening concurrently in multiple interconnected ways.
Similarly, Corcoran et al. [23] reported that learning progressions provide empirically grounded hypotheses about how learners understand and apply core concepts and related practices. Over time and with suitable instruction, learners grow and become sophisticated in how they interact with their comprehension of core ideas of the discipline. Corcoran et al. [23] also noted that learning progressions are not based on logical analysis in selecting sequences of topics and learning experiences but are based on research with empirically grounded and testable hypotheses.

The current characterization of learning progression emerged from the field of assessment, particularly in developing assessments to track students' progress over time [24]. The idea of learning progressions shares similarities with earlier educational philosophies such as the concept of developmental corridors [25], zones of proximal development [26], deepening learners' knowledge over time with a spiral curriculum [27] and cognitively guided instruction [28]. For example, Brown and her colleagues introduced the concept of bandwidths of competence [29]. She then describes that these bandwidths of competence can be thought of as developmental trajectories that grow in "stepping stones towards mature thinking" [30].

2.5 Design Spines

Design courses provide explicit experiences to hone design skills, which are considered to be an integral aspect of an engineering practice [31]. These experiences have been implemented in engineering schools typically as a cornerstone and a capstone design course. Recently, institutes have reasons to believe that design experiences need to be orchestrated more evenly across the curriculum [32][33][34]. Referred to as a "design spine," this sequence of design-oriented courses is a type of learning progression to help students gain an ever-deepening understanding and fluency with design, progressing from designing for issues with known solutions and progressions toward addressing real-world and research challenges [35]. The author in [35] also points out that a design spine, through several cycles of design, may help students to overcome habits detrimental to design, such as jumping to propose solutions. Other implicit forms of design appear in non-design courses with a project-based pedagogical approach or applying design thinking to address an open-ended challenge.

A design spine may also be connected through a design framework where certain elements of the framework are emphasized in each course to develop confidence and competence through repetition [36], which is difficult to achieve in a bookend (cornerstone and capstone) curriculum approach [7]. A design spine/learning progression provides a structure that can thrive through changes such as scaling up a program, increasing offerings of courses, and changing instructors. In addition, the design spine provides a reflective space about the expectations of the profession for students through active participation, which eventually allows them to develop their identity as an engineer [37].

2.6 Program Coherence

As with any sequence of courses and experiences, students should feel the various parts of the program are interconnected and purposeful. Education programs are often plagued by fragmentation within program coursework and between theory and practice. Students must
experience coherence in their program if they are to overcome difficulties in integrating theory and practice [38], experience their program as a whole instead of as “disconnected continents” [39], and find their professional identity [40]. Often, there is a disconnect between planned and enacted curricula [41]. Students have aligned experiences when they can build upon their existing knowledge base and integrate new knowledge and interpretations. In addition, coherence in a program is enhanced when educators start to think collectively about what their graduates would need instead of focusing on their personal wishes [42].

2.7 Reflective Practitioners

Reflective practice is more than just thoughtful practice. Schön’s notion of reflective practice was a reaction against an instrumental notion of the teacher as a technician implementing others’ knowledge in practice [43]. McArthur-Rouse [44] stresses the need for the development of professional identity, and Booth et al. [45] believe that to enable the development of practice, individuals need to explore knowledge that is both tacit as well as explicit. Booth et al. [45] believe that a community provides a vehicle for the translation and transmission of tacit knowledge, thus aiding the development and understanding of expectations of the profession.

3.0 Research Context

The department under study provides design courses across its curriculum, known as the design spine. In the first two years, the entire cohort takes foundational design courses. In the final two years, the design experiences vary depending on the specialization the student has chosen. All students graduate with a capstone design experience. In this article, we present the qualitative results of a program evaluation of the perceptions of faculty, alumni, and students regarding the contribution of the design curriculum to the professional engineering identity. The analysis of the program evaluation data has led to the development of an instrument to understand the role of the design spine better. As such, reflection assignments will be co-developed with instructors to capture how students make sense of the various expectations of the design spine curriculum and how they draw connections to their evolving professional identity. A conceptual framework of a curricular intervention is proposed that incorporates opportunities for group and individual reflection across all years of the undergraduate program.

4.0 Methods

Engineering programs undergo regular program evaluation for accreditation and quality assurance requirements. In the context of this study, we took a different and less common approach in evaluating our program that made us take a step back and scrutinize program goals and teaching practices. This project benefits from such a commitment, in which a nationally reputable Engineering program took an academic approach to this process, orchestrating a multi-stakeholder design process in its own self-study and evidence-based improvement of its design spine. This study builds on relevant literature in higher education and curriculum studies, as reviewed before, and applies a qualitative methodology including a design-based research approach.

4.1 Participant Selection
Participants in this study included faculty, alumni, and students of the program. Purposeful sampling was employed to maximize the range of perspectives examined [46]. The responsibilities of the faculty members were diverse; all have been course instructors, and several are engineering design instructors teaching in the design spine. Some of the faculty members had also served in administrative positions such as Program Chair, Associate Chair or Major Chair. Also, a notable characteristic of the program is that most of the instructors are service teaching in the program and are appointed by other engineering departments. The alumni interviewed had graduated in the years ranging from 1971 to 2019. The alumni are currently active in wide-ranging careers, including entrepreneurship, various positions in engineering firms, academia, graduate studies, business and management consulting, energy management, and law. Many of the participants did not experience standalone engineering design courses while being in the program; however, they reflected on how design plays a role in their profession. We approached students from all four years of the program at the end of the academic year, including ones who were away for a year in co-op positions. Students from the same year of study were grouped into groups and were informed of the nature of the questions that would be asked during the focus group sessions.

4.2 Interview Approach

The interviews were part of a larger program evaluation and curriculum realignment study involving program instructors, chairs, and alumni. As such, we developed a semi-structured interview protocol to gather stakeholders’ perspectives on many facets of the program, such as program values, instructional challenges, and tacit knowledge. The institutional research ethics board approved these interviews. We conducted the interviews virtually via Zoom, a video conferencing software, and recorded, transcribed, and anonymized the transcripts. Each hour-long Interview addressed the distinguishing characteristics of the program, teaching and learning experiences, career pathways, and the purpose of engineering design in the curriculum. This research focuses on interview data collected from a sub-group of alumni participants and analyses questions that addressed engineering design experiences during or after the program. Although the interview questions did not address metacognitive strategies directly, in some cases, the interviewer followed up on the subject when it was discussed by a participant. This supplement intervention helped the researchers understand what kinds and how the learning was happening after graduation.

4.3 Focus Groups

We conducted focus groups with students from the same cohort enrolled in the undergraduate department. Through a process of constructive inquiry, we found ways students formed communities for academic and professional support. Social constructivists believe that learning occurs through a meaning-making process through the discovery of complex knowledge and transforming the knowledge into an internal and collective understanding of reality [47]. A qualitative approach was followed to gain a detailed understanding of students' most valued experiences within their communities. Students participated in the focus group by signing up voluntarily through an end-of-semester invitation email from the principal investigator.
Focus group questions were designed to elicit elaborative narratives to facilitate qualitative analysis. The focus groups were conducted online using the conferencing tool Zoom, and the conversation was transcribed verbatim. Facilitators maintained field notes during the focus group as a way to encourage self-reflexivity throughout the process [48]. The necessary research ethics approval and permission for the study were obtained by the ethics board of the institution. Informed consent was obtained from all focus group participants. All participants could withdraw from the research at any point in time. We chose focus groups as a methodological approach as they are socially oriented and encourage interaction among participants, which makes them appealing to peer-focused adolescents [49]. Focus groups are also appealing as they facilitate meaning-making through dialogue and create the possibility for spontaneous responses [50].

4.4 Data Analysis

Through a thematic analysis of semi-structured interviews with 15 instructors, 12 alumni, and 6 focus groups with students, we developed a better understanding of the purpose of the design spine in professional identity development and the caveats that need to be addressed through curriculum intervention.

A multiple case study approach was adopted to provide a detailed understanding of the epistemic role of design in the program [51]. By unpacking data for each type of stakeholder over time to reconstruct their experiences in engineering design, the multiple case study approach helped to understand the nuances of stakeholders' engineering design philosophy. Data collected from the instructors were analyzed using an inductive process [52] and coded to identify prominent themes through the emergence of “patterns and processes, commonalities and differences” [53]. To reduce researcher bias, we used thematic coding and display charts [51]. To address Lincoln and Guba’s four general types of trustworthiness in qualitative research: credibility, transferability, dependability and confirmability, stakeholder checks and checks of interrater reliability were conducted [54].

5.0 Results

Qualitative analysis of the interview and focus group responses indicated that all participants viewed design as the space in the curriculum where real-world challenges and practices can be brought into the classroom. The instructor and alumni results are from semi-structured interviews. The student perspectives are from focus groups that were conducted across all years of study.

5.1 Instructor perspectives

This section presents an analysis of participant interviews with instructors who teach design and other technical courses in the program. Each subsection represents a theme derived from our qualitative analysis.

5.1.1 Real-world expectations
All instructors indicated that they tried in various ways to bring in real-world contexts in their design courses. Some emphasized the hands-on and building skills, while others thought the repetition of design experiences made students confident to engage in and showcase their engineering work in the future. For example, a capstone instructor said, "we're training people to be professionals, that they can jump into the workforce and feel like their level of self-efficacy is really high and that they feel comfortable going into the whatever role that they want to." Another instructor created assessments in their design course based on professional engineering codes to simulate written documents and etiquettes required by the professional body. Lastly, instructors wanted their students to understand the relationship between framing design opportunities and temporal constraints and recognize that “one line in a textbook that we teach, in you know five minutes, took 50 scientists their whole lives to get to that point.”

5.1.2 Forming a Professional Identity

Generally, instructors agreed that the purpose of the design courses was to introduce curricular spaces for students to integrate conceptual learning from various non-design courses with professional skills such as iterative designing. Some instructors questioned the relationship between the nature of the profession graduates might pursue and the related expectations of design in the profession. An instructor commented that entry-level jobs for graduates from an undergraduate program might not be expected to design but follow and comply with standards from a handbook. At the same time, another professor said that for students who want to pursue an entrepreneurial route after graduation, design thinking abilities were fundamental in building their professional identities. A few instructors thought design courses in the foundation years shaped individual designer identities, and most instructors believed that the upper-year capstone experiences inform students’ professional identity formation.

5.1.3 Lack of coherence in the design spine

Instructors were asked how the design courses were connected to each other in the design spine. Most instructors indicated that they did not know the details of design courses that students experienced before taking their course. They had a sense of the learning objectives of the courses that form the design as one instructor said, "I've got some sense of what they're doing in the first and second year, but it's just kind of just small snapshots." The instructors had varied reasons why there was a lack of coordination among the courses. Some said they took the initiative to know about the courses but through informal chats with other instructors and others who taught in capstone courses said there was a lack of awareness of how other capstones in the program were offered to the students. One instructor suggested that "it would be a useful thing for instructors who are teaching the capstone projects to have a better understanding of what was going on in the previous courses of design.”

5.2 Alumni perspectives

This section presents our analysis of the participant interviews who are alumni of this program, most of them working as engineers in the field for a minimum of 2 years, but at least one who
graduated more than 40 years ago. The subsections below represent distinct ideas that emerged from our qualitative analysis.

5.2.1 Shifting Mindsets

When alumni were asked about the purpose of design education in the curriculum, many responded that the problem-solving skill in design helps to have a “completely different mindset to be so creative and come out of my shell of knowing the question, giving me all that information, and having to do it all.” One alumnus emphasized that the shifting mindset from being theoretical learning to understanding the expectations of the profession allows students to “brainstorm to pick your passion, what they want to do, leading to projects that were astounding.” Also, one alumnus noted that expectations such as accountability to external design reviewers “created this environment where you have to act like a professional” that forced students to develop a professional mindset.

5.2.2 Encountering design work

The alumni interviewed for this study pursued a wide range of careers; hence they experienced design in various capacities and nature. One alumnus reflected on their first job experience in an engineering firm and credited the design experiences to “getting closest to those real-world experiences and acronyms that you encounter once you enter the real world.” Another alumnus, a serial entrepreneur, said the design experiences shaped his career because they helped him to frame ideas at a conceptual and interdisciplinary level that reflected the skillsets of paramount importance for technical entrepreneurs. Many alumni use their design skills to unpack complexity in their daily work; as one alumnus noted, "it also gave me a better appreciation for a lot of the design work that happens in the real world. Because you realize how many different decisions have to be made about things as small as like the designing a door frame, a door handle and stuff like that.”

5.2.3 Headspace for design

Some alumni reflected on their design experiences in the program in tandem with other commitments. For example, one alumnus said, "sometimes I couldn't really enjoy it [design course] - my second-year design project on top of everything else. Like they [curriculum] really just overload you, but looking back, I ask why did I do that to myself? Our team ended up winning the design competition. So, I still learned a lot." Similarly, another alumnus echoed, "I think it is also hard because in the first few years you're really focusing on theory, and so it is hard to say what is the environmental impact of like a calculus equation - it does not make sense. I think there is some opportunity, maybe to acknowledge how the different pieces of the courses lead to the bigger picture.”

5.3 Student Perspectives

This section presents the analysis of the data collected from conducting student focus group sessions. Subsections below represent distinct ideas that emerged from our qualitative analysis.
and from across all years of study. Comparative analysis between academic years of study was not in the scope of this study.

5.3.1 Curriculum integration

Students across all years identified the design courses or assignments as where they found the "reason why we're learning all of these other things." Second-year students noted that "sometimes understanding calculus or all these things, it is kind of hard to see it manifest somewhere." Some students also indicated that the design courses helped them to find their calling as engineers as one of them articulated, "by the end of this we all want to become engineers and work on the design and help like improve the world through one the different kind of ways of science, that are big and some of them are like really huge like domains such as environmental or like biomedical [engineering]."

5.3.2 Understanding the profession

Like alumni perspectives, current students identified the program "as something that would provide us the background in various different interdisciplinary fields, and that fosters us to be a leader in [such fields]." Along with professional expectations, students positioned themselves at the intersection of creating their professional identities. One student indicated that the “ongoing design throughout really helps a lot of us kind of understand who we are better. What we value and what we want to do with all this knowledge that we're learning through this enrichment, and I think that's really important too.”

5.3.3 Building communities

Students in the upper years credited the teamwork experiences in design courses with helping them build communities with peers that often lasted till graduation. Many students indicated the program as being difficult, and working in teams allowed them to cope together for design course deliverables as well as other commitments. Several students also mentioned that the design skills helped them to find new communities such as research groups during summer and get on engineering competition teams. One student indicated that using design experiences in other contexts is useful "I think people can get stuck in that exact vocabulary, and then when you're working with other students who didn't take similar design courses, they say the same thing in a different way."

6.0 Discussion

Significant differences were found in the relative importance of other components of the engineering design curriculum. While faculty tended to value design processes such as scoping the problem and application of science and math concepts, alumni and students highlighted the messiness of design projects and understanding one's strengths as the most important contribution. Lastly, alumni suggested that the design courses should allow students to experience the complexities of design by incrementally raising the stakes in the design courses as they approach their capstone experience. Hence, the analysis of the participants’ comments revealed a generalized tension between student and alumni emphasis on the need for courses that
promote interdisciplinary thinking and interpersonal relationships vs. faculty emphasis on the development of critical thinking alongside technical skills.

In evaluating the design spine of the program, we identified that there is a lack of interconnections among the various design courses reflecting the need for greater coordination of the design spine all together. As such, students' experiences during each year of the program were varied and often relied on self-directed learning. Hence, to better understand the role of the design spine within the engineering program, as well as to help students make strong connections with disciplinary and professional expectations, we co-designed with instructors a series of reflective assignments across the design spine curriculum. The assignments would also provide evidence for curriculum integrators and instructors of the design courses to understand how students seek coherence and the potential spaces for better curriculum alignment [42]. The reflective assignments ask students to articulate their positionality, critique design tools and processes, become self-aware of their biases, contemplate the role of empathy in design, and how these engineering design considerations support their professional identity.

The development of reflective skills is central to students’ academic and professional development within a discipline [55]. The ability to reflect on one’s practice when confronted by a novel, unusual, or complex situation distinguishes expert practitioners from novices [43]. By including a collaborative reflection activity for all students, every year, we responded to our program evaluation which raised the need for greater coherence. By providing reflective moments for students, the program can support their deep understanding of the nature and demands of their profession while also supporting their developing career identity. Also, these student reflections can serve as an ongoing instrument for evaluating the design spine to promote continuous improvement and accountability.

In Figure 1, a conceptual framework was created to connect the analysis of the program evaluation to the literature. Engineering design experiences provide the platform to form professional identities, showcase disciplinary expectations and build socio-technical skills such as empathy for stakeholders. We want students to reflect on these aspects of their design experiences every academic year within the context of their design course. As the intention is to understand how learning progresses within the design spine, the prompts for the reflective assignments will speak to the unique experiences that the students will have in any given academic year.

To support community building and leveraging on others’ experiences and conceptualizations of the various constructs, prior to individual reflections, a studio or cohort-based community activity will enable students to be aware of others’ perceptions of professional identity [56], disciplinary expectations [43], and socio-technical skills, for example, empathy in design [57], as they relate to their profession. The document generated in these studios will be available to the entire class as a resource to make deeper connections to the concepts of concern during individual reflection.
6.0 Conclusion and Next Steps

Thematic analysis of instructors, alumni interviews and student focus groups revealed complex relationships between curriculum factors and design course motivations and strategies. Outcomes of this study included the need for students to encounter practices and skills required by profession. Learning about engineering design learning appears to be particularly valuable for interdisciplinary work, innovation, and expanding knowledge domains for career transitions. As would be expected, alumni and students’ past experiences and predispositions impacted their understanding of their profession and perceived expectations.

To explore this topic further, we plan to analyze reflection assignments submitted by students across all years that will serve as snapshots of student learning and progression. Thus, we have built upon the conceptual framework presented in the previous section and to develop an instrument that benefits students through reflective practice and curriculum developers through the understanding of how students recognize engineering design as part of their professional identity. Our next steps involve analyzing reflections across different years to identify the role of the design spine in forming professional identities and engineering design education outcomes. The analysis will be shared with instructors to inform their course objectives and design pedagogy for future iterations of their course.

References


