Choice, Context, and Career: A Closer Look at Capstone Project Pathways

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Abstract

Engineering capstone design projects are a staple feature for engineering undergraduate programs, but much remains to be explored about the impact capstone projects have on students' career trajectories. At our particular institute, engineering students select a multi-disciplinary, capstone-like project for each of the last four semesters of their programs. While the ability to choose and adapt these projects ideally allows students to gain experiences aligned with their aspirations and interests, thus supporting their career trajectories, we seek to better understand the factors that influence their decisions and subsequent professional preparedness. For this study, we have conducted fourteen semi-structured interviews (seven third-years, two fourth-years, and five alumni) about participants' project experiences. Guided by Social Cognitive Career Theory, we use thematic analysis to identify key aspects of participants' expectations, goals, external influences, choices, and outcomes of participation in these projects. We will leverage the insights gained in this analysis to inform adaptations to our university's capstone model, from how we advertise potential projects to students, to the types of supportive infrastructure we provide throughout the curriculum. As we work to better understand student perspectives, their choice-making processes, and their needs for professional readiness as they relate to design projects, we anticipate that, beyond our own institute, the results of this study will help to inform best practices for capstone curricula broadly.

Introduction

Capstone design experiences are widely recognized as the culminating step, or "crowning achievement", in an undergraduate engineering curriculum [1, 2]. Research shows that the benefits of these experiences can extend beyond the classroom, contributing to long-term career success [3]. By combining various aspects of engineering education, such as real-world relevance, open-ended problems, technical expertise, and communication skills, capstone experiences serve as a bridge between academic and professional spaces. During this pivotal milestone, students are expected to apply their engineering skills while honing their professional competencies to understand complex problems, develop viable solutions, and effectively communicate. While these key features of capstone design remain a throughline amongst most programs, it has been shown that some modifications, such as incorporating multidisciplinarity [4], engaging external sponsorship [5], implementing multi-term projects [2], or offering multiple project experiences [6], can amplify benefits. Allowing students to choose their own project is also a feature that can be changed in capstone models, which ideally would increase student agency to align their experiences with their goals; however, to the best of the authors' knowledge, this effect has not been directly explored. Based on literature that illustrates a direct relationship between interest and a willingness to set mastery-based learning goals [7], we anticipate that enhanced choice opportunities in capstone projects can also enhance learning in these settings.

Rowan University's Henry Rowan College of Engineering (HMRCoE) capstone program embraces multidisciplinarity, external sponsorship, multi-term and multiple project experiences, and most notably, student choice. HMRCoE uses an expanded model of engineering capstone

experiences (‘Clinics’) for the final two years of the undergraduate engineering program [8–10], where students can work on a variety of projects over the course of four final semesters. Each semester, students share their preferences for which project they would like to work on, choosing from a variety of projects proposed by HMRCoE faculty from six disciplines. Students have access to a collection of 100-word project descriptions, akin to abstracts. In addition to breadth of disciplinary options for their projects, students experience project variety related to the size of their teams (e.g. one person up to 10 or more), who supervises the project (e.g., industry vs. faculty), and the kinds of work performed (e.g., research, design and development, design competitions). This variety, coupled with agency to choose projects that align with their interests, makes Clinics a unique opportunity for students to tailor their engineering experience and build their expertise before they transition into their careers [8, 11, 12].

While we suspect that the ability to choose and adapt these projects allows students to gain experiences aligned with their aspirations and interests, thus supporting their career trajectories, we seek to explore this possible relationship to better understand the factors that influence their decisions and subsequent professional preparedness. Beyond our specific context, this study helps inform more generally how design opportunities, both curricular and co-curricular, are considered, chosen, and impactful to engineering students.

Using semi-structured interviews and implementing both deductive and inductive thematic analysis, we aim to ground our analysis in a well-established framework (Social Cognitive Career Theory) as well as uplift student voices by sharing what is most salient to them. We explore the following research questions:

1. *What factors influence students’ project selection?*
2. *How do these choices relate to career goals and preparedness?*

Theoretical Framework: Social Cognitive Career Theory (SCCT)

Social Cognitive Career Theory (SCCT) is a framework that connects personal factors, behaviors, actions, and external influences to explain how one navigates career choices and achieves success [13-15]. SCCT is appropriate for the present study because it captures the element of student agency in the Clinic model and allows us to explore the interactions between student choice and outcomes.

By using SCCT as our framework, we were better able to explore how students’ expectations for Clinic involvement (as aligned with outcome expectations) impacted the choice criteria they used to select their preferred projects (e.g., general or specific interests, goals, and other environmental influences). SCCT also helped us explore how their choices impacted how they participated and developed professionally which we looked at through the constructs of choice actions and performance domains and attainments. Because students have the opportunity to choose four Clinic projects in the Clinic model, we were also able to understand how students connected their previous experiences in Clinic to new expectations, criteria, and outcomes.

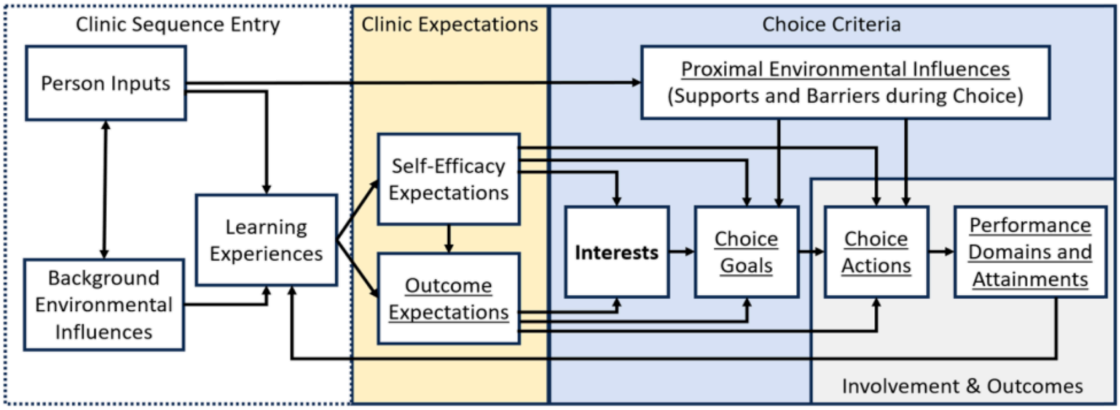

Figure 1: SCCT constructs and processes adapted from [12-14] overlapped with the Clinic model. Underlined text emphasizes SCCT elements focused on in the analysis.

Methods

Recruitment process and participants

A total of 14 participants (7 juniors, 2 seniors, and 5 alumni) were recruited for the present study. Fourteen participants is an acceptable sample size in a qualitative study [16] (p. 179); qualitative studies seek to ask questions that allow for an in-depth understanding of a specific environment [17, 18]. In our study, we found that 14 participants allowed for meaningful development of themes related to SCCT and our research question. Mass emails were sent out to all potential participants asking them to agree to an approximate 30-45 minute interview. Participants were asked to reply with their major, graduation year, gender identity, and the number of clinic projects engaged in. After participants shared their interest in our study and demographic information, they were sent a follow up email with a Google calendar link to set up an interview time. Once interviews were completed, participants were compensated with a $15 giftcard.

Data collection

Semi-structured interviews occurred either on Rowan's campus or over Zoom with the selected participants. All interviewees signed a consent form prior to the interview, and all interviews were performed by the second author and recorded using a recorder. Prior to the interview process, an interview protocol was created and approved by IRB.

The interviews begin with basic questions to learn about the participant and how they found themselves in engineering. Then, the discussion shifted focus to the clinic projects they were on and what the details of each project were. After getting the background information from each interviewee, the questions focused on their experiences in the Clinic selection process and various projects. We aimed to begin with more open-ended questions, then probe more deeply to understand why the participants chose their clinic, asking follow-up questions related to whether friends, scheduling, workload, professor, or career aspirations had any impact on their decision. Participants were asked to share their experience with choosing clinic projects and the reasoning behind each of those decisions. Next, they were asked about their expectations and learning

experiences from clinic. Then, participants were also asked to share the potential usefulness of the knowledge they obtained in the clinic to the industry in the future. They were also asked to reflect on their time in the clinic and to think about whether they would do anything differently if given the opportunity. Lastly, the participants were asked to share any advice that they might have to give second-year students about picking their projects for the first time. All interviews were transcribed using an AI service, Otter.AI, then the transcriptions were cleaned and de-identified by the first author.

Data Analysis

The first round of analytical memos was written throughout the transcription cleanup process, noting key themes from each interview and initial researcher reactions. After a discussion on the first round of memos with Author Four, Author One wrote a second round of memos to explore if and how each interview connected to the SCCT framework. From there, we developed an inductive codebook (Table 1) to highlight the more salient and recurring themes from the interviews in order to help us connect student experiences to the deductive SCCT codebook (Table 2). Author One was responsible for developing the codebooks, which were finalized through discussions and critical input from Author Four. The transcript data were analyzed using MAXQDA software.

Table 1. Inductive codebook based on themes throughout the participant interviews

Clinic process structure	Clinic project advertisement, selection, change, or assignment
Clinic project structure	Team, advisor, or external interactions, project day-to-day
Job preparation	“Real world” experiences, career-relevant skill development
Career clarity	Clarity on what to do or not to do for their career
Good for resume	Expectation that an activity will help their resume or interviewing

Table 2. Deductive codebook based on SCCT constructs

Interest	Attractive topics or activities
Environmental barrier	Outside influence that hindered participants trajectory or success
Environmental support	Outside influence that promoted participants trajectory or success
Performance domains & attainment	Development of competencies or achievement of a successful outcome
Choice goal	Intentions to pursue a certain action or achievement
Choice action	Actions taken in pursuit of a goal

Results: “Building your toolkit with breadth and depth”

Students’ experiences in the Clinic program revealed that having the ability to switch projects throughout multiple semesters allowed many of them to broaden their skillsets, clarify career interests, and explore new team dynamics, while remaining on a single project enabled them to deepen their technical knowledge, leadership abilities, and connections. In this case, we recognized a tradeoff–students were grappling between choices that allowed them to explore multiple interests or deepen specific performance domains. Students who changed projects often did so after realizing a mismatch between their initial interests, expectations, and day-to-day realities of a project or field, giving them a better understanding of what they did or did not want to pursue (i.e. insight on choice goals). Conversely, students who stayed on the same project described gaining advanced expertise, taking on leadership roles, and benefiting from continuity overall (i.e. heightened performance domains), although staying was not always the optimal choice if learning stagnated or interests shifted. Strong mentorship emerged as a crucial factor shaping positive Clinic experiences. While poor mentorship was shown to hinder learning and engagement, in some cases, it pushed students to develop strengths such as team communication and management.

Changing projects enables students to broaden their experiences

As students engaged with a Clinic, they learned more about their project, their teammates, and themselves. Often, students chose to change their Clinic project at least once, and sometimes twice or even three different times throughout their junior and senior years. We found that, when students changed Clinic projects, they were able to broaden their experiences.

For one Mechanical Engineering junior, he entered the Clinic program with an interest in materials science and a goal to try out this field in a team-based setting. The multidisciplinary project offerings supported this goal, and he found one that aligned with his aim. While he learned that he liked being hands-on in the lab, he reported, “I just didn't like material science in general. I didn't like it as much as I thought it would,” and “I think it was good that I had that experience so that way I can say later down the line ‘That's something that I've tried a little bit before and I'm not too interested in.’ So that's an advantage of the clinic.” After discovering that he was not actually interested in Materials Science like he previously thought, this student changed Clinics after one semester with a general goal to give his resume “a better breadth of knowledge”. Despite encountering some barriers with the Clinic match process (i.e. not being selected in time for his first few choices), he landed in an educational outreach-based Clinic that he articulated helped him expand his skillset by strengthening his communication skills.

On that same educational outreach Clinic, a Chemical Engineering junior embraced the value of expanding her experiences. Interestingly, she chose this Clinic specifically because it did not align with her career goal to enter industry. Instead, it aligned with her interest in teaching younger children. She explained, “I do like kids, and because I kind of wanted to be like a science teacher, before picking engineering, I figured this would be like the last opportunity for me to do something like that, because once I graduate, I'll just probably just go on with the industry.” When asked what she took away from that project, she says she gained confidence, improved her English, and became a more “social engineer”. Moving forward, she will pursue a

different Chemical Engineering clinic that more directly supports her plan to have a career in industry. We see this as making choice actions that align closer with her choice goals, expanding off a valuable interest-driven experience that bolstered broader professional performance domains.

Another Mechanical Engineering junior entered the Clinic program hoping to find an experience that was aligned with his career goal to work in the theme park industry. He wanted to learn about the robotics field and joined a multidisciplinary Clinic hosted by the Electrical and Computer Engineering department. However, he soon realized that this Clinic team was looking for a Mechanical Engineering student for their expertise in Computer Aided Design, and that it was not a role where he would actually develop expertise in robotics. In SCCT terms, an environmental barrier (incomplete knowledge of project role) led to a failure to develop the relevant performance domains that aligned with his goals. After this experience, he switched to a different robotics Clinic for the second half of his junior year, one with a role that was better aligned with his goals and expectations within robotics.

An Electrical and Computer Engineering alum reflected, “I didn’t know what my career aspirations were at the time,” so one of his choice goals in Clinic was to get “a feel for some career exploration”. His first clinic involved some heavy coding work, which influenced his decision to not pursue a career in coding. Similar to the first story of the Mechanical Engineer who learned he did not want to pursue materials science, this alumni explained that “some of these experiences teach you what you don't want to do for the rest of your life… great experience, great learning, but definitely something that, you know, you've ticked off the checkbox, like, ‘Yeah, I'm not going to be doing this.’” This alum made a choice action to switch Clinics after this realization and participated in two others that broadened his practical experiences with “real work”. He explained that he would not have changed anything about his Clinic experiences because “if you take it for what it's worth, you will realize that you are building your toolkit with breadth and depth”.

Further, a Biomedical Engineering senior switched Clinics between her junior and senior years. Her advisor encouraged her to be highly independent during her first Clinic, even allowing her to lead collaborative partnerships with external universities. However, she learned during this Clinic that she works better in a more team-based environment, and on top of that, she reported “I wasn't learning anything more than I already know. So I want to switch.” This combination of environmental barriers–ceased skill development and lack of hands-on support–led her to adjust her choice goals. She pursued a different, more team-oriented project, broadening her experiences in a new research lab during her senior year. She reported that both Clinics taught her valuable technical research skills and the importance of teamwork, reinforcing the iterative cycle between environmental influences, choice goals and actions, and performance domains.

While many students talked about the breadth of experience as positive, there was one who valued sticking with one lab group throughout all four semesters, building on his work as a sophomore in the same group. This Biomedical Engineering senior appreciated the way his advisor organized his lab, primarily due to the advisor’s consistent communication and transparency with his students. He also valued maintaining a long-term relationship with his advisor, reflecting, “I think it was really cool how he was able to see me grow from not knowing

anything to knowing just a little bit more now." His interest in the subject also grew, explaining, "I decided to volunteer in his lab, just because I wanted good research experience, I wanted something on my resume. But the more I did it, the more potential, the more value I saw in it." As he spent more time in the lab group, he learned how to open up to his labmates more about his questions and improve his collaboration skills. Another significant influence in his choice to remain in the same Clinic was his established familiarity with the lab norms and procedures. He explained that staying was the more convenient option, which we recognize as influenced by multiple environmental supports (communicative advisor, strong advisor relationship, and familiarity with the lab). However, based on his other reflections, he was also continuing to develop his performance domains by deepening his knowledge of the research and himself – a common theme throughout other interviews that we explore in the next claim.

Remaining on a project enables students to deepen their knowledge and skills

As our first theme indicated, Clinics can help students explore what they do or don't like and provide a breadth of experiences along the way, but if they immediately land on a project that they do really like, it gives them the chance to deepen their knowledge. In our data, we found that remaining on a project could help students deepen their professional skills (i.e. performance domains) in ways that were not as evident for students who were switching between projects.

One Mechanical Engineering alum reflected on staying on a NASA competition project between junior and senior year. He first joined the group as a regular member, but then during his senior year, he took on the group's project manager role and developed an entirely new set of leadership and communication skills. He reflected, "I saw the leader was leaving, so I saw a gap because he was graduating. So I was like, Oh, I liked doing this. I like doing this work. I want to make sure I get on again." This student then spoke to his project advisor to ensure he would remain on the Clinic and noted his preference for the leadership role, taking a clear action towards his choice goals aligned with his career interests (i.e., working for NASA). Perhaps on a similar trajectory, a junior participant reflected on their clinic experience, noting, "I'm really starting to see that I'm the young guy in the group… There's a lot of seniors graduating, and I see a lot of potential for my clinic going forward in the future… I really feel that I can start stepping up as I'll be a senior next semester in the clinic." This student had been contributing to the project on one level as a junior, but being on a team with all seniors allowed him to see the ways in which he could "step up" as a leader moving forward to ensure the clinic's future success as well as his own. Both of these examples also speak to the benefit of having both juniors and seniors on teams – students can change their role in the same project as they mature in their experience levels and level up their performance domains.

Some Clinic projects require students to stay on for a full year. For instance, one Mechanical Engineering alum participated in the Society of Automotive Engineer's Baja competition, where teams of around 10 students design and build a single-seat, all-terrain, sporting vehicle, and then compete with it at the end of the academic year. She had already been involved in the club, but the Clinic took her involvement to the next level. She reflected that it takes a long time to design and build the car, but that it "was nice being able to just focus on that for a whole year". She shared that she had fun on that project, embracing the challenging hands-on work with a worthwhile final product that she could not have achieved in a single semester. Not only did she

deepen performance domains (hands-on skills) by committing to a full-year project, but she achieved a performance attainment (building a physical car, competing with it nationally) that goes beyond a typical Clinic outcome.

There was also an Electrical and Computer Engineering junior who decided to work on the same AI project for a full academic year. He reflected that the first semester was a lot of learning, and that "we actually didn't touch on the project that [the doctoral student] was working on with fractional calculus. It was more so just learning how to work with [the program]... And I wanted to learn about fractional calculus a bit more, because I'm planning on pursuing a math minor." When prompted to clarify, the student explained, "it was like a trial of like, what we could be doing, and I wanted to do more with it." Staying on the same Clinic allowed him to work more closely with a doctoral student to deepen his knowledge on a subject that was aligned with his aim to pursue a specific minor. Through an SCCT lens, this project provided environmental support which influenced his choice to remain on it another term, as he expected to develop performance domains that fed back to his choice goals However, relating back to our first claim, this student plans to change Clinic projects for his senior year, wanting "to experience more" – this especially makes sense for this student, as he is still figuring out exactly what he wants to do for his career. It also demonstrates a potential balance between breadth and depth for students, raising questions about the length of time necessary to facilitate deep learning in capstone projects while also facilitating crucial opportunities for students to explore, hone their career interests, and adjust their choice goals accordingly.

While the above examples illustrate that often students deepen their knowledge and skills by remaining on a Clinic, this is not a guaranteed outcome. For example, the Mechanical Engineering alum who was on the Baja team for both semesters of her junior year opted to start her own NASA-sponsored project after completing a NASA internship the summer before her senior year. This Clinic aligned directly with her career goal to work at NASA after graduation. While she appreciated deepening her interactions from her internship, she said she regretted staying on that Clinic for a full year because she had achieved the skills she wanted to develop and established her NASA network within the first semester. When reflecting on what she would have done differently regarding Clinic experiences, she explained "I realized I love being able to build things with my hands and test them… And the systems analysis work that I did with NASA, while it was very valuable and actually did help me a lot along the way, I wish that I could have gotten back. Maybe I wish I could have done a split that year. I wish I could have done one semester of the systems analysis work with NASA and then maybe another semester on the Rocket Clinic Team." This student reached the performance domains and attainments that she wanted out of one semester's worth of a Clinic and wishes she could have spent the rest of her senior year doing something more aligned with her interests. Additionally, students are occasionally less thoughtful with their choice to remain on a project. Rather than staying on to deepen their skills or push a project further, some students have noted that they are too busy with their high course throughout the academic year, making remaining on a Clinic simply the easier option. Through an SCCT lens, this environmental barrier can also drive students' (in)action.

The quality of mentorship can matter more than the opportunity to choose

While the above results show that the opportunity to choose projects all four semesters enables students to switch out of or stay in Clinics as it suits their needs for a broader or deeper experience, our data showed that this agency is not a replacement for effective project mentorship. In many cases, the quality of mentorship–a key environmental support–seemed to matter more than student choice agency in terms of positive outcomes.

For example, the Mechanical engineering junior who changed directions after his first materials science Clinic encountered an environmental barrier with the Clinic match process and was not selected for his first few choices. He had reached out to a few potential advisors with no luck, and ultimately landed in the education outreach-based Clinic in his second semester. Despite not landing in his first or even second choice Clinic, he reflected "my teammates are great, my professor is great. We are on the same page of what needs to be done and how we're going to do it." Despite lower initial interest in the project, he attributed his successful project and team dynamic to his advisor's clear guidance, and as described in the previous results, planned to stay on the project to take a leadership role, even though it was not originally his first choice.

A Civil and Environmental Engineering senior also greatly benefited from the mentorship on the above project. Even though she had chosen her first two Clinics junior year, she ultimately regretted them because of misaligned expectations in what the day-to-day work would look like for each. For her senior year, she encountered difficulties with the Clinic match process as her first choice was "scrapped". She landed on the same educational outreach Clinic mentioned above, and this was the only Clinic she had decided to remain on for more than one semester. Based on how both students talked about their initial interest in the project and their subsequent perspectives of the outcomes of working on the project, we can gather that this team dynamic and mentorship was exemplary. These students' stories illustrate the importance of mentorship and project management by the faculty or industry mentors of a project.

On the other hand, a Mechanical Engineering alumn reflected on choosing an industry-sponsored project for his final year, which he found very interesting, expecting to explore new technologies and gain more practical experience. However, he found this third clinic was "wasted", as the team received no guidance from the industry sponsor. They only talked to them at the end, and he described experiencing what felt like a total misalignment between what the Clinic team did and what the company wanted. Additionally, even though his hovercraft Clinic sounded "very cool", he described that it was also a "failure," which he attributed to a lack of advisor involvement. Despite multiple negative experiences that he attributed to mentor guidance, this alum's biggest positive Clinic takeaway overall was that he developed management skills, which he attributed directly to the warm, supportive, and understanding Clinic advisor from his combustion project. These examples demonstrate that mentorship is a key environmental influence–either a support or a barrier, it can strongly impact how students engage with a project and what performance domains and attainments they achieve.

While our data demonstrated that good mentorship can have a great impact on a student's Clinic experience, it is not often top priority in students' decision-making processes. One student spoke frankly, stating – "I'd rather have a good topic, bad advisor, than a good advisor, boring topic".

Additionally, a bad mentorship experience can still lead to positive outcomes. For one student, he had a “weird dynamic” with his advisor and teammates, but this bad mentorship experience is what showed him that he can really step up and take charge of organizing and communicating for a team.

The differing experiences and perspectives students had related to mentorship in our data highlighted another tension in the Clinic choice process. While strong mentorship was seen as a positive for nearly all of our participants, it is not considered sufficient in all cases to foster interest and development in Clinic students. Similarly, there are instances where students can overcome mentorship challenges to develop new and unexpected performance domains, raising questions about how we might foster professional skills in Clinic students more intentionally.

Discussion: Implications

With a capstone-experience model that places such high emphasis on student choice, we can better serve our students by helping them to reflect on their Clinic takeaways and think critically about their next step. A desire to broaden their experiences can stem from an interest in leveraging Clinic to explore topics temporarily or a realization of misalignment between their goals and the reality of the project. It is important to consider how we can help bridge the gap between their goals, expectations, and reality. This may look like clearer communication from the professors on what the day-to-day work, knowledge and skill development, and potential outcomes will look like on each Clinic project. This is true for any project, but especially for multidisciplinary teams (where students may understandably expect interdisciplinary training yet end up working within disciplinary silos on the team) or larger teams (where students may lose a sense of agency or direction amongst several peers working on the same thing). We saw that when students' expectations for a project are aligned with what the project actually entails, it allowed them to make more informed decisions about which projects to pursue and mitigated the chance of them needing to change simply because of a misunderstanding of the expectations. While it is good that students can readily pivot out of Clinics that end up being misaligned with their goals for whatever reason, switching every semester might limit their ability to deeply develop skills. This is a tradeoff that should be considered in their decisions. Ultimately, students are effectively sampling projects, but they can be more strategic.

When students change projects, we should try our best to structure the system to mitigate the time and energy it takes to select and join a new project, minimizing this environmental influence on student’s Clinic choices. This could look like choosing a less busy time during the semester for selections to be due, and creating a list of projects that is easy to navigate and understand. On the other hand, even when students are choosing to remain on a project, we should still support them in setting goals and understanding exactly what they want to gain from staying on the Clinic (e.g. Do they want to move the project forward into another stage, from design to build? Do they want to hone a different technical or professional skill?) We should also not be alarmed if students choose a Clinic seemingly unrelated to their career goals, especially if they plan to explore more aligned Clinics later on. All of these implications would be supported by more intentional and guided reflection within the Clinic program structure. This could take the form of an individual development plan to help students better understand their strengths as well as their areas for growth with respect to their goals and to map out intentional steps to reach

their goals [19, 20]. We could also explore implementing frameworks that have been developed to support critical reflection within applied learning settings, such as the DEAL Model [21].

While we've shown that the Clinic choice model enables students to more flexibly build their skills and knowledge to a level of breadth and depth that is most useful to them, we also demonstrated that student choice does not override the need for effective mentorship. We should still support the students on their chosen project, offering technical guidance and helping strengthen their team dynamics. It may be worthwhile to consider offering multiple mentorship opportunities during a capstone experience–one for the more technical aspects of a project, and another for the professional development component. Perhaps instead of serving as a mentor on a particular Clinic, some professors could instead focus their efforts on offering guidance to the general junior and senior student populations as they navigate team dynamics, develop communication skills, and set career goals. A recent "holistic" approach to capstone design has successfully incorporated four distinct mentorship roles – a course instructor, a project sponsor, a technical advisor, and a facilitator who focuses on networking and special seminars [22]. Broadening the mentorship opportunities could serve as an avenue to explore supporting critical reflection throughout the Clinic process, and hands-on guidance could ease the transition between Clinics for some students.

Further related to mentorship, if a project is sponsored by industry, students can greatly benefit from having a direct line of communication to their sponsors. Not only could this help with the technical outcomes, but also with their developing collaboration skills and professional network. With good reason, industry involvement in capstone design is a common occurrence throughout many different university programs. Past work has emphasized the mutual benefits for students, faculty, and sponsors, with best practices focused around clear communication about timelines, funding, roles, meeting frequency, project goals, and final deliverables [23]. If direct, hands-on participation from industry sponsors is not possible, it is still essential to clearly define expectations for outcomes, as for any Clinic project.

Limitations and Transferability

A limitation to this study is the relatively small group size (14 interviews). Further, some participants had not yet completed the four semester sequence, and some had not yet entered professional roles. While these recruitment choices limit how concretely we can talk about the professional relevance of some of the performance domains discussed, our varied sample provided important context about how participants interpret how their Clinic experiences both in the moment (i.e., while enrolled) and in retrospect (i.e., after graduation). Additionally, while HMRCoE has an especially choice-driven capstone model that supports this exploration, it limits how immediately transferable the results are across other institutions with different capstone models. However, as described in the implications, good mentorship practices can be emphasized and expanded regardless of capstone design structure. Further, schools with two-semester capstones and no current option to change could explore opening up opportunities to switch mid-year if the students can justify it. While this sounds potentially disruptive, perhaps there could be a system where students who want to move out of a project could find a replacement student who wants to move into it. Regardless of the degree of student agency in capstone design choice, our study suggests that curricular opportunities to deepen domain experience and explore

interests help students navigate their choice goals and actions. Engineering programs could look to expand these opportunities in other areas of the curriculum.

Conclusions

Our findings illuminate some of the factors that influence students' project selection, with some students changing Clinics to broaden their experiences, and others remaining on a Clinic to deepen their knowledge and skills. More specifically, we saw that students can be driven by developing career clarity, changing interests, or positive teammate or mentorship experiences. They are also influenced by how easy or difficult it feels to switch Clinic projects between semesters. Student goals and outcomes vary between developing technical, communication, and collaboration skills, and they view their ability to select their projects as offering flexibility in which skills to prioritize; although, their expectations are not always aligned with reality.

When offering students the ability to choose, it is essential to give them as much information about each project as possible. While the project managers can be more descriptive about the projects, students must also consult the managers or students already on the project to inquire about the day-to-day. For capstone experiences that do not offer as high of a level of agency in the processes as the Clinic model, positive mentorship experiences can still have profound effects. Considering both of these implications, we advocate for more thorough project descriptions (i.e. the day-to-day work, teammate roles and responsibilities, and expected outcomes) and more intentional and/or expansive mentorship practices.

In terms of future work for this study, we anticipate that a longitudinal follow-up with the juniors and seniors from these interviews would reveal valuable insights on how these choices relate to their career preparedness. At this point, these students have since graduated and entered the workforce. We are interested in asking them how the rest of their Clinic experiences went and how they did or did not prepare them for the realities of attaining and performing in their current job. We are also developing and administering an annual survey based on these results and the SCCT framework. This would provide us with deeper and dynamic insights into our own study population, as well as open the possibility for a mixed-methods study that builds upon the current work. Concerning practical implications at HMRCoE, this work has inspired a push to expand the mentorship and professional development opportunities offered during the Clinic program so that we can better assist students in strategizing their pathways from Clinic to career.

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