Contingent Identification in a Biomedical Engineering Classroom

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Abstract: This study, set in a university biomedical engineering capstone design course, explores how students identify as engineers, finding this process to be contingent and dynamically negotiated. Biomedical engineering, as a degree program, serves as a legitimate pathway towards engineering and medical school, making identification with engineering particularly contingent. Living narratives provide glimpses into experiences students have in their design course, which aligns more closely with authentic engineering practice than their previous coursework. As a result, the design course is a significant opportunity for students to consider themselves to be engineers. Framed by changes in *accountable disciplinary knowledge* and *navigation* (Stevens, O'Connor, Garrison, Jocuns, & Amos, 2008) within the interdisciplinary context of biomedical engineering and the varied goals of students for choosing the major (engineering vs. health sciences), students' identification as engineers emerges as particularly contentious. Leadership and underrepresentation are considered in relation to identification, navigation, and accountable disciplinary knowledge.

Everything I have learned comes into play.... All I can say is that I think like an engineer. I see things from many different angles. I calculate. I am much more realistic.

I mean, like a surgical procedure? I mean, that's not considered any sort of technical…? Like, a surgical procedure? And, like, taking readings in a rat's stomach? I mean, something that nobody else has ***even*** *ventured to do in* ***this*** *course?!*

Background

These two quotes from students express tensions between two predominant and legitimate pathways (biomedical engineering and medical school) students pursue while yet positioned as "BMEs"- students in biomedical engineering. This paper explores how students working in teams in a university capstone biomedical engineering course contingently express their identification with engineering as they learn to design. Ethnographically-collected lived narratives (Ochs & Capps, 2001) provided glimpses into student experiences during this process, highlighting tensions and dimensions of contingency in students' identification as engineers, and how this intersects with their learning. These are viewed through three *dimensions* for understanding pathways through engineering education: *accountable disciplinary knowledge* (ADK) - that is, the work and practices that *count* as engineering at a given point; *navigation* of pathways; and *identification* with and by engineering (Stevens, et al., 2008). Additionally, underrepresentation and leadership are considered in terms of how they might intersect with these dimensions of ADK, navigation, and identification.

The capstone model provides a fertile ground for observing learning and related shifts in identification, taking learning to be an "experience of identity"(Wenger, 1999, p. 215). The social process of engineering design (Bucciarelli, 1994) and learning to design in a team involves the coordination of many lenses. The capstone design course introduces new identity spaces for the students: They may form a team identity as they develop a sense of belonging in a consequential manner to their team (Guzzo, 1986). They negotiate various design decisions (Bucciarelli, 1994), learning by explaining perspectives (Webb, Troper, & Fall, 1995) and by comparing to team mates' perspectives (Phelps & Damon, 1989). Within a team, each member assumes roles such that in total, all steps are accomplished, but not by all team members (Goldschmidt, 1996). Gunther, Frankenburger, and Auer (1996) caution that though enacted roles have been noted, understanding how and why roles form is largely unexplored for design contexts. By exploring students' identifications as engineers, we may shift focus to understanding some of the dimensions students face along their paths towards or away from engineering. Additionally, understanding how individuals from underrepresented groups identify as engineers may elucidate some of the experiences that contribute to their (dis)engagement (Heyman, Martyna, & Bhatia, 2002; Seymour & Hewitt, 2000).

Setting and Participants

The participants of this study were undergraduate senior biomedical engineering students enrolled in the capstone, year-long design class at a large public southern university. Six case study design teams were drawn from two iterations of the course (2006-07 and 2007-08). Design teams were composed of four students, organized by course instructors, and persisted across two consecutive semesters. Teaching assistants played a large role in facilitating learning, spending approximately 100 contact hours with teams. The course comprised a two-month redesign project followed by eight-month industry-sponsored project, during which teams were mentored by faculty advisors and sponsors. Course instructors used team rankings of sponsored projects to match teams to sponsors; when multiple teams ranked a project highly, the sponsors were asked to "hire" based on resumes submitted by the students. The projects came from hospitals, industry, government, and universities, and while they varied in terms of difficulty, all were real-world, complex, and ill-structured.

Methodology

Guided initially by theories (Fetterman, 1989) related to design process (Jonassen, 2000; Schön, 1983) and learning (Hatano & Inagaki, 1986), I entered the design studio as a non-participant observer (LeCompte & Schensul, 1999) intending to study design *learning* and to model how innovative design products might arise (Svihla, 2009). As I built rapport and reconciled my etic understandings of practices in relation to these theories, I transitioned to a participant observer role (e.g., discussions of statistical analysis, assisting with presentation preparation decisions), and began co-constructing emic understandings related to the practices and experiences of specific student design teams. Adopting an ethnographic approach (LeVine, 2007) to understanding students' experiences learning to design afforded an opportunity to consider concurrent shifts in identification.

Given the diversity of projects, comparison was of primary importance, allowing me to select cases by comparison, spontaneously use comparisons as a means to understand, and comparing across cases (Vogt, 2002). For each class iteration, I collected qualitative data related to three case study teams, providing six case study teams. Teams were selected with input from the professors and teaching assistants, who listed their highest and lowest performing teams, which teams sought out resources and which did not, and were invited to suggest teams they thought might be interesting to study for other reasons. These data along with peer evaluations and a survey of interactions formed a matrix yielding three levels (high, medium, and low performing), from which teams with all or most members consenting into the study were selected.

Teams were observed as they met together and with mentors. Meetings were audio rather than video recorded due to limitations posed by the settings: much of the design activity took place in a room with only one available electrical outlet, and this was commonly in use by a student; additionally, not all sponsors were comfortable with video recording of materials covered by Intellectual Property. Informal interviews/discussions emerged during observation, either instigated by myself or by the students. Such conversations were used for member checking and clarification, though the latter was rarely needed as the students tended to assume that I had insufficient understanding of their projects, and would often teach me and ask if I had questions.

Field notes and transcriptions of interactions were reviewed multiple times and initially analyzed as team narratives of designerly solutions (Cross, 2001) to impasses in design process (Svihla, 2009; Svihla, Petrosino, & Diller, 2009). Initial analysis of transcripts involved grounded coding, allowing themes related to initial research goals to emerge, then seeking counterexamples. This process uncovered other persistent themes related to leadership and underrepresentation in relation to the adoption of designerly perspectives. Transcripts were re-analyzed using the framework presented by Stevens and colleagues (2008), framing students' experiences by accountable disciplinary knowledge (ADK), navigation, and identification.

Navigation

Though the focus of this study is on how students identify during their capstone design experience, it is useful to consider both unofficial and programmatic aspects of navigation preceding the capstone course. The majority of students are admitted to the degree as freshmen when they are admitted to the university, and therefore recognized as "BMEs" from their first day at the university. The program is competitive even within engineering, with the 100 highest ranking students admitted each fall. This ranking is articulated as follows: "To be competitive for admission to the Biomedical Engineering program a student needs to be very strong in the following areas: 1) Class Rank and 2) SAT composite score. Incoming First Year students are ranked based on their scores in these areas and then the students at the top of this list are offered admittance to the Biomedical Engineering degree program." Reflecting on this rather general process that selects them for membership as BMEs, one student expresses a matched generality: "When I joined BME I just picked it out of a list. It wasn't until three years into the program that I realized it was exactly what I wanted to do with my life."

After two years of core curriculum, students select a track: Biomedical Imaging & Instrumentation, Cell & Bio-molecular Engineering, Computational Biomedical Engineering, and Pre-medical Engineering. Most students opt for Cell & Bio-molecular Engineering track. These official pathways mask the unofficial navigation students undertake, which comprise myriad experiences: internships of varying relevance, engineering clubs and camps in high school, and participation in social (formal and informal) aspects of being a BME.

Identity, Identification

Wortham (2004) describes the process of social identification as possessing characteristics or behaviors that allow others to classify an individual according to a socially agreed-upon category. This process is interactional (Gee, Staff, & Paul, 1999) and contextualized by metadiscourses (in this case, biomedical engineering students and their various mentors), but also backgrounded by other social identifications that become relevant. I employ an understanding of identity that is social, negotiated, and *double-sided*, meaning that an individual may position herself or himself in a certain manner, but this occurs within social contexts such that the individual may or may not be recognized or be positioned by institutions, organizations, or others (Holland, Lachicotte, Skinner, & Cain, 1998; Skinner, Valsiner, & Holland, 2001). Considering practices of identification (Becker & Carper, 1956) affords a focus on the actions and behaviors related to positioning. I adopt this double-sided understanding of identification to explore how students negotiate and coordinate multiple identities as they transition from problem-set engineering to engineering design.

Accountable Disciplinary Knowledge

In their framework for understanding pathways through engineering education, Stevens and colleagues (2008) refer to *accountable disciplinary knowledge* (ADK) as one of three dimensions. This term encompasses that which is counted as engineering knowledge relative to the context. As the context shifts, the ADK shifts. Reflecting on the core coursework, one student describes a burgeoning awareness both of his chosen discipline and a sense that some of the ADK of the core coursework was of less relevance for his future:

> "What do you need to know that's actually going to be useful in the future? Because, I mean, some classes, you kind of – especially when in the first couple of semesters for BME, we kind of got to see what we were going to be doing in the future. See, I mean, and I didn't do it as much at first, but then I kind of realized, like, you know, there's certain classes that we have to take as part of the core curriculum that really aren't – parts of it I don't think matter as much. So some stuff you just learn for the test and then there's some stuff you learn for life."

In core engineering coursework, ADK includes problem sets, whereas in the design courses, which reflect the professional engineering design studio, this includes actions that reside within the educational context despite originating from the professional context, as well as actions recognizable as professional. This semi-professional setting is captured is a student's description of the design class as "working more in the 'real world' environment, and getting the chance to apply what we've been studying in the classroom." The design projects were punctuated by tools (e.g., Gantt charts, Pugh charts) borrowed from the design studio but used such that the timing may not have highlighted their relevance, as evidenced by statements that the tools "detracted from the progress of the project," and "have actually hindered us." Other tasks, such as meetings with industry sponsors and progress reports for sponsors greatly reflected the professional design studio, requiring students to negotiate professional relationships, and sometimes choose between a professional goal and a classroom goal. Such professional connections, which sometimes deviate from the course structure, can be motivating (Magleby, Sorensen, & Todd, 1991), as expressed by a student: "We were very motivated in this project by our sponsors, who both impressed on us the potential for our device and made many valuable contributions to its design." These relationships may offer points of entre to engineering or provide students with examples of professional practice, allowing them to focus on what lies beyond their coursework (Stevens, et al., 2008).

Lectures given during the capstone design course touched on the nature of BME: In one lecture the course professor, Dr. Davies (a pseudonym) described his role in helping to define this relatively young discipline ("BME is a new breed"), and encouraged the students to "be a part of the definition." These lectures served as touchstones for students to decide whether they fit with this definition, ("You are probably motivated by the practical") and to highlight the shift in ADK that accompanies the transition to capstone design:

- "Engineering is doing"
- "Solving new problems in new ways"
- "Engineering is opportunity to be creative and come up with new ideas"

These lectures included discussions about differences between science and engineering, and positioned engineers as "doers." Students were told that "engineering is design" and that as mathematics is used as a tool by scientists, science is a tool of engineering. The nature of science was represented as unproblematic (e.g., "In science, there is always a right answer") and this was reflected in the engineering science courses completed previously, filled with problem sets with right answers. In an engineering program in which approximately 30% of the students plan to go on to medical school, this divide between ADK for college and for their professional futures may lie along multiple dimensions.

Leadership and Underrepresentation

Within the design teams, students negotiated their roles. Some teams appointed leadership roles, some leaders delegated further roles, and some teams allowed leadership to be an emergent property. In some teams, emergent leadership subsumed prior leadership roles: in each case, this occurred in conjunction with shifts in relevant expertise: leaders appointed during the preliminary project initially maintained their roles in the sponsored project, but as the ADK within the team changed, leadership shifted. In one team, this shift was explicitly recognized by the team as a whole; in the other two teams, no one claimed new leadership roles, yet in both specific individuals came to be recognized within the team as the person to check with on major decisions, though in one case (expanded upon in the second case study below, team 3.4) this role was contested.

In all case study teams, underrepresented groups, specifically women and Latinos, served in non-leadership roles. In several case study teams students from underrepresented groups were the first to promote designerly ADK. Two case studies highlight how leadership and identification with engineering or health sciences promoted types of ADK and intensified or mitigated a sense of underrepresentation. Data presented here are brief due to page limitations, however, analysis of the fuller corpus of data supports these findings.

Team 3.2: Shifts towards Designerly Accountable Disciplinary Knowledge

In team 3.2, Tom, Greg and Cynthia all planned to become biomedical engineers at the beginning of the design class, whereas Addai explained his interest as “consulting or energy policy … Of course I might wind up working in BME, although I would be a little surprised at that.” The design project involved creating a way to measure movements in a patient’s limb, and was sponsored by a physical therapist who described himself as “naïve” to the nuances of the project and “not an engineer!”

Tom led his teammates by deliberately not “micromanaging” so as not to risk ending “up doing almost nothing as far as my real contributions to the engineering.” Tom identified strongly with engineering, and expressed this as part of his past, both in high school and in an undergraduate internship, as well as in his future plans to get a PhD in biomedical engineering:

> “I feel the senior design is sort of just one in a series of such projects. So like in high school, I did these robotics competitions that every year […] My friend and I started this club, so we tried to recruit as many of the nerdy kids [as] we could, and there was like 30 of us, 50 of us, at various levels of involvement, different schools.”

Tom’s identification with engineering, beyond “nerdy” was tied to a deeper understanding of design process than many of the students expressed: **“**There’s all these different solution paths, right? There’s all these different ways that I can come to a solution. And then there’s not even one ending. There’s a lot of different places to go and then even more ways to get there. And so you’re trying to choose a path.” Although Tom embraced the complexity of the design space, he struggled to lead his team towards choosing “a path” because of a theoretical/engineering science framing initially adopted. Tom invited his team mates into this problem space by offering an exemplar that was accessible, as evidenced by many conversations following it, an example of which is presented below:

> Cynthia: I seriously just learned more than I did in my *entire semester* of physics.
> Tom: Very difficult.
> Addai: It's such a weird notion that you can be moving-
> Cynthia: *Yeah.*
> Addai: -and have the same vector sum as *not* moving.
> Tom: Right.
> Cynthia: That is a weird thing.
> Tom: That's, that's the whole problem with these accelerometers.

Overcoming this “problem with these accelerometers” required creativity, as Tom explained and “one of the things that spawns creativity and innovation is having so many different perspectives work at once.” Not every team member can productively be a leader, and it is important to explore the experiences of the less vocal team members. Cynthia, who rarely spoke during team meetings, explained mid-way through the project that she felt she had less to contribute than her team mates. Cynthia contributions, which helped to steer the team in designerly directions by invoking the customer needs and practical requirements of the sponsor, did not reflect the ADK associated with their prior coursework, but her team mates recognized that her contributions did reflect the ADK of the design course. Tom, in particular, valued Cynthia’s contributions, though this was not apparent to Cynthia until later in the design project, when the shifts in team ADK meant that her design perspectives were of particular relevance. These shifts were brought on, to some extent, by the need to generate a prototype that would help them convey to their sponsor some of the theoretically challenging aspects of the design goals (Svihla, et al., 2009). Their sponsor expressed satisfaction with their final project: “I really see even more clearly that it’s a viable possibility to create this thing and before, it was, before, I had a dream list of three things or four things that I would like to see become three dimensional and I think this is phenomenal! Because it really is- they're bringing a lot more data to this than has ever even been questioned.” All members of team

3.2 expressed satisfaction with the design experience, including Cynthia ("I had a great experience!") and decided to pursue graduate degrees in engineering, even Addai, who explained "It is a shame that this class is the first course I've ever taken in my almost 5 years here where I have thought I know what a biomedical engineer is, and I wouldn't mind being one."

Team 3.4: Tensions between Pathways

Team 3.4 was led by Steve, who completed an internship working with medical testing studies on animals, a connection he leveraged to position the project as more of a medical project. Steve and Dillon both planned to attend medical school, whereas Daniela and Bob planned to become engineers. This divide was a significant one for the team, particularly given that what their sponsor desired was for the team to demonstrate, through animal testing, the feasibility of placing an existing externally-used sensor internally to monitor chemical changes related to a medical condition. During their weekly team meetings with their teaching assistant, Michelle, it became increasingly apparent that the team was not designing anything. Michelle urged them to adopt a design/engineering perspective, and tensions emerged across these disciplinary identifications. Several interactions highlight these tensions, as Daniela struggled to interject a design perspective. In the first example, Daniela posed the question to Michelle, turning to face her and speaking to her as she interjected this dissonant perspective:

Daniela: I just, um, something bothers me. The fact that we are putting the sensor on the stomach during surgery, but then we're gonna, the surgery only lasts one to two hours and we're gonna take it off and the patient is gonna be, well, the surgery is gonna be over and there's not gonna be any monitoring afterwards, and I'm thinking well, there's higher chance of sepsis, I mean shock, afterwards, right? So, should we think about leaving the sensor, or… cause I don't really?
Dillon: Seriously, that could be, like, the next project.
Steve: Yeah, I think that, like are you talking about in real life? Like…?
Daniela: Yeah, like, so using it.

Steve's question about how the device would be used ("Are you talking about in real life?) not only challenged the design perspective Daniela attempted to adopt, but also demonstrated a disconnect in perspective; Steve framed this as a school problem even though they were asked to solve a real-world problem. The response Daniela received from her team mates seemed like an attack, but Daniela did not appear to take it personally, though whenever she posed these dissenting design ideas, she tended turn her body towards Michelle and to speak facing Michelle, as if this was how she gained voice. As they continued this conversation, it became increasingly clear that there was a lack of agreement about what they were doing. They retreated into an explanation of what they were "supposed" to be doing, also highlighting a lack of design perspective:

Bob: I thought the project was to do an internal sensor that you left in?
Daniela: So we are gonna?
Steve: I think that that's, be-
Daniela: How long are we gonna leave…?
Bob: I'm not sure, uh.
Steve: I think that would be something left up to surgeon or something, honestly, likelikelike, our project, I think it's kinda outside the scope of our project.
Bob: If we left it up to the surgeon and whoever actually designs the sensor?
Steve: Yeah, whoever is *really* doing this.
Bob: 'cause we're not supposed to be designing anything.
Steve: Yeah, we're just seeing if you can do it. We just have two types of sensors and we're gonna see if we can do it- we're gonna see if a [specific type of] patient- whether or not the [chemical] levels can be measured or change to a degree that we, they show up, or the…
Bob: Using currently available sensors.
Daniela: I don't even know if it's okay to just leave it there.
Steve: It's all right.
Daniela: These are, I mean, sort of? *Days?*
Dillon: They're not gonna want to cut them open again and just take it out.

Bob and Daniela's comments express, to varying degrees, dissatisfaction with the direction their project was headed, but these practical, engineering perspectives were quashed by Dillon and Steve who together, positioned these questions as peripheral or irrelevant. Later, Bob and Daniela discussed their project and the lack of design or even engineering focus:

Bob: Well, this project is definitely nothing like the hard-core engineering I thought engineering would be like, where you go, and designing a machine, to go through those, or doing material analysis? But this is a lot more like a bioinformatics problem with the evaluation method, doing statistical analysis of various sensors, correlating how they work.
Daniela: It's not really- we're not designing it, I mean, *anything*. It would be more design if we had to design the sensor, which I thought we were gonna have to do, but he didn't want, the company doesn't want us to.

Michelle leveraged this dissatisfaction to challenge Steve again to adopt an engineering perspective:

Michelle: You have to remember how you talked about all the technical aspects. I mean, most groups are having that problem anyway, and I think, like, that would be a good project for this class.
Steve: A grade.
Michelle: I mean, if that's not what he wants-
Bob: The sponsor said 'no.' He doesn't even want us to try.

This exchange highlights tensions between the ADK of the design course/perspective, and the ADK in the project Steve thought would satisfy the sponsor. Steve identified with his prior animal studies experiences, denigrating the designerly perspective as "a grade." He enthusiastically valued the opportunity to position the design project as a continuance of his prior experiences: "The whole senior design course was worth it to me because we went through this process where something, I'm gonna be doing time and time and time again." This is starkly contrasted with his frustration with the designerly ADK:

Steve: It's just my biggest, my biggest frustration with this is just, like this, like this is the project, like *this is the project we were given*. I mean if, if like Dr. Davies, and I don't mean to be disrespectful, I mean, if somebody didn't want us to do this project it shouldn't have been accepted. It shouldn't have been given to us.

Steve constructed a science problem space and phrases such as "project we were given" indicate that a lack of flexibility with regard to that problem space. That statement in particular is troubling because it is the designers' job to define that problem space. Whether he recognized it or not, they did, in fact, create a problem space, but one that was framed as a science rather than engineering problem.

Steve brought the focus back to the novelty of their project's science goals, at least in terms of the course. The novelty that excited Steve, troubled Michelle and Dr. Davies because it was effectively a substitute for a design project. As Steve expressed this, Daniela once again turned to Michelle and expressed a dissenting designerly perspective:

Steve: I mean, like a surgical procedure? I mean, that's not considered any sort of technical…? Like, a surgical procedure? And, like, taking readings in a rat's stomach? I mean, something that nobody else has *even* ventured to do in *this* course?!
Daniela: Well, we're not *designing* anything.

Because of concerns Dr. Davies met with the team. He explained to them:

> "Now, in BME, we have to be careful a little bit. It's really easy to get off and to, uh, do life sciences kind of things that are not engineering, and nearly any project can, uh, have identified some appropriate engineering dimensions for it and, uh, I think this is an important part of your education experience. […] I encounter this in my own research and can identify all sorts of neat medical things to work on. The question is, *What can you really uniquely contribute as an engineer?* Somebody across the street, this brilliant life scientist, is not gonna be able to put on the table?"

Though the sponsor was very impressed with what the team accomplished, not all team mates felt enthusiastic about the experience: "There was no design portion to the sponsored project. The design portion was assigned by Dr. Davies halfway through the project," and furthermore, this aspect was "created to fulfill graduation requirements."

Discussion

Viewing these cases of design team lived narratives through the dimensions of accountable disciplinary knowledge, navigation, and identification provides ways to understand how differing pathways create tensions in capstone design, but not earlier. When the ADK is no longer the domain of problem sets, but instead reflects the professional design studio, students who have no intention of becoming engineers have opportunity to exploit the lack of designerly perspective brought on by having an official pathway containing no previous design experiences (Figure 1). Given that many students, as part of their unofficial navigation, have worked in laboratories doing what Dr. Davies termed "life sciences kind of things that are not engineering" it is unsurprising that a team leader might consider such activities to be the ADK of the design studio, and to see them as valuable in the future. This is expressed by Steve, reflecting on the animal testing his team undertook: It "was worth it to me because we went through this process where something, I'm gonna be doing time and time and time again." Steve expected to find the ADK of medical school to have more in common with his prior coursework ADK than that of the design course, and this made the design aspects very artificial ("A grade.").

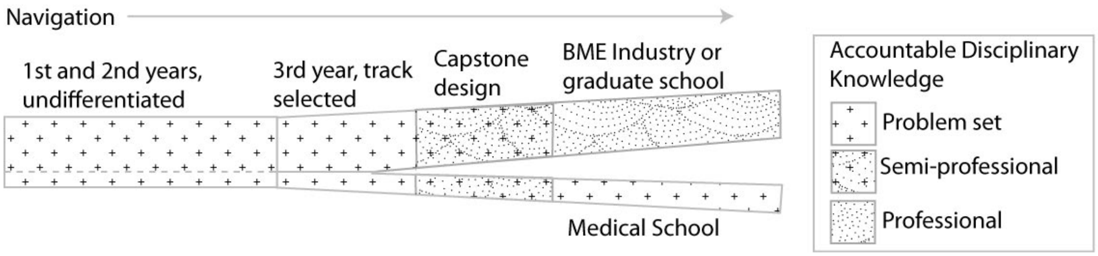

Figure 1. Changes in accountable disciplinary knowledge along pathways towards engineering and medicine.

In contrast, Tom, whose unofficial navigation included very different experiences, desired to adopt designerly ADK, though he struggled to do so. That it was such a challenge even given his desire and his team's desire to engage with design highlights what an opportunity Steve had to steer his team towards a "life sciences kind of thing." Given that official navigation pathways lack early design experiences, it is left to those with design experience from unofficial navigation to be the *chauffeurs* of designerly perspectives. In these case study teams, this role was filled by women. Thus gender emerged as a complex dimension because these women who helped to shift their teams from problem-set ADK to designerly ADK, viewed these designerly perspectives as somehow weaker than problem-set ADK. This perspective is warranted by their prior experiences in courses that emphasize engineering science. Though women were not the *chauffeurs* of designerly ADK in all case studies, gender is an important aspect to consider, given that problem-set ADK holds a privileged position garnered through prior experiences; this, taken with the degree to which team mates, especially those in leadership roles recognize the need to make such a shift, may explain, in part, why Daniela's repeated appeals for designerly perspectives were left largely unheard, whereas Cynthia's were adopted.

The official navigation creates a space in which those who champion designerly ADK may be positioned within a design team as having productive, disruptive, or irrelevant perspectives. When the chauffeurs of designerly ADK are from groups underrepresented in engineering, there is the potential to widen or narrow gaps, depending on whether those perspectives are treated as productive, disruptive, or irrelevant.

Institutional identification of students as BMEs from the first day has been noted as beneficial elsewhere (Stevens, et al., 2008). Taking identification as double-sided, it is relevant to consider students may identify themselves as engineers or as pre-medical, and that for those who identify themselves as engineers prior to the capstone design, official navigation offers few opportunities to reconcile what this means. Adoption of designerly ADK depends much, therefore, on endorsement by team leaders and unofficial navigation.

Implications

The focus on engineering science in prior coursework and accompanying accountable disciplinary knowledge places much of the burden of becoming an engineer upon the capstone design course. The open-ended nature of the design projects, the lack of prior design experience, and the legitimacy of BME as pathways to both engineering and medical school means that students may steer their projects towards or away from engineering design projects. If students so not see design as relevant to the pathway they have selected, they are unlikely to engage with a project as designers, and may even discourage their team mates from adopting designerly perspectives. For these students, identification as engineers is contingent indeed.

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