

Engineering student identities in the navigation of the undergraduate curriculum

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Recent educational theory emphasizes the importance of considering identity processes in studying learning and development. In engineering education, identity has been cited as central in student development, for example, as a key factor in retention of students in the discipline. This paper examines how identity relates to students' decisions about whether to remain in or switch out of engineering majors. We develop case studies of two students, both women and both members of underrepresented minority groups. One successfully gained admittance into her desired major, and one is considering leaving engineering. We argue that while each woman takes a different position on what engineering education should offer, both display a common, and we argue troubling, view of this educational experience. Our analysis seeks to explicate our ethnographic methods and to explore the broader possible significance for engineering education of the views that these women hold.

Introduction

In this paper, we introduce a study in which we are following college students across their years as undergraduate would-be engineers. This research project, led by the first author, is being conducted at four universities; in this paper we report on data from just one of these universities. This study is based on an ongoing set of field observations of these students and extensive informal and semi-structured ethnographic interviews. Our goal is simple but executing it is complex. We want to understand the multiple dimensions of development involved in how young people who enter college with generally ill-formed understandings and practices of a discipline, in this case engineering, "become engineers."

Twenty years of research influenced predominantly by cognitive science have typically answered developmental questions in terms of a single dimension—the acquisition of disciplinary knowledge. While we share the view that disciplinary knowledge is a critical dimension along which undergraduates develop¹, representing only the concepts and problem solving practices of would-be engineers provides merely a partial understanding of how disciplined people develop. A person can be capable of solving every problem and passing every test, but if she or he does not see her or himself as "one of us" rather than "one of them", that person is unlikely to become an engineer in any genuine sense of disciplinary participation.

The critical dimension of disciplinary development that addresses these issues is *identity*. Recent educational theory emphasizes the importance of considering identity processes in studying learning and development.^{2,3} In engineering education, identity has been cited as central in student development, for example, as a key factor in retention of students in the discipline, in particular with regard to underrepresented groups.^{4,5}

The concept of identity that we adopt here is informed by anthropological and other sociocultural approaches to this topic. As we mean it, “identity” refers to both one’s self-understandings about and actual ways in which one is positioned—both by others and by institutional representations—within some social world. Identity is something experienced (as in “I belong”) but also something bestowed and maintained by others (as in “to us, you belong”). This “double-sidedness” of identity⁶ distinguishes the concept from the more familiar psychological notion of self. The psychological concept of self highlights the internal ways that we see ourselves, but it fails to show how these internal representations are reciprocally formed in relation to how others position us in situated social life. For our research, the double-sidedness of identity is a critical construct for pursuing our analytic goals of understanding people’s development in context. Our broader analysis of the young people we are studying traces the development of both their disciplinary knowledge and their identities as they *navigate* the institutional contexts of engineering education.

In this paper, we use a particular formulation of the identity concept. Rather than refer to the abstraction of “identity”, we will mostly refer to *practices of identification*,⁷ or *identifications* for short. We favor this term, because unlike the abstraction “identity,” identifications are empirically tractable (e.g., “when I am an engineer”); we can see and hear the ways that people do or don’t identify with others and with particular activities associated with the discipline of engineering and engineering education. It is an open question for our own ongoing analysis of how these identifications accumulate into either a stable sense of one’s self or a stable position with the particular social world that makes up engineering.

Methodologically, this perspective leads us to a primary research focus on the details of the identifications made over time by individual persons as they develop. This is thus a form of “person centered ethnography”⁸, which led us to design ethnographic interviews that have two key properties. First, because our interviews take place with the same participants over a number of years, we have designed them with an explicitly *past, present and future* structure. By this we mean that at each interview we ask questions about these three phases of experience, relative to their current point in personal and cultural time. Because our study is longitudinal, present experiences reported in Interview N become past experiences in Interview N+1; similarly, projections of future experiences during Interview N move into the realm of presently experienced events during Interview N+1. The value of this approach is that we are generating data that allow us to explore how students progressively *recontextualize* experiences, which we take as a key manner in which people construct their identities. For example, a “class I hated” represented shortly after its end might be recontextualized in a later interview as an “awesome class” which is where “I realized I could really do engineering”. Such a recontextualization, we

argue, would represent a deepening identification with engineering education.

The second distinctive property of person-centered ethnographic interviews is that they are conducted to “encourage respondents actively to reflect on and evaluate their life experiences” with the aim of exploring “the most significant and meaningful aspects of the world of the individual as experienced by him [or her] and in terms which he [or she] thinks, is motivated to act, and satisfies his [or her] need” (p. 3).⁸ In summary, we are trying to understand what developing membership in engineering and engineering education *means* to the students in our study and *how these meanings change* as they move along a developmental path toward or away from more publicly recognized membership and participation (e.g., admittance to a major, earning a degree, taking a job in an engineering firm).

This approach leads to detailed case studies of individuals, especially with an eye to how similarities and differences in cases can inform our understanding of the broader culture. In this paper, we explore how two students identify themselves as part of the social and cultural worlds of engineering education and the prospective world of engineering work (i.e., a projected future). Our analysis is based on field notes and interviews at two points in time: one long interview toward the end of each student’s freshman year and one shorter interview just after each returned to begin her sophomore year. Each woman spent part of her summer in an internship, and it is these experiences as interns, as they relate to their ongoing, contingent trajectories through engineering education that we discuss here. Our primary goal is ethnographic: to understand how each narrates herself in and out of the contexts to which she refers in these interviews.

A Tale of Two Students: Tarja and Bryn

This is a short comparative case study of two young women who are enrolled in programs designed to prepare them to apply to an engineering major at West State, a large flagship state university in the western US. Most students are not admitted directly into an engineering major upon admission to the university, but rather apply for admission to majors, typically after their sophomore years, though a relatively small number of students can gain early admission after their freshman year. Students spend much of their first two years on prerequisites offered outside of the college of engineering, taking courses such as mathematics, chemistry, and physics. While most students have very little exposure to engineering courses, some, including both students we discuss in this paper, take a project-based “introduction to engineering” course during their freshman year.

The data analyzed in this paper are drawn from interviews and field notes spanning the end of their freshman and beginning of their sophomore years. In many ways that traditional social science uses to categorize people, Bryn and Tarja are quite similar. Both are members of underrepresented minority groups; Bryn is a Mexican American and Tarja is a Native American. Both won competitive minority student scholarships to attend the university. Both are active in several minority student organizations on campus, including those associated with the college of engineering.

We highlight the contrast with traditional social science, because it allows us to surface important differences in how our analysis proceeds when compared with a more common logic of scientific inquiry, which is perhaps more familiar to an engineering education audience. Much social science research begins with pre-established social categories of these kinds as “independent variables” and looks for correlated data. Among the things that this approach cannot do and that our person-centered ethnography is designed to do is discover new analytic categories. We want to discover from our data the ways that our participants organize their experiences, both in practice and in speech. If, for example, a person repeatedly tells us, without prompting, that she is a certain kind of person and sets this in opposition to a particular group or activity, our analytic approach guides us to pay particular attention to this oppositional relation. Our bottom up approach similarly guides us to look for these analytic categories in the words and deeds of our other research participants and to actively look for disconfirmation of our evolving generalizations. Proceeding this way in the comparative case study at hand, has led us to see how different these two women are in their expectations for engineering education and, at the same time, to expose a troubling similarity in their underlying views.

The key similarity in their views is that neither woman believes that engineering education provides her with a supportive context for personal development. This may be troubling to this audience for obvious reasons, but we will be explicit in the discussion below about why we see it as troubling. The key difference in the views of Tarja and Bryn revolves around how each woman sees the role her education plays in her personal development. For Tarja, it does not matter that engineering education does not support her personal development. She draws a sharp distinction between the world of school and “the real world” and looks to the real world for resources for this aspect of her development. She sees engineering education as a critical means to an end, and she narrates her activities within this “cultural model”.⁸ Bryn, on the other hand, cares deeply about her undergraduate education as an occasion for personal growth, and expects her experience in school to lead to self-realization. She finds that engineering education is disappointing these expectations, and her narrative seems organized as one that could provide a rationale for leaving engineering. (As this paper goes to press, it appears increasingly likely that she will leave engineering).

In the conclusion we draw some speculative and perhaps troubling inferences about how students view engineering education on the basis of the limited data presented in the paper and point outward to our larger ongoing analysis. We also complicate our story a bit, by exposing some elements of these contrastive stories that make this something less than a straightforward indictment of what “engineering education” is for these students.

Tarja

For purposes of presenting the most data and analysis in this brief section, we must necessarily limit the depth of our contextualizing description. For the same reason, the transcripts segments we include are also short. Our broader analysis of these data supports the points that follow.

In Segments T.1 and T.2, Tarja describes her view of school in contrast to what she repeatedly calls “the real world.” Her view of the real world was formed in large part by an internship at a well-known West Coast laboratory, referred to in these segments.

Segment T.1. And I really liked- I like actually working in like science, because going to school is one thing, but actually doing it, and seeing like why you learn all that stuff in school, really helps. And you- I think you learn more when you actually have to do things, as opposed to just being in school... like real science experiments that, not- because in school you do like chemistry labs, but, and usually they're fun ones. (laughs) It's not really anything new, like, other people have done the same lab ten million times before you. (laughs) It's not that great. But when you're actually out in the real world, that's what the real scientists who already have all their degrees are doing. And it was actually like new research.

Segment T.2. Um, I don't know, it's weird, cause it [the experience in the lab during the internship] helps you in so many areas of life. Cause like it helps you cause, it helps you like even in chemistry lab, like my, like whenever I weigh stuff now, it's so exact, cause that's another thing I did was weigh the, all the samples. Cause we had to know like the molecular weight of each of em, so we could back calculate to make sure that we didn't make any mistakes, when we were measuring em into their little test tubes. And so like now, in chemistry lab, it annoys the other kids, cause I take like so much time to like weigh it down to like the exact, like gram, or tenth of a gram or whatever we need, cause I'm really, really like meticulous about it now. I do everything, I think I do everything correctly, cause I learned so many lab techniques there, even stuff like that and then, it really, really helps motivate you, cause like if you want to be doing this, uh, permanently you're gonna have to get through school.

For Tarja, the knowledge and experience she developed in the internship are resources for school, not the other way around. Tarja views school as a means to an end, that end being a job working “permanently” at the research laboratory where she has spent two summer internships. In the following segment, Tarja expresses further regard for what she learned during the internship. The interviewer has just asked her, “So could you summarize what you think you get out of this internship?”

Segment T.3. You get research experience, which is always really important. Um I've been looking a lot more into getting into grad school right now, and I know research is really important for that. Um it gives you- it gives me a better, at least, a better idea of what I want to do with my life. Cause I really want to work there um after school, so um I think a lot of people don't really have- like don't know what they wanna do, for- as a career for sure. They have ideas, but I know exactly what I wanna try to do...[i.e., work at the lab “permanently”]

In sum, Tarja's view of school, as it relates to her sense of self, is as a means to an end, rather than a place to gain important life abilities or experience. For that, she has looked

to her experience in the internship. Engineering education, as she understands it, is not a source of personal fulfillment—nor should it be, as long as it helps her move along a path toward her desired goal of employment in the renowned laboratory.

Bryn

Bryn views college differently. For her, college should be a place that supports her development as a person and builds on the abilities that she believes she brings with her to college, like being a “people person.” In Segment B.1, Bryn describes her stance on engineering as it relates to her own abilities.

Segment B.1. I've questioned if it was- if I was for engineering or if engineering was for me. Um, I'm a very people person, and a lot of the stuff that I've been exposed to in engineering has been behind the desk. Not as much exposure with um people. And I know that I need to be working with people. And I've seen that a lot this summer. I counseled kids this summer that were doing the Genome project. I was their counselor. And then I you know do Girls' State as a counselor. And then I helped coach Jr. High Girls' Basketball. I was around people and I was just- you know I know that that's a gift that I've been given, and to deny that would be- would not be good. So- and I don't know where engineering would fit into that. And so I'm still looking at that. But the experiences I've had that's really been something that has- that has turned me off.

What Bryn does not find in engineering, a sense of personal development, she does describe finding in other courses.

Segment B.2. I'm taking Spanish, which I want to take, that's something that I was going to take no matter what, um, because I want to learn to speak Spanish, because it's kind of my culture, and I haven't been exposed to it as much because I don't speak the language. I'd eventually like to go visit our family in Mexico, so that's a big thing, something that's interesting to me ... I really wanted to do some English because last year I noticed having the whole year [her freshman year as a pre-engineer] without writing a paper, my writing skills just went down the drain and that's something that I think is important in life is- are your writing skills...

Unlike Tarja, Bryn looks to her college education to both develop her pre-existing strengths (as a “people person”) and also extend her as a person. From our analysis of her views, neither of these criteria is being met by her experience in engineering education. As a result, she voices the possibility of leaving engineering.

Discussion

Bryn and Tarja identify differently vis-à-vis engineering education, and as we have argued, this may have consequences for how likely each is to stay with the field.⁵ Tarja's expectations are limited; an engineering education has a job to do, which is to position and certify her for her future. She expects to learn how to do the work at work. Bryn

appears to hold education to a different standard, expecting that it develop her as a person. Despite these differences, it is the similarity that we highlight here for the purposes of an argument to an engineering education audience. The perspective these women share is that engineering education is not a site for personal development. Tarja simply does not appear to care about this; Bryn does. The question this view, that engineering education is not a site for personal development, raises is whether a field can retain students in the numbers and diversity it seeks if it cannot offer them an experience in which *the educational activities themselves* matter to the students as developing adult human beings.

Regardless of an answer to this question (requiring as it does more data), we note a complicating and ironic fact—that the views that these women have of “engineering education” are, in fact, not formed through experiences in engineering education, with a single exception. As we described earlier, at West State these women and nearly all freshman and sophomores are not yet admitted to an engineering major. During these two years students take pre-requisite courses in other technical and scientific departments and then apply to the engineering majors toward the end of their sophomore year. Even though these women and many others are significantly committed to engineering through a “pre-engineering” program, the courses they take are in departments of physics, chemistry and mathematics. It is in these courses that the impressions of engineering education we described are formed. This is one of the structural dilemmas we have found in this study. There are others. For example, there is a single introductory course that both of these women took. This course was designed to provide an experience of “real engineering” and was perhaps located early in the curriculum of pre-engineering as a response to the problem of deferring an engineering experience that can be seen as “real”. Nevertheless, for students taking it, the course is understood differently; as Tarja put it and was echoed by Bryn, “it didn’t seem like college, cause we were building stuff out of popsicle sticks and glue. It felt more like preschool.” In other words, the “real” engineering class—involving design, testing and working in teams—seems unreal, because it does not match their cultural models of engineering courses, which as we have described, are cultivated in large part from non-engineering courses.

The ethnographic approach we are taking is distinctive for discovering *the work* people do to manage the relationships between institutionally structured dilemmas and the meanings these dilemmas create for them. In turn, these dynamic relationships between person and culture create contexts for evolving identities, our continuing topic of study.

Acknowledgments

This material is based on work supported by the National Science Foundation under Grant No. ESI-0227558, which funds the Center for the Advancement of Engineering Education (CAEE). CAEE is a collaboration of five partner universities: Colorado School of Mines, Howard University, Stanford University, University of Minnesota, and University of Washington.

We thank those students who are participating in this study, in particular the two women discussed in this paper, and the Learning, Technology and Interaction Group led by Reed Stevens at the University of Washington for helpful comments on and discussion of an earlier draft of this paper.

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