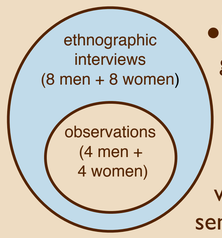
becoming an engineer: ethnographic perspectives on engineering education

Reed Stevens, Andrew Jocuns, Lari Garrison, Daniel Amos Univ. of Washington

Our ethnographic perspective has enabled us to take a holistic approach to the study of identity development among engineering students. This approach we refer to as becoming an engineer and it enables us to consider this ethnographic problem by observing three dimensions that change over time: **identification**, **navigation**, and **accountable disciplinary knowledge**. While these are presented as three separate dimensions, it should become apparent that they work together in forging a trajectory of becoming an engineer.

- **ETHNOGRAPHIC INTERVIEWS** at 4 U.S. campuses with 16 engineering students taking part at each school; open-ended structure

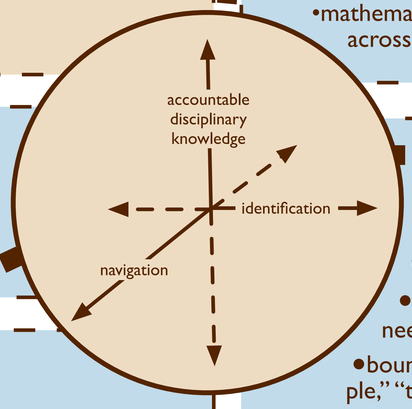


- **ETHNOGRAPHIC OBSERVATIONS**: of 8 engineering students (4 male, 4 female) at University of West State (UWest) across the span of their undergraduate engineering education

-observations included classroom interaction, group work, study groups, student organization meetings, and senior design/capstone courses

- **VIDEO & AUDIO RECORDING** of key activities (e.g., capstones, lab courses)
- **PERSON-CENTERED ETHNOGRAPHY**

How do these three dimensions change over time?



navigation

how different individuals navigate a pathway towards becoming an engineer.

- different navigational pathways have a clear effect on the identification of students as engineers
  - first year admits perceive themselves as engineers, whereas other students are lost in a pre-engineering purgatory until they are admitted
  - "keys to the clubhouse"
  - taking a more agentive stance towards education

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). Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation. The authors would like to thank the 64 students who took part in the study.

accountable disciplinary knowledge

actions when performed are counted by someone as engineering knowledge

- coursework was similar on all four campuses during the first two years
  - technical subject matter (mathematics physics, chemistry) outside of enineering
  - course sequences assume students master content prior to the next course
  - lecture-based teaching, with individual-based problem sets and exams
  - competing against others for a finite number of best grades.
- a shift in coursework during the latter two years
  - open-ended problems where the locus of responsibility shifts to students for finding and posing problems
  - students' relationship to data changes from mathematical puzzle solvers to data users and data collectors
  - capstone/senior design project serves at the biggest change in accountable disciplinary knowledge
- such changes affected students identifications as engineers differently depending upon whether or not they perceived their core abilities as being sponsored
- mathematics as a shifting object across the early career of an engineer across school and work.

identification

the practices by which an individual becomes identified with engineering (by her/himself and by others).

- participants display an increasing solidarity with other engineering students
- boundary work: "we vs. they" language, "the north campus people," "techies & fuzzies"
  - identity displays (e.g., personal networking websites such as facebook, wearing clothing that aligns with a particular group of engineers, social activities.
- increasing expression of views that they are different and in some ways superior to other (non-engineering) students
  - engineering is difficult because it is about real rather than arbitrary things
  - harder work & sacrifice in college justifies a better lifestyle (Stevens, et al. (2007)). Engineering as a lifestyle and a meritocracy of difficulty: two pervasive views among engineering students and their possible effects (ASEE 2007 proceedings)
- gender identification
  - similarities across men & women
  - women are perceived to have an advantage in the admission process at UWest--**potential stereotype threat?**
  - women feel the need to work harder to prove themselves
  - women go underground for help, to avoid perpetuating stereotype that women are less qualified than male counterparts

early career engineers

- mathematical works are differentially distributed across people; people's use of mathematical tools and ideas varies widely
- computer tools are part of a key job that is mostly invisible in undergraduate engineering education
- much of the mathematical work is embedded in noticing and seeing relevant phenomena and trouble in and across visual representations. Team leaders problematize computers, because computers lack this embodied "judgement."

  "often it takes looking at graphs for 20 years to see problems."

  --Casey, recent UWest graduate
- most work involves examining, transforming and taming A LOT of data. Massive immersion in data.
- surprisingly large amount of ad hoc creation of tools
- the expressed meanings of and the actions that represent "mathematics" change dramatically over the early career of *becoming an engineer*
- what this implies for how to reformulate basic, necessary or generative learning of mathematics in engineering is uncertain but a critical educational task
- why? because the problem set and test version of mathematics remains the gateway in and largely the gateway out of engineering, but it's not what a lot of work looks like
- a lot depends, here again, on how we conceptualize learning *transfer* but this analysis really problmeatizes the learn-apply model, because of such big changes in what counts as accountable disciplinary knowledge

what's next?

- students' images of engineering and how they change over time?
- variations of engineering culture across the four campuses in our study

implications

- admitting students as engineers sooner during their undergraduate experience enables them to be grated the status of "legitimate peripheral participants"
- rethink course requirements to give students a legitimate encounter with other ways of knowing and other people

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