Teachers Becoming (Temporary) Engineers to Become Better Teachers

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Abstract: The new science standards incorporate engineering practices, but few teachers are prepared to enact these. This poster presents preliminary findings from professional development that placed 14 teachers in university engineering labs for six weeks, tracking changes in their understanding of STEM practices, their designs for their classrooms, and the impact on their students. Preliminary findings demonstrate deepened teacher understanding of STEM practices and that their students begin with notions that do not match STEM practices.

Major Issues Addressed

An increasing focus on engineering practices is evident in the Next Generation Science Standards (NGSS), (National Research Council, 2012). However, teachers are unprepared to enact these practices; few teachers have experience in engineering.

Significance

This study builds on and extends what is known about how teachers and their students learn engineering practices and develop STEM identities. Engaging teachers in advanced STEM research can provide them with a deeper understanding of STEM and renew their enthusiasm for teaching, but can be difficult to bring back to the classroom (Blanchard, Southerland, & Granger, 2008; Johnston, 2003). The latter is crucial because research has shown that students who have an understanding of the core disciplinary practices- in this case, design- are likelier to persist through a challenging course of study (Stevens, O'Connor, Garrison, Jocuns, & Amos, 2008).

Learning is a coupled act of identity; who you are affects what you learn, but what you learn changes who you are (Wortham, 2006). Authentic experiences support the development of engineering (Pierrakos, Beam, Constantz, Johri, & Anderson, 2009). We build on past research to investigate how engineering practices were taken up by teachers and their students, and how STEM identities developed.

Methodological Approach

Participants and Setting

Participants include K-12 teachers and their students. At the time of writing, consent forms for teachers are still being returned, with a maximum sample size of 14. Teachers were recruited from rural and urban schools serving students traditionally underserved and underrepresented in engineering. As part of the application process, they submitted a letter from their principal committing to allow the teachers to implement project-based engineering units in their classrooms. The teachers spent six weeks in a university engineering lab conducting research as a lab member and designing project-based units to bring the lab experience back to their schools. They were provided seven days of professional development on designing relevant project-based units.

Measures and Analysis

The teachers completed a daily end-of-day survey to provide brief snapshots of their experiences and information about with whom they interacted; this will be analyzed using social network analysis and open coding. They also completed a pre and post survey that provided a detailed picture of their understanding of STEM practices (150 questions, with 20 constructed response items). The teachers are providing deidentified reports of student responses to a shorter survey that asks related questions. To date, two teachers have provided these data and analysis of all data is in progress.

The survey given to the students asked four open-ended questions: how they thought the work they did in their classes mimicked what an engineer did, what they might be doing if they were scientists working in a lab like the one their teachers visited, and they were asked to define science and engineering. Likert-style questions included items that asked the students to rate their understanding of what they did in the classroom, how much the teacher guided their inquiries, and about their future intentions of going into the STEM fields. Likert items were analyzed using basic descriptive statistics and will be compared to post-unit responses and teacher responses. Open coding of the qualitative data is ongoing.

Findings, Conclusions, and Implications

Preliminary findings suggest that the research experiences teachers had varied by lab. Some mentors were excited to have a teacher present, while others were not. The teachers all learned a great deal about social norms and the realities of lab work, including: (1) lab work occurred in evenings and weekends, but rarely in the early morning hours the teachers preferred to keep; (2) much time is spent waiting for experiments to happen; (3) equipment and materials are highly specialized and costly and require training prior to use; (4) the experiments they conducted led to highly specific, complicated results. They therefore initially struggled with how to bring the experience back to their classrooms. Because the professional development also focused on ways to make STEM practices meaningful and relevant, most teachers found ways to accomplish this in their unit designs.

Preliminary analysis of student surveys completed prior to the units indicate that few students are interested in becoming STEM professionals (Figure 1). Student descriptions of what it would be like to be in the lab revealed an understanding based in school experience, with little understanding of STEM practices:

- "I imagine it would be a lot like class; people would tell me what to do and I would have a little freedom to learn by myself."
- "It would be very interesting but it would be the same that we are doing in our labs. But with bigger problems to solve."
- "I think it would be really high tech and nice looking. I would just be helping to keep it nice looking."

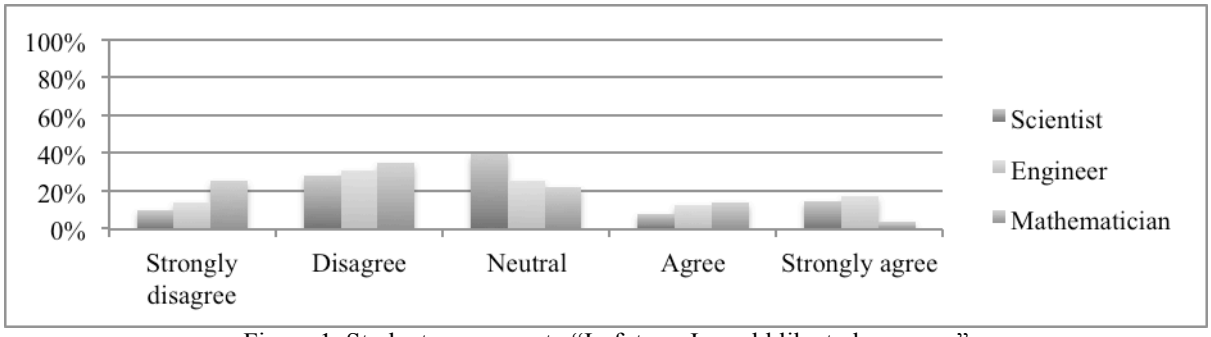

Figure 1. Student responses to "In future, I would like to be a ____"

The poster will present detailed cases following the teachers from the research lab to their classrooms, connecting teachers' beliefs to changes in student understanding of STEM practices.

Connection to Conference Theme

This on-going work is strongly connected to the conference theme, *Learning and Becoming in Practice.* Preliminary findings suggest that teachers –even with no prior experience in engineering—can learn by being placed in an engineering lab. By temporarily becoming engineering lab members, they developed stronger identities as teachers who can engage their students in STEM practices.

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