Examining Online Teacher Learning in Engineering Education

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TEACHER ENGINEERING EDUCATION PROGRAM TUFTS UNIVERSITY

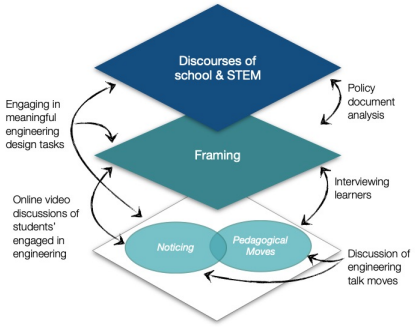
Program Design

Teacher Engineering Education Program (TEEP, www.teep.tufts.edu) is an 18-month, graduate teacher education program for K-12 educators.

- Entirely online and asynchronous
- Enrolled over 130 educators worldwide
- Focus on incorporating engineering design in school & out-of-school
- Design of disciplinary activities to engage teachers as adult learners
- Emphasis on teachers learning to be *responsive* to student thinking

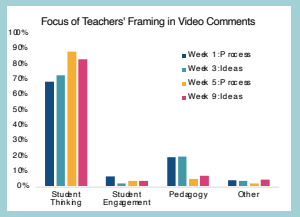
Fall 1	Engineering Content 1	• Reading articles about professional engineering • Participate in targeted lessons on key topics (e.g., simple machines) • Engage in ill-defined engineering design problems (e.g., automatic fish feeder)
Spring 1	Engineering Pedagogy 1	• Reading articles on learning engineering & policy documents • Interview learners on engineered objects • Discuss videos of classroom engineering using web-based annotation tool
Summer 1	Engineering Content 2	• Read about human-centered design practices • Participate in targeted lessons on key topics (e.g., electric circuits) • Engage in human-centered design project in local community
Fall 2	Engineering Pedagogy 2	• Read about teaching engineering (e.g., talk moves, responsive teaching) • Evaluate and design tasks attending to different aspects of engineering and students' thinking • Collect & analyze video from own classrooms

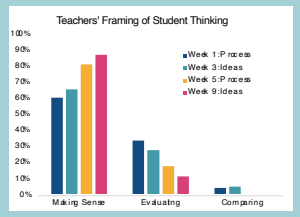
Connecting Theory-Design



We consider teacher learning within a multi-leveled ecology that involves teacher noticing (Sherin, Jacobs, & Philipp, 2011), pedagogical moves (Michaels & O'Connor, 2015), how teachers are framing activities (Russ & Luna, 2013), and larger institutional & disciplinary discourses (Louie, 2017). The figure shows how we conceptualize intersections between our theory & design of TEEP to support teacher learning.

Online Video Discussions





Even at the start of the course, teachers were framing the online video discussions as opportunities to focus on student thinking. And yet we still saw significant shifts toward focusing on student thinking between early & later videos.

Within comments focused on student thinking, we found significant shifts between the distributions of teachers' framing in Early and Later Videos. By Week 9, teachers were overwhelmingly taking up the video discussions as making sense of student thinking.

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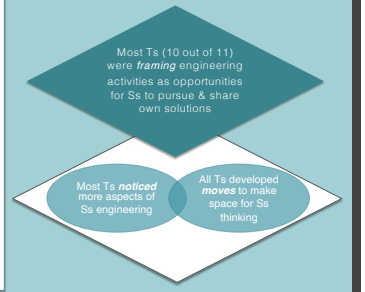
Teacher Responsiveness

This kid, Charlie, he was trying so hard to make an air-tight rocket. 'Cause he figured, mine is not going far because it's leaking. That the air is going through it and it's leaking, so it's not going very far. 'So I am going to make an air-tight rocket.' Well, he had layers of wax paper, aluminum foil. He pinched off every little corner he could find. Little holes he covered with metal washers, which then had a lot of masking tape. [laughter] This thing weighs a ton! So I'm sure it doesn't have any air leaks, but it weighs a ton!

...I'm watching him put all these layers on... and **I am letting him put all these layers on it**... 'Cause if I just tell him, 'Honey, that's going to be too heavy,' he's just gonna, you know, be disappointed and take my word for it. Or he's such a lovely polite person, he's not going to argue with me, and he hasn't tested it yet, so he doesn't have the evidence to counterclaim or whatever. **So I would have really stolen from him the opportunity to think that through.**

(Margaret, Interview 5)



Connecting to Discourses

Pattern 1: Drawing on established hierarchies to reason about Ss' engineering

Pattern 2: Drawing on unique skills in engineering to invert Ss' hierarchies

Pattern 3: Drawing on diversity in engineering to broaden competencies

Recognizing that teachers' sense-making about engineering is situated within broader ideologies of K-12 school, we explored interactions between novel conceptual elements in engineering education (unique skills, design process, emphasis on diversity) and dominant discourses of school (establishing hierarchy, exerting control, & assigning blame). Here we show three patterns of interaction in teachers' pedagogical sense-making around Ss' status.

Research Questions

Online Video Discussions
- How did educators frame the online video discussions in their comments early & late in Pedagogy Course 1?

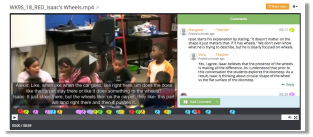
Teacher Responsiveness
- How did teachers' shift in their framing, noticing, & pedagogical moves from the start to end of the program?

Connecting to Discourses
- In what ways did broader discourses of STEM & school interact in teachers' pedagogical sensemaking in engineering?

Methods

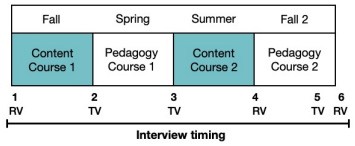
Data Source: Asynchronous Online Video Discussions

In Pedagogy Courses, teachers commented weekly on online video discussions using Torsh Talent web-based platform.
- Compiled teachers' comments on 2 videos *early* and 2 videos *late* in the course
- Coded for how teachers were framing the video discussions
- Compared distributions of *early* (N = 954) and *late* (N = 1018) video comments



Data Source: Participant Interviews

11 teachers participated in semi-structured interviews six times in the program
- Teachers watched videos of classroom engineering from research projects (RV) and from teachers' own classrooms (TV)
- Focused on episodes of pedagogical reasoning & video discussion
- Analyzed for teachers' moves, noticing, framing, & drawing on discourses



Implications

Highlights possibilities for online PD in STEM
- Finding ways to negotiate framing with teachers is more challenging, but critical in online environments

Contributes to theory development on teacher responsiveness
- Links framing, noticing, & pedagogical moves as entangled aspects of teacher learning
- Emphasizes need to consider interactions with broader ideological discourses & structures in teacher learning

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