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# Characterizing Out-of-School Time Educators' Teaching Talk Moves During Engineering Design Activities (Fundamental)

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Karen Miel's research focuses on PK-16 students' reasoning and decision-making in collaborative engineering design and the ways educators facilitate engineering sense-making.

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# Characterizing Out-of-School Time Educators' Teaching Talk Moves During Engineering Design Activities (Fundamental)

Out-of-school time (OST) offers many opportunities for youth to learn engineering; youth in OST engineering programs engage in engineering practices, increase their disciplinary knowledge, strengthen their identities as engineering learners, and build interest in engineering careers. OST educators contribute to these positive outcomes for youth through a variety of teaching practices. One way that educators influence youths' learning is through ambitious instruction that elicits and supports youths' engineering reasoning and engineering identity. This study focuses on ambitious engineering instruction at the level of educators' moment-to-moment dialogue with small groups of learners.

While it is known that schoolteachers' pedagogical talk moves influence learners, little is known about out-of-school time educators' talk moves. This study examines the pedagogical talk moves of experienced out-of-school time educators during engineering design activities in OST programs for youth aged 8-12 years. The study identifies the talk moves of OST educators, adds to the understanding of pedagogical talk moves, and considers these talk moves within the framework of Ambitious Engineering Instruction. This study asks: ***What kinds of pedagogical talk moves do experienced OST educators use when interacting with youth during engineering design activities?***

In this study, educators facilitated a series of engineering design challenges for a total of six to twelve hours in afterschool programs (one hour/week) or out-of-school workshops or mini-camps (two to four hours/day across two or three days). All educators taught at least five of six possible design challenges. We selectively sampled and analyzed the video- and audio-recordings of two educators teaching two of the same design challenges. We used the Ambitious Engineering Instruction Framework to classify the teaching talk moves that these educators used in interactions with individual youth and small groups of youth who were participating in these engineering design challenges.

We identified ambitious, inclusive, and conservative talk moves across the four samples. We observed educators seeking to understand youths' design ideas, eliciting youths' engineering reasoning, and encouraging youths to persist despite frustration with a design failure. These teaching moves have the potential to guide students to engage in productive engineering design practices and to support youths' identities as capable engineering learners and possible future engineers. This analysis of educators' teaching talk moves contributes to our understanding of ambitious engineering instruction in out-of-school learning environments.

## 1. Introduction

Out-of-school time (OST) engineering educators are a significant contributor to K-12 engineering learning. Across the United States, in afterschool programs, camps, and workshops, OST educators engage hundreds of thousands of K-12 youth in engineering design learning [1], [2]. Despite the reach of OST engineering education, little is known about the ways that OST educators' interactions with youth influence their participation in engineering learning. To increase the effectiveness of OST engineering educators, it is important to understand which pedagogical talk moves OST educators use and how those moves influence youths' participation in engineering. This study explores the discursive interactions between OST educators and youth participating in an OST engineering program and asks: ***What kinds of pedagogical talk moves do experienced OST educators use when interacting with youth during engineering design activities?***

## 2. Historical and Theoretical Background

Out-of-school time engineering education programs offer youth enticing opportunities to participate in engineering learning and to consider possible futures in engineering [1], [2], [3], [4], [5], [6], [7]. In this work, we consider youths' present participation or engagement in practices and norms of engineering to indicate learning. We use a framework of ambitious engineering instruction [8] to characterize the teaching moves of OST educators that make space for youth to participate in engineering learning.

### 2.1 Out-of-school time as a context for studying pedagogical talk moves

Out-of-school time engineering education programs are an important context for studying educators' pedagogical talk moves. Studies suggest that the ways educators speak with youth can influence their understanding of the nature of a discipline [9]; their identities as agentive, capable learners in a discipline [9], [10]; and their participation and persistence in a discipline [10]. When engaging youth in engineering learning, OST engineering educators prioritize both 1) cultivating interest in engineering and 2) engaging youth in "doing engineering" — facilitating youth-driven engagement in the practices of engineering [3]. Given these pedagogical goals, it is worth exploring the ways in which OST educators use pedagogical talk moves and the ways in which those talk moves create opportunities for youth to achieve these learning goals.

While studies have characterized the teaching moves of OST science educators [11], K-12 integrated science and engineering schoolteachers [12], elementary school engineering outreach educators [8], and university-level engineering peer educators [13], the pedagogical discourse of OST engineering educators is not well-understood. Given the extensive reach of OST engineering education programs, it is important to understand the nature of and potential impact of OST educators' dialogue with youth.

### 2.2 Ambitious engineering instruction

The concept of ambitious engineering instruction arose from the broader concept of ambitious instruction. Ambitious instruction is a set of educator practices that support learning by scaffolding students' reasoning about the students' own ideas [14], [15], [16], [17], [18]. Ambitious engineering instruction supports students to generate, build on, reflect on, and revise design ideas and solutions [8]. Miel and colleagues [8] have described three categories of teaching talk moves in engineering education. They describe *ambitious* talk moves as moves that "invite, foreground, or promote student thinking about engineering design or engineering science" and "invite students to share ideas or open space for students to discuss their ideas," *conservative* talk moves as moves that "orient student attention to [educator]-preferred actions" and "provide opportunities to stabilize students' participation in dominant ways of thinking, knowing, or feeling in engineering," and *inclusive* talk moves as moves that "offer equitable participation and offer all students a voice in the discussion or hands on the build" [8, pp. 362-363].

We take up this conceptualization of engineering educators' teaching talk moves in this work to explore the pedagogical moves of OST engineering educators. Educators' pedagogical moves can include speech, gestures, and physical positioning. In this work, we focus on educators' verbal moves in interaction with individuals and small groups of learners. We refer to these verbal moves as educators' teaching talk moves or talk moves.

## 3. Researcher Positionality and Epistemology

We are current and former engineering education researchers, OST educators, university instructors, and providers of professional development for OST educators and schoolteachers. We are motivated to understand OST educators' pedagogical moves to lay the groundwork for supporting OST educators to leverage their teaching talk moves to maximize youths' engineering learning. We begin with the premise that educators make multi-layered decisions in fast-paced environments. Thus, in this work we take a naturalistic inquiry approach [19], and observe and describe OST interactions in vivo. We take a sociolinguistic perspective and we consider discourse to be language-in-use and as negotiated meaning within a shared cultural context [20].

## 4. Methods

### 4.1 Study context and participants

This study took place within a university-led OST engineering program in the midwestern United States. In this study, OST educators facilitated an engineering design series with rural youth ages 8-12. Youth participated in five engineering design challenges over two to six meetings for a total of between six and twelve hours. We selectively sampled and analyzed two educators' enactments of two activities within the design series. We selected the samples to include 1) youth from varied rural locations in the state and 2) activities that engaged youth in varied engineering learning practices.

Both educators were skilled teachers who had been working as full-time OST educators for three or more years. The engineering design challenge curricula were provided by the research team and were new to the educators. In a virtual, synchronous professional development workshop series, the research team talked with the educators about possible ways to implement the design challenges. The researchers introduced educators to the idea of educator talk influencing youths' participation in engineering, but did not ask educators to change the ways they talked with youth.

The study protocol was reviewed and approved by the University of Nebraska – Lincoln and Tufts University Institutional Review Boards. We obtained informed consent from participating OST educators, assent from participating youth, and permission from parents or guardians of participating youth. All names are pseudonyms that respect the gender of individual participants.

The data set includes audio- and video-recordings of OST educators Kelly and Tess teaching two engineering design challenges. In the Wind Tube challenge, youth used craft materials to build contraptions that could hover within or fly out of a transparent tube placed over a fan while the fan blew upwards. In the culminating capstone project, a community-based engineering challenge [21], youth teams selected a real-world problem to solve over two class meetings. Teams of two to four youth selected problems from their own lives, such as experiencing difficulty carrying maker tools and supplies or finding something exciting to do when youth were stuck inside during inclement weather. They envisioned, built, and tested solutions created from craft materials and simple electronic materials.

### 4.2 Data collection and reduction

We made multiple video- and audio-recordings of the engineering design sessions to obtain optimal data. The educators wore lapel microphones connected to audiorecorders to capture their speech. Additionally, in each session, we set up three videocameras and two supplemental audiorecorders to capture the engineering activities from varied viewpoints.

We first observed the focal engineering design sessions or watched videorecordings of the design sessions to understand the arc of the activities. However, we focused our initial analysis on the audiorecordings of the educators and we later complemented our analysis of the audiorecordings with additional review of the videorecordings. We initially transcribed the audiorecordings with automated transcription software. Members of the research team then checked and improved the machine-generated transcripts while listening to the audiorecordings. If the audiorecording or transcript were ambiguous, researchers watched the videorecordings for clarification.

In the focal engineering design sessions, the educators began with a whole-class introduction to the design challenge, then circulated through the room and talked with individual learners or small groups of learners. At times, the educators ended the session with a whole-class discussion of the challenge. Often, educator talk moves are described in the context of whole-class instruction or discussion. We chose instead to examine the talk moves of educators in interactions with individual learners and small teams of learners, because we believed these moves could afford opportunities for educators to tailor their talk moves to the learning of individual youths and small groups of youths.

## 5. Data Analysis

We focused our analysis on the interactions between the OST educators and individual youths or small groups of youths. After transcribing the audiorecordings of the educators, we identified all turns of talk when the educators spoke to individual youths or small groups of youths. We excluded from analysis any educator talk that was directed to the whole class or to another adult in the room (e.g., a member of the research team or a teaching assistant). Excluding talk directed to the whole class or another adult reduced the combined total length of analyzed audiorecordings to 185 minutes.

We coded the data using the Ambitious Engineering codebook from Miel and colleagues' characterization of the talk moves of elementary school engineering outreach educators [8]. This codebook contains three broad categories of codes: *ambitious*, *conservative*, and *inclusive* moves. Each category contains three or four codes: ambitious moves include *design check-in*, *probing question*, *press for explanation,* and *revoice or reflect;* conservative moves include *display question, evaluate, minilecture or suggestion,* and *process management;* and inclusive moves include *distribute participation, acknowledge contribution,* and *repeat* [8, pp. 362-363]. Although we used the a priori Ambitious Engineering codes, we remained open to the possibility of additional codes emerging from the data. To align with the codebook, two members of the research team independently coded two transcripts, then adjudicated the coding and resolved any discrepancies through discussion to reach consensus. After adjudication of these two transcripts, we were confident that the coders were aligned with the codebook and could reliably code the data, and a single coder coded the remaining two transcripts.

In our coding, we segmented turns of talk into contiguous, non-overlapping units of meaning. That is, one turn of talk could be comprised of a "probing question" followed by a "press for explanation," or a "revoicing" sentence could be followed by an "evaluating" sentence. When we coded educators' talk, we considered the context of their talk; that is, we took into consideration the prior conversation they had with a particular youth or group.

## 6. Findings

We observed the same types of teaching talk moves observed by Miel and colleagues [8]. Broadly, we observed educators use ambitious, conservative, and inclusive moves. Further, we observed every subtype of move in the Ambitious Engineering framework. Ambitious, conservative, and inclusive moves were distributed consistently across design challenges, and educators' talk moves promoted youths' participation in engineering.

### 6.1 OST educators used ambitious, conservative, and inclusive moves

In this analysis of talk moves, we included only ambitious, conservative, and inclusive teaching talk moves; we excluded talk moves that could not be classified in one of these categories (and thus were coded as "other"). The distribution of each broad category of talk move was fairly consistent across the four design sessions. Ambitious moves ranged from 15% to 23% of all talk moves, conservative moves ranged from 70% to 74% of all moves, and inclusive moves ranged from 10% to 15% of all talk moves in this set. Figure 1, below, shows the distribution of ambitious, conservative, and inclusive talk moves across the four design sessions.

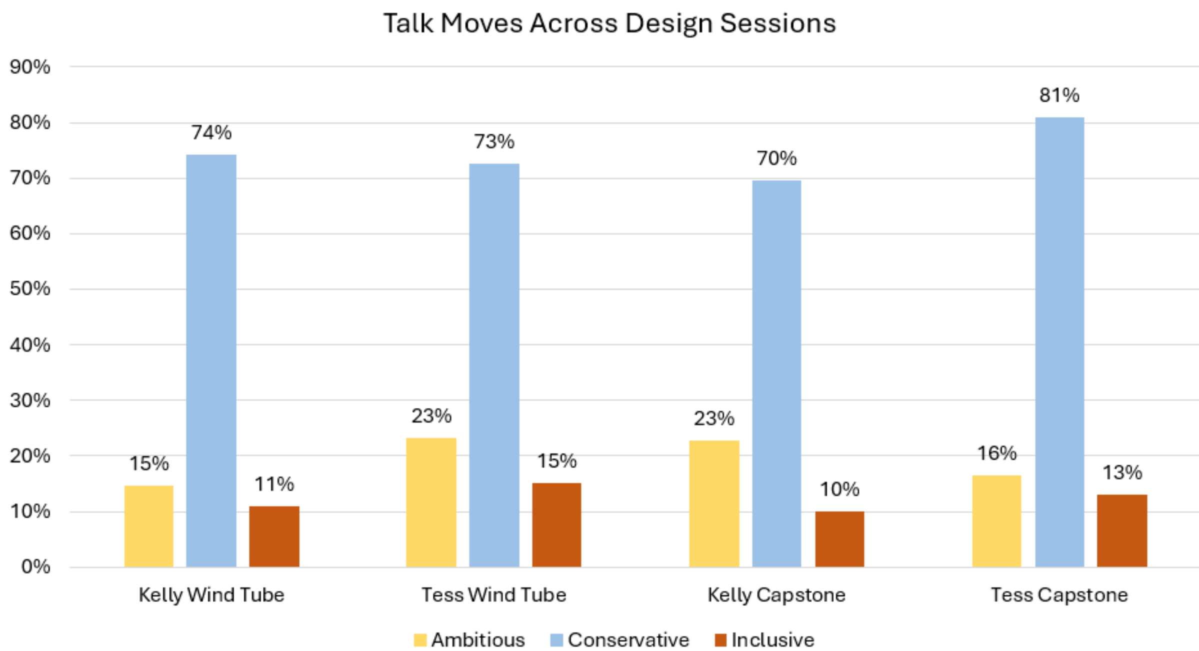


Figure 1. Talk Move Prevalence Across Design Sessions

We had envisioned that different engineering design challenges might encourage different distributions of talk moves. Both engineering design challenges were open-ended problems with multiple possible solutions, but in the community-based engineering challenge, youth in a single engineering series were able to select varied problems to solve. During that challenge, the educators could be facilitating several different youth projects at the same time; e.g., one group could be creating a tool belt to organize their maker tools, a second group could be developing a tabletop badminton game to play indoors in inclement weather, and a third group could be designing a better boot scraper to keep mud out of the room. We could imagine that facilitating multiple projects could encourage an educator to ask multiple youth ambitious questions about their design ideas and reasoning, or could encourage an educator to emphasize conservative moves including process management (including helping youth find materials) and minilectures or suggestions (including giving youth information about materials and designs). However, as seen in Figure 1, above, there was little difference in the distribution of ambitious, conservative, and inclusive moves from one challenge to another. We did not see evidence that the nature of these two design challenges encouraged relative differences in the use of educator talk moves.

It was also possible that different design challenges could have encouraged the use of particular categories of talk moves at different times or at different paces throughout a design session. The Wind Tube challenge promoted rapid iteration throughout the session; typically, youth quickly built a contraption, tested it, changed it, and tested again. During the capstone design challenge, youth built, tested, and revised in fewer, longer cycles. The rapid iteration cycles of the Wind Tube challenge could have made it challenging for educators to find moments to use ambitious talk moves to dig into youths' engineering design ideas, while the extended pace of the capstone project could have afforded educators longer moments to observe youths' design work and ambitiously invite them to discuss their ideas. Figure 2, below, represents educators' ambitious, conservative, and inclusive talk moves over time. This figure shows the teaching talk moves that each educator used in each activity in chronological order, with the first talk move at the top of the column and the last talk move at the bottom. Each talk move is represented by a colored band; thicker bands represent larger numbers of talk moves (not lengthier talk turns).

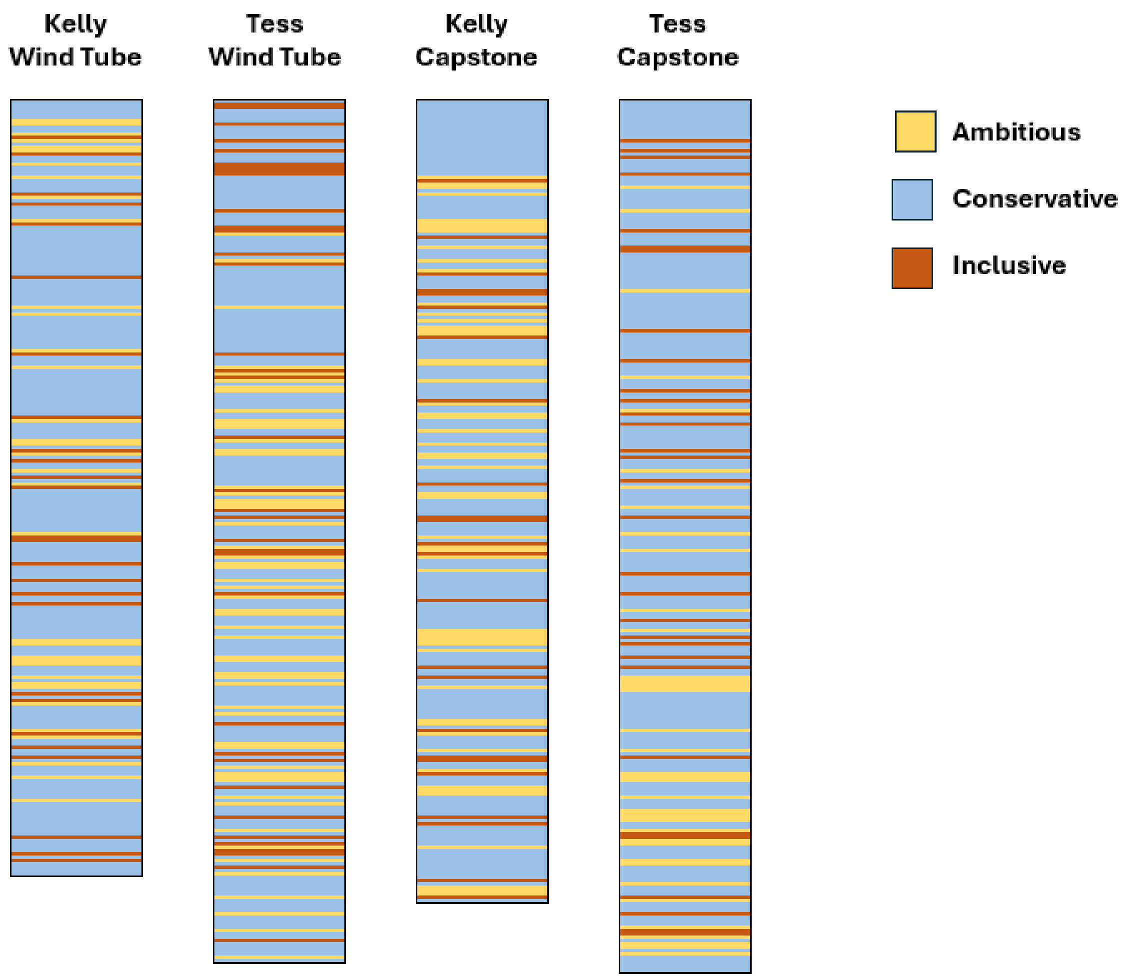


Figure 2. Talk Move Distribution Over Time

We did not observe differences in the timing or clustering of talk moves from one design challenge to another. The distribution of talk moves over time, shown in Figure 2, above, suggests instead that as the OST educators moved around the room and interacted with small groups of youth, they adjusted their teaching talk moves to what each group was doing at the moment of interaction. Youth in these design sessions were not all doing the same thing at the same time; at any given moment, each group was at a different point in their design process. Examining the conversations between educators and youth suggested that the OST educators tailored their talk to the group and the moment in ways that promoted youth participation in engineering.

### 6.3 Educators tailored their talk moves to promote youth participation in engineering design

We identified ambitious, inclusive, and conservative talk moves across the four design sessions. Below, we focus on talk moves that promoted youths' immediate and possible future participation in engineering design. We observed three discourse patterns that were likely consequential for youths' participation in engineering; educators making space for youths to reason about their own design ideas, noticing and revoicing youths' design ideas, and encouraging youths to persevere despite frustration with a design failure.

Educators Kelly and Tess used a variety of talk moves in both the Wind Tube and Capstone design challenges. For the reader's convenience, all examples shown below have been drawn from the same context — Educator Tess's interactions with youth during the Wind Tube activity.

#### 6.3.1 Educators made space for youth to reason about their own design ideas

Educators' ambitious talk moves made space for youth to reason about their own design ideas. Below, we offer an example of Educator Tess making space for a youth to reason about what could improve his design and why a modification might work.

Luca was testing a bowl-shaped design made from a coffee filter. He had poked holes in the coffee filter in an attempt to make it fly higher than before, because his prior designs did not hover as high in the wind tube as he wanted. Tess probed Luca's thinking, creating opportunities for him to reason about the phenomena and mechanisms involved in achieving his design goals.

> Tess: So, what are you doing to your design that's making it now fly?
>
> Luca: I just put little holes with the paper clip in the coffee filter.
>
> Tess: Added some holes to the coffee filter. OK….So, added a couple more holes. So what do you think? What else –
>
> Luca: It keeps moving to the heavier side, which is what is making it go down, 'cause there's no air going inside the gap.
>
> Tess: OK, so what do you think you can do?
>
> Luca: So, yeah, so I'll make the coffee filter lighter.

In this conversation, Tess asked a series of "probing questions," open-ended questions that surfaced Luca's ideas about his design [8]. First, she asked Luca what he had done that caused his design to fly, which made space for Luca to explain his reasoning that the holes he had added had contributed to his contraption's performance in the wind tube. Next, Tess asked, "What do you think? What else?", cueing Luca to extend his reasoning about his design. Luca considered the testing results and identified a pattern ("It keeps moving to the heavier side") and a reason for the results ("There's no air going inside"). Tess asked one more probing question ("What do you think you can do?"), which again made space for Luca to advance his thinking about his ideas, and Luca decided to make the coffee filter lighter. Tess's probing questions made space for Luca to reason about his design and offered him opportunities to develop his own thinking. Luca took up these opportunities, reasoned about what might be influencing the performance of his design, and — based on his reasoning — came up with an idea to improve his design.

### 6.3.2 Educators noticed, revoiced, and reflected youths' design ideas

We observed educators using the ambitious talk move "revoice or reflect," that is, they noticed and emphasized youths' ideas, either by paraphrasing or highlighting a selection of a youth's design related-comment, or by voicing the action the youth was doing with their design [8]. *Revoicing* is distinct from *repeating*; revoicing is not echoing a youth's speech or action, but rather interpreting it. Revoicing suggests that an educator is attending to and working to understand a youth's design idea, and the act of revoicing offers youth an opportunity to respond to the educator's interpretation [8]. Below, we share examples of Educator Tess revoicing youths' ideas during the Wind Tube challenge.

Before building and testing a design, Miri and Danielle worked together to explore how different materials behaved in the wind tube. As they started to build, they explained to Tess why they chose to use cardboard in their initial design, and Tess revoiced their reasoning.

> Miri: We decided to use the biggest cardboard because it flies, and number one, it flies, and number two, it will hold everything.
>
> Danielle: It will hold them here.
>
> Tess: Ah, so it's sturdy. OK.
>
> Miri: Yep, that's what we're going after.

Miri and Danielle stated that they would use cardboard because "it flies," "it will hold everything," and "it will hold [other materials]." Tess revoiced their reasoning that the cardboard would hold everything or hold materials as "[the cardboard] is sturdy," suggesting that she interpreted Miri and Danielle to be saying the cardboard would not collapse or break. This revoicing move offered Miri and Danielle an opportunity to confirm or correct Tess's interpretation. Miri confirmed Tess's interpretation, affirming, "That's what we're going after."

In the above example, Tess revoiced Miri's and Danielle's words. In other instances, Tess revoiced youths' tangible designs. Revoicing, as conceptualized in Ambitious Engineering Instruction, includes stating what the educator notices about a youth's tangible design ideas [8]. On several occasions, Tess looked at youths' design artifacts and commented on changes in the appearance or performance of the artifacts. In the example below, Luca, who had already tested three prior designs, was testing a new iteration in the wind tube.

> Tess: You changed your design completely, didn't you?
>
> Luca: Yeah.
>
> Tess: Not bad, Luca. You did a lot of adjusting on yours.
>
> Luca: I did.

Luca had not talked with Tess about these recent changes to his design, thus, Tess's comments about Luca's design were based on her observations of his artifact, not in conversations about his design ideas. Tess had seen Luca test a cup-shaped design made from a plastic bottle, a bowl-shaped design made from a paper coffee filter, and a perforated, bowl-shaped coffee filter design. The first iteration sank to the bottom of the wind tube, the second iteration hovered just above the fan at the bottom of the tube, and the third hovered in the middle of the tube. Luca's fourth iteration, also made from coffee filter paper, was smaller than any of his prior designs and was shaped like an octopus with paper clip arms. This fourth design hovered at the top of the wind tube. Although we cannot know if Tess was commenting on changes to the physical appearance of Luca's design, the performance of Luca's design, or both, Tess's revoicing talk moves of "You changed your design completely" and "You did a lot of adjusting on your [design]" showed that she had noticed new traits of Luca's design solution. Her two revoicing moves offered Luca opportunities to confirm her interpretation of his design, and in both cases, Luca affirmed Tess's interpretation, responding, "Yeah" and "I did", respectively.

In both of the above examples, Tess's talk moves indicated that she noticed and was working to understand youths' design ideas. Further, Tess's revoicing moves signaled *to the youths* that she was attending to their ideas, and that their ideas mattered. These revoicing moves did more than acknowledge youths' thinking; they positioned youths as the authors of their own design ideas, and positioned the educator as a supporter, rather than an evaluator, of the youths and their ideas.

### 6.3.3 Educators encouraged iteration and persistence

Tess often followed an ambitious revoicing talk move that recognized a youth's idea as significant with a conservative talk move that encouraged continued iteration or persistence. After the interaction (above) when Tess said to Luca, "You did a lot of adjusting on [your design]," Luca built and tested a fifth iteration. Luca's next iteration also failed, and Tess turned that failure into an opportunity and encouraged Luca to try again.

> Luca: Epic fail!
>
> Tess: You know what epic fails are?
>
> Luca: Adjustment.
>
> Tess: Adjustments. They are opportunities to try something new. So try something new. What do you think worked, though?
>
> Luca: The water bottle.
>
> Tess: OK, so I've seen a bunch of your different modifications. See what you can do.

Using a conservative "minilecture" (a talk move that delivers a design-related suggestion or information about disciplinary norms [8]), Tess characterized failure as an opportunity ("[Epic fails] are opportunities to try something new") and followed that move with an ambitious probing question ("What do you think worked?") to elicit Luca's design ideas and thinking. She then called back to her earlier noticing of Luca's productive iteration (the earlier statement "You did a lot of adjusting") and reinforced that Luca had many ideas ("I've seen a bunch of your different modifications"). Combined, Tess's talk moves reframed the design failure as an opportunity and suggested that Luca had the capacity to draw on his experience, envision new ideas, and persevere.

Similarly, Tess observed teammates Felicity and Penny modifying their hovering contraption; revoiced that they had made changes; and after Felicity described failure, encouraged them to persist (“You keep changing it. You keep trying.”).

> Tess: You keep changing your design, too, don’t you?
>
> Felicity: Yeah, ‘cause it doesn’t work.
>
> Tess: Well, you keep changing it. You keep trying.

In both of these examples, Tess’s talk moves framed design failure and iteration as norms of engineering, rather than as indicators of learners’ competence. In this way, Tess made space for Luca and Felicity to see themselves as capable engineering learners who could persist through difficulty and frustration.

## 7. Discussion and Implications

Our findings contribute to characterizing OST engineering educators’ discourse and identifying talk moves that open opportunities for youth to participate in engineering design, and they provoke conversation about the affordances of educators’ talk moves. Our data suggest that these OST engineering educators, like engineering outreach educators [8], use varied talk moves that promote youths’ agentive participation in engineering learning. In this way, these OST educators are advancing the OST education goal of facilitating youth-driven engagement in engineering practices [3]. We highlight that in our data, we see educators use ambitious talk moves to elicit, sustain, and advance youths’ design thinking. These ambitious talk moves make space for youth to engage in engineering reasoning grounded in the youths’ own ideas. We also see educators use conservative talk moves to convey norms of iteration and persistence in engineering design. These talk moves make space for youth to see themselves as capable engineering learners who can overcome setbacks and who persevere.

Our observation that these educators revoice youths’ design ideas has implications for both educators and youth. In order for educators to revoice youths’ design ideas, the educators need to attend to, notice, and highlight the youths’ thinking. This attention to learners’ thinking is essential to carrying out responsive engineering teaching — an educational approach that supports learners to engage meaningfully in engineering design [22], [23]. The educators in this study are not simply acknowledging youths’ ideas in passing; they are building on that noticing to respond in ways that position youth as capable thinkers, and they are employing a teaching approach that treats youths’ ideas as the engine of engineering learning. That is, not only are these educators noticing youths’ ideas, they are building on that noticing to respond to youths’ ideas, engaging in a teaching approach that facilitates youths’ agentive engineering learning.

The identity-supporting work of educators’ talk moves deserves particular attention. Revoicing youths’ design ideas and asking probing questions to encourage youth to build on their own ideas signal to youth that their ideas are attention-worthy. These talk moves can bolster youths’ beliefs that they are capable engineering learners and thinkers, and support them in their present engineering endeavors. Rather than positioning the educator as the arbiter of correct ideas, these moves position youth as the originators and developers of engineering ideas — and position youth as authorities in their engineering learning.

Similarly, conservative moves that frame struggle, frustration, and failure as normative and as opportunities within engineering learning make space for youth to see their experiences as acceptable and typical; again, supporting youth to participate in engineering learning in the present. Importantly, these conservative moves convey disciplinary values. When Tess tells Luca that epic fails are opportunities, she is not offering empty encouragement — she is communicating how engineering works. These types of moves provide access to the culture of engineering, not just the procedures of a design challenge.

Additionally, it is possible that that these talk moves could support youth to participate in future engineering endeavors. Perceiving struggle, frustration, or failure as acceptable and typical can encourage participation and persistence in learning [24], [25], [26]. Research also suggests that that youth who see themselves as capable engineering learners are more likely to participate or envision participating in future engineering learning and careers [25], [27], [28], [29].

These findings have practical implications for OST educator preparation and professional development. Our findings suggest that talk moves are a productive focus for professional preparation and development — not as scripted responses, but as an approach and set of practices that educators can refine over time. Supporting OST educators to notice youths' ideas, revoice their design thinking, and reframe failure as a disciplinary norm could amplify the impact of OST engineering programs on youths' engineering learning, engineering identities, and affinities for engineering.

## 8. Limitations

Our interpretation of the data was at times limited by the constraints of video- and audio-recording in an active learning space. We chose to use the audio captured from a lapel microphone worn by the educators so we could be sure to hear what educators were saying throughout the activity, regardless of their proximity to a camera. However, we were not always able to clearly identify which learner an educator was addressing, making identification of and analysis of a conversational thread difficult at times. In unresolvable instances of ambiguity, we coded the educator's talk as "other"; as a result, we under-report the ambitious, conservative, and inclusive talk moves employed by these educators.

The data presented here did not include educator talk during whole-class activity introductions, whole-class design share-outs, nor whole-class wrap-up discussions. It is likely that educators used a different range of teaching talk moves when they interacted with the whole class, and our findings can not be generalized to all OST educator talk during an engineering design challenge.

## 9. Conclusion

Understanding OST educators' discourse builds understanding of the possibilities and challenges in OST engineering education. This paper identifies OST engineering educators' teaching talk moves and highlights these educators' capacities to teach engineering ambitiously. OST engineering educators' talk moves can make space for youth to participate and persist in engineering learning. Future research should partner with OST educators to better understand how educators could use ambitious talk moves in varied engineering education activities and contexts.

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