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Successes and Challenges in Supporting Undergraduate Peer Educators to Notice and Respond to Equity Considerations within Design Teams

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Abstract

We describe and analyze our efforts to support Learning Assistants (LAs)—undergraduate peer educators who simultaneously take a 3-credit pedagogy course—in **fostering equitable team dynamics and collaboration** within a project-based engineering design course. Tonso and others have shown that (a) inequities can "live" in mundane interactions such as those among students within design teams and (b) those inequities both reflect and (re)produce broader cultural patterns and narratives (e.g. Wolfe & Powell, 2009; Tonso, 1996, 2006a, 2006b; McLoughlin, 2005). LAs could be well-positioned to notice and potentially disrupt inequitable patterns of participation within design teams. In this paper, we explore (1) How do LAs notice, diagnose, and consider responding to teamwork troubles within design teams, and (2) What ideological assumptions plausibly contribute to LAs' sensemaking around their students' teamwork troubles? To do so, we analyze how the LAs notice and consider responding to issues of equitable teamwork and participation, as exhibited in three related activities: (i) an in-class roleplay, (ii) observing and diagnosing teamwork troubles (TTs) in the engineering design teams, and (iii) imagining possible instructional responses to those troubles, and students' possible reactions. We articulate three modes of thinking that roughly capture patterns in LAs' descriptions and diagnoses of, and imagined responses to, the teamwork troubles: *individual accountability*, where the trouble is seen as caused by individual(s) described as "off task" or "checked out" or demonstrating some level of incompetence; *delegation of work*, where the trouble was located in the team leader's inability to delegate tasks effectively to team members, or in the group's general lack of communication about what tasks need to be completed, who should execute the tasks, and what work other groups in the team were doing; and *emergent systems*, where trouble was described as a group-level phenomenon emerging from the patterns of interaction amongst group members, contextual features, and larger structural forces. We find that LAs drew on *individual accountability* and *delegation of work* to evaluate TTs. Much rarer were ascriptions of TTs to interactional dynamics between teammates. We connected these modes to the underlying ideological assumptions that have consequences for how meritocracy and technocracy (Slaton, 2015; Cech, 2014) play out in an engineering design classroom and serve to ameliorate or reify engineering mindsets (Riley, 2008). The modes are asymmetric, in that *emergent systems* based interpretations hold more potential for elucidating ongoing social processes, for challenging meritocracy and socio-technical duality, and for seeing power differentials within interpersonal and institutional contexts. We argue for the need to better understand the ideological assumptions underlying how peer-educators—and other instructors—interpret classroom events.

Introduction

Previously, we reported on our efforts to adapt the Learning Assistant Model (Otero, et al, 2010) at our university (Quan, et al, 2017). In our program (adapted from the CU-Boulder model), undergraduate peer educators or Learning Assistants (LAs) have 10-12 contact hours per week with students in a first-year engineering design course (UMD ENES100) while concurrently

participating in a 3-credit pedagogy seminar (UMD EDCI488E). Our pedagogy seminar integrates foundational education topics with those focused on engineering design (e.g., design thinking, engineering epistemology, teamwork and equity). Our peer educators move between these two activity systems: one is the field site for their teaching responsibilities within one of ~15 sections of a first-year engineering design course (UMD ENES100), and the second is an engineering-design focused pedagogy seminar (UMD EDCI488E). The co-occurence of these experiences in the same semester allows our peer educators to have firsthand experiences working with students while trying to make sense of key ideas from education theory and research. Details of the design of the pedagogy seminar and the design course context are provided in Quan et al. (2017), and the design of ENES100 course is presented in Calabro, Gupta, & Roshwalb (2015).

In this paper, we discuss our efforts to support LAs in **fostering equitable team dynamics and collaboration** within the project-based engineering design course (ENES100). Tonso and others have shown that (a) inequities can "live" in mundane interactions such as those among students within design teams and (b) those inequities both reflect and (re)produce broader cultural patterns and narratives (e.g. Wolfe & Powell, 2009; Tonso, 1996, 2006a, 2006b; McLoughlin, 2005). With careful preparation and support, LAs could be well-positioned to notice and potentially disrupt inequitable patterns of participation within design teams. As evidenced in the LA pedagogy seminar, we document LAs' resources for and challenges to noticing and responding to equity concerns in design teams. Specifically, in this paper, we ask the following questions:

- How do LAs notice, diagnose, and consider responding to teamwork troubles within design teams?
- What ideological assumptions plausibly contribute to LAs' sensemaking around their students' teamwork troubles?

Motivation

Instructors' Awareness of Equity Issues within ENES100 (the engineering design course)

Based on the lived experiences of one of our course designers and additional stories of classroom life conveyed to us by our colleagues, we knew that it was common within ENES100 design teams for students to quickly fall into roles based on their incoming expertise. This can potentially limit opportunities for students to learn new skills. For example, the students with the most prior programming experience would often take the lead on programming work, which closed off opportunities for students new to programming to gain access to such experiences. The closing off of opportunities is especially problematic since many students enter the course expressing a desire to pick up new skills such as Computer Aided Design (CAD), 3D printing, and programming. In other words, the prior-experience based role-distribution within teams hurts students' ability to make progress towards their own learning goals.

Additionally, this specialization leads to a silo-ing of team members to their specific task, limiting opportunities for them to engage with all aspects of the design process. This further harms how team-members experience communication within teams, when it is reduced to exchanging notes on delegation and completion of work. As the project progresses from the

fabrication to the testing phase, it sometimes means that students who primarily contributed to construction are left out and the team splinters. Such static division of roles also serves to reify meritocratic ideas and narratives, since some skills such as programming are seen as higher status than other skills such as construction and project management. Some of these negative effects of expertise-based work-distribution could be ameliorated by having sub-teams that are a mix of people with prior experience on a skill and those new to that skill, or by having team members cycle through a variety of roles; but we haven't seen such practices deliberately taken up within student design teams.

We also knew that it was common for students to get enamored with a particular design idea or direction without engaging in extensive divergent thinking (Jansson & Smith, 1991). This can mean that many team members do not often find space to share their design ideas and have their design idea considered by their teammates. We knew from Tonso's analysis of such spaces (and accounts of our own local context) that much of this differential access to engaging in design tasks/thinking was often gendered (and racialized). However, the structure of the engineering design course gives little opportunity to build capacity within students for recognizing, refraining from, and responding to instances of microaggressions and implicit bias; or for helping them develop language tools for evaluating ideas without shutting down divergent thinking, or attending to implicit bias in the evaluation of ideas.

Pedagogy Seminar for Learning Assistants: Brief Description and Rationale

Two assumptions, one logistical and one cognitive, undergirded the design of the LA pedagogy seminar. Logistically, we assumed that LAs would spend much of their time interacting with individual students and with design teams. Therefore, our seminar readings and activities focused on helping LAs notice, interpret and respond to aspects of groups' teamwork and design thinking, making in-the-moment judgments about how a group might best be helped. The pedagogy seminar therefore differed from one designed to, say, help LAs create design challenges or lecture about the design process or technical content. Cognitively, we assumed that our engineering LAs would enter our seminar with a variety of ways of thinking about teaching and learning, as opposed to a single hardened set of beliefs. So, while we thought it likely that without substantive training and support our engineering LAs were likely to favor transmissionist ideas and take on the role of the explainer or problem-solver, we assumed our LAs possessed intellectual resources for understanding the value of sensemaking and figuring things out for oneself as a learner, resources we could build upon to help them understand and value "constructivist" teaching strategies based around helping students articulate and build on their ideas. So, our seminar aims to help LAs recognize the different ways they have for thinking about teaching and learning and introduces techniques aligned with student-centered learning (listening patiently to students, drawing out students' thinking, and pressing/responding to students' thinking). However, we assumed that classroom cues and pressures may push LAs back to transmissionist modes, (e.g., students asking for answers or trouble-shooting solutions, time constraints or pressure to finish tasks, the behaviors of other LAs or instructors, fear of lack of knowledge being exposed, initial awkwardness in implementing less familiar strategies from the pedagogy course, and so on). So, we strove to help LAs learn to stably activate their student-centered ideas about learning. To this end, the course is designed to build strong connections between the ideas discussed in the pedagogy course and students' field experiences in the

engineering classroom. This is achieved through having LAs study video clips from other engineering education contexts and from their own classroom interactions (or simulated classroom interactions), regularly write field notes on their teaching field experiences, and receive in-the-moment pedagogical coaching within the pedagogy course.

Critical and constructive reflection on teaching practice, which we assume is needed to help stabilize student-centered instructional approaches, is scaffolded through course assignments and in-class activities. LAs regularly reflected on (and wrote about) how course readings connect to their to own experiences both as a student and as a peer educator within the ENES100. Through both field note assignments and in-class video analysis sessions, LAs were encouraged to (1) develop detailed descriptive accounts of classroom events, (2) generate multiple plausible interpretations of classroom events, and (3) assess the affordances of instructional moves in relation to a variety of goals for student learning. Through this process, we worked with LAs to build their observational skills around student thinking and teaching practice, to substantiate claims about student learning, to substantiate assessments about effects educators are having, and to cultivate LAs' agency in building and refining such claims.

We now proceed to our literature review, where we focus on work that helps to (i) ground our design of the LA pedagogy in previous research and (ii) motivate the analytical lenses described in the subsequent Methods section.

Literature Review: Helping Instructors Attend and Respond to Student Thinking and Interaction

We start by reviewing work concerning the importance of instructors attending and responding to the disciplinary substance of students' thinking and the ways in which teacher educators have helped teachers develop these skills and attitudes. Then we focus more narrowly on previous work about teachers' noticing of equity-related issues in students' interactions. Almost all this literature addresses K-12 teachers and pre-service teachers; but we assume it has relevance to novice instructors—like LAs—working in introductory university courses as well, and to our pedagogy course for these instructors.

Teacher noticing of students' disciplinary thinking

In K-12 mathematics and science education, a research-based consensus has emerged that effective student-centered pedagogy is grounded in "responsive teaching"–eliciting, attending to, interpreting, and responding to students' ideas in ways that help students build on their prior knowledge (Richards & Robertson, 2016; Sherin, Jacobs, & Philipp, 2011). As Ball & Cohen (2013, p. 16) put it, "Examining student thinking is a core activity of [teachers'] practice." In order to help teachers develop their responsiveness, teacher educators and teacher professional learning communities typically rely on artifacts of classroom practice (i.e. examples of student work, video or audio recordings of classroom events, or field notes on classroom events) to analyze pedagogical moves/approaches, to investigate the possible consequences of their pedagogical approach for students' learning, and to consider intentions and plans for future pedagogical actions (Horn & Little, 2010). For instance, "video clubs," in which teachers or pre-service teachers meet regularly to discuss video of classroom discussions/activities, lead to

improvements in the consistency and depth with which teachers noice and interpret students' reasoning (Levin, Hammer, & Coffey, 2009; Sherin & Han, 2004; van Es & Sherin, 2010). Other teacher professional development aimed in part at helping teachers attend to and interpret the substance of students' reasoning are centered around "problems of practice"—the in-the-trenches, often emotionally charged dilemmas that teachers face (Lampert, 2003; Horn & Little, 2010)—using the kinds of classroom artifacts mentioned above to ground detailed discussions of what students were thinking, what was "learned," and what could be tried next. Below, through episodes of seminar activities, we show how such "problems of practice" become objects of collective inquiry for the engineering LAs. While inspiring many of our seminar activities, however, the above literature also establishes that becoming more consistently attuned to students' thinking and learning how to respond effectively are difficult, long-term processes for novice teachers. They are not simple "skills" that can be quickly mastered (Ball, 1993; Jacobs, Lamb, Philipp, & Schappelle, 2011). And this conclusion applies equally strongly to another aspect of teacher responsiveness that researchers have recently started exploring more systematically: attention and response to equity issues arising in student interactions.

K-12 teacher noticing of equity issues

A fast-growing body of literature on K-12 mathematics and science teachers' and pre-service teachers' noticing of inequitable participation patterns has reached some early conclusions that are consistent across multiple studies (Gutierrez, 2002; Hand, 2012; Louie, 2018; Luna, Walkoe, Bernstein, Stoltz, & Cook, 2018; McDuffie, Foote, Bolson, Turner, Aguirre, Bartell, Drake, & Land, 2014; Turner, Drake, McDuffie, Aguirre, Bartell, & Foote, 2012; Wager, 2014). First, these studies illustrate that novice teachers are able to notice interactional and power dynamics that marginalize certain students, disproportionately those from groups underrepresented in STEM. And this is true even before the teacher educators intervened to introduce these ideas. For instance, Luna et al. (2018, p. 8) comment on one of their empirical results by noting, "We see glimmers of discussion about equity rise out of discussions focused on student mathematical or scientific thinking. Thus, we argue that teachers can notice and attend to these aspects of classroom interaction, even when not prompted to do so." Similarly, even at the beginning of their coursework, pre-service teachers in McDuffie et al.'s (2014) study were able to notice issues of positioning and power dynamics in students' interactions.

Second, the studies suggest that professional development is needed before teachers consistently connect the in-the-moment inequitable participation they notice to deeper systemic equity issues reflected in the structures and culture of their classrooms (and of "school math and science" more generally). For example, in Wager's (2014) study, only teachers who had become particularly attuned to inequitable participation patterns ever brought up possible interventions aimed at the structure and interactional dynamics of classroom activity. Similarly, in a conjectured learning trajectory for novice teachers based on a six-institution empirical study, Turner et al. (2012) propose that most teacher progress from simply noticing the mathematical thinking that students bring in from their home environments/cultures to recognizing the systemic ways in which classroom mathematics activities can hinder this "home" mathematical thinking from becoming integrated into the "school math" students are learning.

Third, these studies suggest an entanglement between teachers' noticing of the substance (not just the correctness) of students' reasoning and their noticing of equity-related issues of participation and positioning. McDuffie et al. (2014) documented how growth in teachers' attention to the substance of student reasoning was accompanied by growth in their noticing of (in)equitable participation patterns and power dynamics.

Fourth, these studies found that teachers' attention to inequitable participation patterns is linked to ideologies—both those of the teachers and those reflected in broader cultural assumptions about who can and cannot do math or science. Louie (2018, p. 55), documenting the classroom practices of an experienced teacher, found that "The teacher's noticing involved not only cognitive processes like attending to, interpreting, and deciding how to respond to students' thinking, but also managing dominant ideologies that position students—especially students from non-dominant communities—as mathematically deficient rather than as sense-makers whose ideas should form the basis for further learning." And summarizing multiple studies, Hand (2012) concluded, "Research suggests that being able to teach mathematics in a manner that affords high quality and meaningful opportunities to learn for nondominant students is partly related to having a critical perspective on the relation between mathematics learning, mathematics learners, and broader sociopolitical structures (Gutiérrez, 2002; Lerman, 2001; Valero, 2004)."

Conceptual Framework

Broad Orientations

This section lays out ways of thinking about the culture of engineering that motivate and inform the analytical framework we will introduce in the next section.

In Donna Riley's book *Engineering and Social Justice*, she powerfully describes worldviews that are currently prevalent and taken for granted within both the engineering profession and engineering education—engineering *mindsets*. Through a cultural analysis of common jokes about the engineering profession, Riley aims to "draw out some characteristics of these mindsets that are relevant to the intersection of engineering and social justice" (Riley, p. 34). Riley proceeds to outline the following six common engineering mindsets: (1) Positivist epistemology / Myth of Objectivity, (2) Commitment to Problem Solving /Reductionism, (3) Desire to Help/Persistence (e.g."Something in the spirit of engineering that wants to help ...Engineers are known for our work ethic; we are committed to getting the job done and will slog through hours of grunt work to make it happen." (Riley, p. 39)), (4) Centrality of Military/Corporate Orgs (e.g. "engineers work overwhelmingly in private profit-oriented organizations and on industrial, commercial, and military problems." (Riley, p. 40), (5) Narrow Technical Focus/Lack of Other skills, and (6) Uncritical Acceptance of Authority. These mindsets characterize part of the broader culture of engineering and manifest themselves in the ways that engineering work is organized: from the reduction of a complex project into a set of smaller components, valuing accountability of work and success on project components, often hierarchical organization in teams, valuing technical skills over "soft" skills such as collaboration and communication, and the devaluing of engineering work focused on social welfare.

Congruent with some of the mindsets discussed by Riley, Cech (2014) describes how engineering has a "culture of disengagement" supported by "ideological pillars" such as (i) science and engineering are "pure" spaces free of social and cultural concerns, (ii) technical knowledge and competencies are more valued than social ones, and (iii) scientific systems are unbiased, with fair systems of advancement. Similarly, Slaton (2015) details how engineering education is dominated by the ideologies of technocracy (lack of attention to the social, cultural, and political dimensions of engineering processes) and meritocracy (relying solely on merit-based eligibility and evaluations). This notion of technocracy connects to what Faulkner has called *social-technical dualism*, "the distinction between being technology-focussed, on the one hand, and people-focussed, on the other" which is "manifest in the distinction often drawn between narrowly specialist and more holistically heterogeneous types of work and knowledge in engineering" (Faulkner 2000, p. 761-2). We note that the emphasis on meritocracy and the socio-technical dualism is common across Riley's, Cech's, and Slaton's characterization of engineering culture.

These aspects of engineering culture strongly influence the ways in which resources and rewards are distributed within teams, organizations, and institutions, and how status is built within engineering communities. Because of this, we link these cultural norms to the notion of ideology as described in the next section. Below, in our analysis, we draw on the ideological assumptions underlying LAs' understanding of and responses to classroom scenarios. Then, in the Discussion, we circle back to how our analysis connects to the notions of meritocracy and social-technical dualism as underlined by Riley, Cech, and Slaton.

Analytical Framework

In our analyses, we centrally focus on the ideological nature of students' reasoning about the engineering design course context. Drawing from foundational work by Stuart Hall (1982, 1996) and Thomas Philip (2011), we conceptualize ideology as "composed of taken-for-granted assumptions that are often 'fragmentary, disjoined, and episodic' (S. Hall, 1996, p.43), specifically sensemaking that stabilizes, challenges, and/or transforms the distribution of material and symbolic resources in society. We consider people's ideological stances as potentially important resources for learning (Philip, 2011)." (Philip, et al, 2017). In this view, we see ideological assumptions as commonsense cognitive elements that people use in social sensemaking often without explicit justification (Philip, 2011, p. 302) and which:

- Have shifting salience across contexts (Philip, 2011, p. 301),
- Result in varied contextualized meanings (Philip, 2011, p. 302), and
- Reflect taken-for-granted ways that power gets structured in society.

This theoretical perspective developed by Thomas Philip is often referred to as ideology-in-pieces (Philip, 2011). Philip shows how ideological assumptions and stances are coordinated via concepts that can be nascent or explicit. Ideological transformation involves shifting meanings of these concepts. For example, Philip documents how one teacher's sensemaking of students' participation in class was initially coordinated via the nascent concept of "teachers blaming students." Through extended engagement in a teacher research group focused on social justice in science and math classrooms, the concept of "teachers blaming students" is made more explicit and is linked to ideological assumptions that cohere with systems-based reasoning, assumptions that recast "teachers blaming students" as a problematic alternative to explanations that

acknowledge systemic inequities and the role of class and race in expectations for classroom behavior and practice. This change is an ideological transformation.

As we work to understand our LAs sensemaking about the social world of the engineering design course, we aim to identify these taken-for-granted ideological assumptions about how society works—what Philip (2011, p. P. 302) calls "naturalized axioms." We look at the variety of meanings that are infused into LAs' observations of design teams and ask ourselves, what (perhaps tacit) ideological assumptions are influencing what is made salient and what is ignored or obscured in LAs' accounts and explanations. We see these salient ideological assumptions as having ideological consequences for the collective discourse that occurs within the LA pedagogy seminar, as one location where culture is being (re)constructed. We suspect that, as these ideological assumptions present themselves in the engineering design course, they have consequences for how LAs engage with design teams, with the course serving as another location where engineering culture is (re)constructed. So, within each context, these ideological assumptions define the space of possibilities that participants collectively consider, affording some kinds of learning and constraining others.

In our analysis, we assume that these ideological assumptions can cohere into patterns of reasoning that we call *modes*, akin to the "concepts" of Philip (2011). However, we refrain from calling them concepts in this paper, to allow for ambiguity about the extent to which these modes are psychologically "real" versus useful categories for analysis. Crucially, we do not assume that an ideological mode observed by a student or by a group will characterize the student or group in a different context.

We note that mindsets and "the culture of disengagement" prevalent in engineering and engineering education are cultural constructions that have ideological character. The ideology-in-pieces theoretical framework provides us with theoretical and analytical tools for making sense of engineering students' reasoning in ways that allow us to begin building a bridge from students' contextualized, often tacit ideological assumptions to the grand "mindsets" and "ideological pillars" described in the engineering education literature. When using Philip's ideology-in-pieces framework, we cannot assume *a priori* that in students' reasoning specific ideological assumptions will consistently cohere into "mindsets" or "pillars"; students' ideologies might present themselves in more fragmented ways or might cohere into *modes* that lack the theory-like robustness or coherence of a mindset or pillar. Nonetheless, our awareness of the structures that Riley and Cech describe will allow us to see potential resonances between the modes we document and these broader structures and to see the ideological pieces out of which these broader structures might be constructed—but without treating cultural constructions as deterministic. We see the claims and explanations that students construct as moments where people contest or perpetuate cultural constructions that over time contribute to the construction of mindsets. In the Discussion, we circle back to how the ideological assumptions and modes we document connect to the ideas about meritocracy and technocracy that Riley, Cech, and Slaton have documented as characterizing engineering cultures.

Methods

The data for this study include video and field notes from the LA pedagogy seminar (in which 14 LAs were enrolled), copies of written artifacts from the seminar (such as LAs reading responses, in-class assignments, jointly constructed documents, etc.), video of interviews with a subset of the LAs, and minimal video recordings of the LAs interacting with students in the first-year engineering design course (ENES100).

For this paper, we analyzed only a subset of this data. This selection was informed by instructors' memory of moments that provided opportunities for students to sense-make about team-level issues and interactions as well as equity concerns. After excluding data of 3 non-consenting students, our first round of data selection included (1) LAs' written reading responses to two articles, Tonso (2006) and Barron (2003), about power dynamics and collaboration in engineering teams, (2) video from the pedagogy course of LAs' participation in a roleplay featuring a "quiet student" and an "overbearing student," and the whole-class debrief that followed the roleplay, (3) a set of written "teamwork trouble" scenarios that LAs generated individually during an in-class activity, and (4) a set of "instructional moves" and anticipated "student reactions" that LAs generated in response to each others' "teamwork trouble" scenarios. After a round of detailed analysis, we narrowed our data selection to exclude the reading responses. This choice was motivated by our interest in understanding how LAs' ideas about teamwork dynamics were contextualized in relation to ENES100. Since the reading responses were further removed from that context, we eliminated it from our final analysis.

The video-record of the role-play segment was transcribed by Hannah Sabo. As a group, we watched the video, noting how the participants in the roleplay were orienting to one another, specifically attending to the interactions between the "students," and the instructional moves made by the "peer-educator." Here, drawing from interaction and discourse analytic methods (Jordan and Henderson, 1995), we attended to the content of their speech as well as to paraverbal and non-verbal aspects of their performance, such as gestures, posture, tone, register, volume of speech, intonation, gaze, etc. We also analyzed LAs' conversations during the debrief immediately after the role-play. Here, we attended mostly to the content of their speech. We marked what aspects of the role-play interactions were noted by the LAs, and specifically if they attended to the marginalization of the quieter student, or commented on how instructional moves served to ameliorate or reify the inequitable dynamics. Hannah Sabo then produced a detailed analytical memo of the video-record. In this paper, we focus our analysis on the debrief conversation following the role-play.

For the teamwork trouble scenarios (TTs) and the instructional moves (IMs) students generated in response, working collaboratively, we first articulated patterns that we saw in how the LAs described the trouble as well as in suggestions they made for how to address the trouble. We noticed that some LAs were mostly focused on whether an individual student produced their portion of the work, while some others elaborated on communication and relationship patterns within the team. Working iteratively between generating analytical memos and engaging in group discussions about the validity of interpretations, we articulated three modes that seemed to roughly capture patterns in LAs teamwork trouble scenarios and aspects of the instructional

moves that students generated: *individual accountability* (IA), *delegation of work* (DW), and *emergent systems* (ES).

We found that TTs which reflected elements of the *individual accountability* mode often described the trouble as caused by a single individual or group of individuals who were engaged in what they described as "off task" or "checked out" behavior or who demonstrated some level of incompetence. IMs reflecting this mode commonly recommended interventions that targeted the "problematic" individual, often by reprimanding them or motivating them to do their work.

TTs that reflected the *delegation of work* mode commonly located the trouble in the team leader's inability to delegate tasks effectively to team members, or in the group's general lack of communication about what tasks need to be completed, who should execute the tasks, and what work other groups in the team were doing. TTs reflecting this mode often described group-level dynamics that were relevant for understanding the division of labor, but did not describe details of problematic interactions or interpersonal dynamics nor did they relate these dynamics to larger-level group stabilities. IMs reflecting this mode commonly recommended interventions focused on producing more efficient distribution of labor systems, such as clarifying the roles and responsibilities of each team member or pushing the team leader to delegate more effectively.

Finally, in what we call the *emergent systems* mode, the responses elaborated on system-level explanations of teamwork trouble and constructed trouble as a group-level phenomenon emerging from the patterns of interaction amongst group members, contextual features, and larger structural forces. TTs reflecting an *emergent systems* approach might describe the dynamics contributing to a group's lack of communication/cohesion, the power dynamics amongst group members, or the features of the group's culture. Rather than constructing individuals as delinquent or incompetent, an *emergent systems* approach explains the roles, behaviors, and identities of individuals as constructed by (as well as constructing) dynamic interactions amongst the group-members. Through an *emergent systems* approach, the student framed as "checked out" through an *individual accountability* lens might instead be understood as having limited access to particular roles or interactions due to inequitable group dynamics. IMs reflecting the *emergent systems* mode often focused either on information gathering about the group dynamics, or on intervening at the group-level by asking students to reflect explicitly on their interactions and how they impact their feelings about the project and the team. This mode often supported more complex and nuanced accounts of student engagement.

In analyzing these scenarios, we found that an individual LA's description of TTs, or the set of IMs generated by an individual LA could draw on reasoning patterns across multiple modes. In other words, we didn't see the modes as stable and unitary properties of LAs' cognition, rather as clusters of reasoning patterns that are useful for making sense of the LAs' responses.

After identifying these modes, we then tried to enumerate several ideological assumptions underlying LAs' descriptions of TTs and the possible consequences of those assumptions. We then went back to the LAs' responses and mapped specific lines of text within a response to corresponding ideological assumptions. While some LA responses had coherence in the underlying ideological assumptions, others drew on assumptions that are closely tied to more

than one mode. However, this fine-grained variability is consistent with the ideologies-in-pieces framework that we draw on. We present these ideological assumptions in our analysis section.

Finally, we also analyzed the set of anticipated student reactions/feelings that LAs generated in response to the IMs. For these data, we mainly noted whether the LA predicted a positive/effective or negative/ineffective outcome in response to the IM. While this was in many ways a much more straightforward analysis, there were a few entries we marked as "ambiguous" when the student's attribution wasn't clear or was neutral.

Data Analysis & Results: Overview

In what follows, we present abridged analyses of (1) LAs conversations about the in-class role play activity, (2) teamwork trouble scenarios that fell cleanly into each of the three modes, IA, DW, and ES, and (3) the instructional moves and the imagined students' reactions that LAs brainstormed in response to a peer's teamwork trouble scenario. Analysis (1) establishes both the range and context-dependence of the LAs' abilities to "see" teamwork troubles in ways that invite an *emergent systems (ES)* based diagnoses and interventions; and yet, when discussing instructional interventions, the LAs focus on "helping" individual students and reject as detrimental the possibility of raising teamwork issues explicitly with the team, more consistent with an *individual accountability (IA)* mode. Analysis (2) further refines our sense of this context dependence: in describing and interpreting the teamwork troubles of their own *real* ENES100 students, all but one LA's response was coded as *individual accountability* and/or *delegation of work (DW)* modes, with corresponding ideological assumptions in evidence. The one exception, "Maria"[1] displayed ES interpretations of teamwork troubles accompanied by more "collectivist" ideological assumptions about how power differences and work patterns in a team are a matter of collective responsibility (and hence collective credit or blame). Analysis (3), in which each LA suggested possible interventions and anticipated student reactions to those moves for *another* LA's student troubles, more diversity among IA-, DW-, and ES-based ideas re-emerged, though with a fairly consistent pattern of rejecting instructional moves—especially ES-based moves—fearing these might ruffle feathers or create tensions/awkwardness in a team. Taken together, these analyses suggest that LAs' tendency to display IA and DW perspectives (including ideological assumptions) in diagnosing and treating their own students' teams stems not from being unable to "see" and treat teamwork troubles from an ES perspective, but from trepidations about carrying out ES-based interventions and perhaps from the status of IA and DW ways of thinking as deeply rooted cultural norms in ENES100 and in the engineering major more broadly.

Data Analysis & Results: In-Class Roleplay

Introducing the "In-class Roleplay" Episode

In the pedagogy course the week before, LAs had been ask to: "Write a teaching challenge you've encountered on a notecard" (Seminar prompt, 10/12/16). Two of the LA-generated notecards contributed the following teaching challenges:

[1] All LAs and students mentioned in this paper have been given pseudonyms

(1) "*Dealing with students who don't contribute to their group —OR— How to help students who are quiet / overshadowed by other members of their group.*" (Maria)
(2) "*Overbearing members of a group.*" (Vincent)

The seminar instructors blended these two teaching challenges into the following scenario for the LAs to roleplay within the seminar context the next day:

> *Some members of the group are being overbearing. Some students, who are quieter, are overshadowed by other group members. (Note: Based on your experiences in ENES100, feel free to create your own local context around these issues for the role-play.)* (Worksheet Prompt, 10/18/16).

A group of three LAs were invited to prepare and act out this roleplay in front of the rest of the class. In this roleplay, Anthony and Molly played the role of "students" within ENES100 where Anthony played the role of the "overbearing student" and Molly played the role of a "quiet student." The overbearing student (Anthony) kept excitedly stating his ideas for how to collect debris with a autonomous overland vehicle – such as using a magnet to pick up copper pieces. The quiet student (Molly) wanted to give feedback and state her ideas. Christian, the "learning assistant," responded to the situation. The rest of the class watched. Approximately 4 minutes later, the roleplay was called to a close, and the students commented on the moves that they saw Christian make. We note that at various points throughout both the roleplay and the discussion, the class laughed.

We claim that in the context of this roleplay LAs can notice and attend to how dominance is enacted in design teams. We support this claim with empirical evidence from the in-class discourse. Following the presentation of this evidence, we also summarize briefly other salient aspects of this roleplay activity.

LAs can attend to how dominance is enacted in design teams

From the analysis of the roleplay and the following debrief discussion, we found that students can attend to how dominance is performed and constructed among people. At multiple points during the enactment of the roleplay, Anthony interrupted Molly before she had a chance to finish a single sentence. When these moments of interruption occurred, the students watching the roleplay would often laugh out loud. This laughter served to demarcate these interruptions as salient to students in the seminar.

In the discussion following the roleplay, the students were able to notice verbal interruptions and how multi-modal enactments affected power dynamics within the trio. Thomas noted how Christian made moves to address the quiet student:

> "*I saw both moves try to like address the student who was quiet. Like they could see that the student had ideas about what was going on and so like taking opportunities to actually address them specifically by name or direct eye contact.*" (Thomas, L136-139).

Thomas noticed how Christian interacted both verbally and non-verbally with Molly to draw out her ideas. He mentioned that Christian called Molly specifically by name and made direct eye-contact when interacting with her. Thomas noted how Christian made space for and valued Molly's ideas.

While discussing the roleplay, Anthony (who played the overbearing student) elaborated on how Christian (who played the learning assistant) subtly used body language in order to limit the moves the overbearing student could make. He said:

> "*One kind of subtle thing he did was he stepped kind of in front of me a little bit. I feel like when I said something that was kind of escalating the conversation, he escalated it one further. And from there, if I do it one more time, it becomes super blatant and awkward on my part. And like from there, it forces me to stay quiet without saying something like 'Let her speak' do this again, and then you just seem like ass in front of everyone. Like more than you already do.*" (Anthony, L197-204, Appendix I).

Here, Anthony called attention to how subtle body language can affect the power dynamics between students. He noticed that Christian took a step towards Molly, thus blocking him out of the conversation. He was aware of how Christian's body positioning limited the discursive moves that he could make. Anthony recalled that during the roleplay, Christian stepped in front of him, making it harder for him to interject in the conversation. Anthony elaborated on the impact of that step, relating Christian's perceived action to the effect that it had on the power dynamics during the roleplay. He recalled that if he were to interrupt Molly again, it would become "super blatant and awkward." He continued, "it forces me to stay quiet." Because Christian's body language was not open to Anthony, he felt forced to stay quiet – and therefore unable to interrupt, diminishing his power within the interaction.

Across these excerpts, we see evidence that the LAs understood how verbal, and paraverbal cues affected how dominance was enacted and power distributed across the three actors.

LAs can frame quiet student as having good ideas (abridged)

Just as they could "see" power imbalances as arising from group dynamics, the LAs were also able to see a student's lack of participation as arising from team dynamics, not from a deficit of engagement or ideas on the part of the "quiet" student. In particular, a salient feature of the roleplay is that the LAs framed the "quiet student" as having good ideas. For instance, during the roleplay, in which participating students had creative license over the substance and direction of the conversation, the presenting group chose to portray Anthony, the overbearing student, as sharing design ideas that were not viable (i.e., using a magnet to pick up non-magnetic debris) or over-the-top (i.e., collecting debris using a claw with five serial motors), whereas Molly not only challenged the implausibility of Anthony's ideas, but she also proposed her own ideas that were far more practical. Similarly, in the discussion after the roleplay, other LAs noted that Molly had good ideas and they highlighted Christian's instructional moves that made space for them.

This framing of the "quiet student" as having good ideas contrasts with characterizations of students in teamwork trouble scenarios as "checked out" or "not working/participating," which we show later. The differences in these characterizations could be understood as students drawing on different ideological assumptions informing their interpretations of reserved behavior. This suggests that LAs have a multiplicity of resources that can be elicited differently across contexts.

LAs foreground an individual student in their analysis of the roleplay (abridged)

Despite their demonstrated ability to "see" teamwork troubles from an ES perspective, however, in the debrief after the role play, LAs primarily oriented to the quiet student as the locus of the "problem" rather than acknowledging Anthony's overbearing behavior as limiting Molly's participation. LAs focused on how Christian drew out the quiet student's ideas, framing Christian's moves as helping Molly become more involved, rather than as pushing Anthony to recognize his problematic behavior. This diagnosis of the events obscures Anthony's role in making it difficult for Molly to participate. In other moments, LAs focused on Christian's attempts to address Anthony's bad ideas without mentioning Molly, the quiet student, at all. In this way, the LAs in the debrief tended to foreground Christian's interactions with a single student within the team, and didn't discuss the dynamic between the pair explicitly. The only time when the interactional dynamics between Molly and Christian were explicitly discussed was when it was seen as a bad idea to interfere with team dynamics and possibly leave things awkward between the team. This tendency to zoom in on a particular individual within a design team is a theme that comes up again when we consider the "teamwork troubles." We propose that the focus on an individual and the treatment of "quietness" as largely the property of an individual have underlying ideological assumptions that **individuals are divorced from their local and broader setting** and that **success/achievement is an individual endeavor, not a function of how the individual is embedded in context**.

LAs reject interventions that explicitly note problematic interpersonal dynamics (abridged)

In addition to seeing Christian's instructional moves primarily through an IA lens, the LAs expressed trepidation about instructional attempts to address teamwork directly. Throughout the roleplay Christian had many resources for mediating the inequitable dynamics between Molly and Anthony. In particular, his instructional moves included interrupting Anthony when he was boxing Molly out, asking Molly to share her ideas, validating Molly's critique of Anthony's ideas, and suggesting they try both Anthony's and Molly's ideas. In the post-roleplay discussion, the LAs praised Christian's relatively non-invasive technique, noting that he didn't "make it awkward" by explicitly drawing attention to the inequitable dynamics.

This captures a common fear that the LAs expressed at multiple points during the course – that interventions explicitly addressing team dynamics are likely to have detrimental outcomes. In this case, they worried that if Christian were to address the dynamics directly, it might create conflict or awkwardness between Molly and Anthony that could have repercussions that last beyond the moment of intervention. This mirrors the negative impacts many LAs anticipated might arise from interventions in response to the teamwork trouble scenarios.

Data Analysis & Results: LA-generated Teamwork Trouble Scenarios

So far, our analysis has shown that LAs, though capable of interpreting teamwork troubles from an *emergent systems* perspective, tend to favor *individual accountability* and *delegation of work* perspectives when discussing instructional moves. The following analysis further supports this result.

Introducing the "LA-generated Teamwork Trouble" Course Artifacts

Two weeks after the roleplay, the LAs were given the following prompt:

> *On a notecard, write out a detailed scenario of one of the teams that you think is running into intra-team communication or process-management issues. Don't simply write what you think is going wrong, but also provide details of what you have observed over the last 3 weeks that inform your interpretation.* (In-class prompt, 11/01/2016)

These notecards were collected and used the following week (11/08/2016) as a starting point for developing and discussing potential instructional moves and anticipated student reactions to those moves. In analyzing these scenarios, we identified three modes that roughly captured LAs descriptions of teamwork trouble: (1) individual accountability (IA), (2) delegation of work (DW), and (3) emergent systems (ES). We then articulated some ideological assumptions evident in exemplary cases of each mode. Although many of the scenarios didn't fit neatly into a single mode, for brevity and clarity we present only three scenarios that fall more cleanly into each mode.

Analysis linking Vincent's "IA" teamwork trouble scenario to ideological assumptions

Here is the teamwork trouble scenario that Vincent wrote in its entirety:

> *3 members of the team seem to be checked out. One shows up very late or not at all each day and seems to not do much work (electronics guy but no electronics have been put together). The second has been showing up ~10-15 mins late to each class and does not do much, has only touched the pH set once so far as only job. The third has been contributing little and spends most of the time on the computer side of the lab doing homework for other classes.*

In this scenario, Vincent focused his account of "trouble" in the team on three members who he positioned as being "checked out." In the following sentences, he then elaborated on the actions of each of these three individuals to support the "checked out" evaluation. For the first two, Vincent noted that they showed up late to class. For all three, Vincent framed them as contributing minimally to the project-relevant work. For the third student, Vincent noted that they stayed "on the computer side of the lab doing homework for other classes," which seems to suggest that they were both physically and mentally distant from the work of the project.

In Vincent's account, what is elaborated is just as important as what is left out. For example, the account does not elaborate on any relations between team members, or the contexts of their work (see Maria's account below for a contrast). Neither do we find elaboration of how other team members might be impacted by their actions. There are glimmers of distribution of work (one person is framed as "electronics guy" and working on pH set is indicated as the job of the second person), but we don't see any elaboration of the assignment/allocation of this work. This reflects an ideological assumption of **individuals as divorced from their local and broader setting**. In addition, the individuals, in this account, were held only accountable to their specific work towards the team project, not towards the collective enterprise or towards maintaining or nurturing relationships within the team. This accountability, their success or failure at delivering their work, is tacitly treated as resulting from their own actions, not as an emergent property of the team, resulting from interactions between team members. This suggests an ideological assumption that **success/achievement is an individual endeavor, not a function of how the**

individual is embedded in context.

While the work of engineering almost always happens in teams, these assumptions underlying "individual accountability" obscure group processes and disacknowledge meaningful relationships between teammates, reinforcing both meritocracy and social-technical dualism. Success (or failure) is determined solely through the measurement of technical work and correspondingly merit (or the lack of it) gets attributed to individual students, marking them as targets of praise or of corrective intervention or punitive action, with consequences for differential accruement of power and status for individuals within a team. The team as a whole never emerges a winner in the calculus of individual accountability.

Sensemaking about teamwork troubles from an *individual accountability* mode can also limit the imagining of instructional strategies that seek to understand group processes and relationships and work to repair and strengthen them. Why should, for example, a team-member being late only generate reprimand, rather than concern and empathy for why someone might be late and interventions to check-in with them, offer help, and in the interim reorganizing workflow to accommodate their delay? Delayed classroom arrival could stem from familial obligations, additional constraints on students who work to support themselves, mental health issues, or from unwieldy course loads. Expectations for work and classroom participation are structured in ways that privilege those who are already privileged. Individual accountability, in not attending to these systemic issues, makes navigating the academic life even harder for those who are facing financial struggles, have significant obligations towards family (such as caretaking), and don't have access to sensitive advising at school and home. Reasoning within the *individual accountability* mode assumes that the work of the classroom takes precedence over those personal, relational, or financial needs. It punishes those who might be trying their best to balance these different priorities, rather than help to support these students navigate difficult moments in life.

Analysis linking Anthony's "DW" teamwork trouble scenario to ideological assumptions

Here is the teamwork trouble scenario that Anthony wrote in its entirety:

> *One student skipping / coming late a few times, is the treasurer and was not ordering parts as asked by his team. The other members appear stressed and have just begun coming to me with their concerns. A decent amount of sitting around due to lack of parts to work with. Most of the other members have stated they are disappointed that they are being held back by this incident and want to begin building.*

In Anthony's account, he conceptualized the team as essentially two entities, the "treasurer" and "the other members," who he placed in a relationship with one another. He did not further differentiate between the "other members." The "treasurer" was characterized as not punctual or diligent towards attendance, and as having failed to do the task of ordering parts. This caused stress to the "other members," since their work had been stalled. Compared to Vincent's account, here we can see more elaboration on the assignment/allocation of work: the treasurer was "asked by his team" to order parts. We also see how this performance failure of the treasurer impacted the other members emotionally, with the emotions stemming from their own inability to perform their task

("begin building"). Thus the primary (or only) way in which Anthony conceptualized relations between team members was in terms of assignment/allocation of work and task-dependencies while friendship and any other meaningful social relationship between teammates were obscured. This reflects the ideological assumption that **only salient relation between team members is based on assigning/allocating work and individuals doing that work.** That this is then framed as a "teamwork trouble" reflects an ideological assumption, **success of group is judged by production of work**.

Ideological assumptions underlying *delegation of work* have the consequence that group relations such as friendship or other meaningful social relationships remain unarticulated. Communication between team members isn't conceptualized as encompassing empathy or helpfulness, but only transactions of work. Additionally, only the "object" produced at the end of the group's work is valued/foregrounded, while the means for the production of that work is backgrounded. These too then, as in IA, foreground social-technical dualism. Transactions that privilege work, rather than collaboration, learning together, celebrating proudness moments (Little, 2015), and supporting one another through setbacks are backgrounded. Neither are these brought to bear in re-conceptualizing how a team could be supported. For example, if a treasurer did not order parts, it could be that they had a personal emergency, or that they were struggling with some technical aspect of the ordering and could have benefitted from other members checking in and offering some help. These possibilities become difficult to consider within the *delegation of work* mode. Transactions between members that focus only on trading work assignments and reports of completed work are also likely to generate and reify hierarchical structures within the team rather than horizontal power structures within the team.

Analysis linking Maria's "ES" teamwork trouble scenario to ideological assumptions

Here is the teamwork trouble scenario that Maria wrote in its entirety:

> *Materials team → low cohesion & quiet/distant members. 3 subteam members: Carmen → team leader, very frantic/loud, tries to force the team to be excited/cohesive; Veronica → coding subteam, high performance in coding, low personal performance on quiz; Samantha → coding subteam, low coding knowledge, high grades on quizzes, quiet.*
>
> *Veronica & Samantha are the two primary members of the coding team. Carmen is a member by name only; she is also the team leader and spends her time going between subteams frantically. Carmen has a unique leading/encouragement style that lies between a pep talk and a panic attack. Veronica has coding experience, and spends classes coding alone and not engaging Samantha. Samantha has no coding experience, but is a high achieving student. She wants to learn, so she spends classes trying to struggle through coding exercises, primarily RF interfaces, alone. She is too shy to ask Veronica or Carmen for help, so she often only asks me, the [Learning Assistant].*

In this scenario, Maria first described the focal team as having "low cohesion & quiet/distant members." Here we note that "low cohesion" and "quiet/distant members" are both characteristics attributed to the group. Maria then went on to describe three members of the

group's coding sub-team, Carmen, Veronica, and Samantha. She then described attributes of these individuals in terms of their personalities, performance, and prior preparation. Importantly, Maria depicted each individual in multi-dimensional ways (beyond working/not working, skilled/unskilled) and these descriptions drew attention to how each student had social capital within this educational ecosystem (e.g. through strong academic performance or through prior experience in a high-value technical area). Maria introduced these characteristics of individuals to serve a broader purpose of explaining problematic dynamics that she observed amongst these three students. For instance, she proceeded to write, "Veronica has coding experience, and spends classes coding alone and not engaging Samantha. Samantha has no coding experience, but is a high achieving student. She wants to learn, so she spends classes trying to struggle through coding exercises, primarily RF interfaces, alone." Here, Maria framed Veronica as partially responsible for not engaging Samantha (and working alone). She framed Samantha as having little coding knowledge, but wanting to be involved and wanting to learn. Rather than viewing Samantha's seclusion as laziness or disinterest, she constructed Samantha's engagement as emergent from patterns of work that have emerged between Samantha and Veronica. Maria described Carmen, the team leader as "very frantic/loud" who "spends her time going between subteams frantically." Maria's account implies that Samantha might have been intimidated by Carmen's energy and enthusiasm, and as a result, struggled to approach her for help (e.g. "[Samantha] is too shy to ask Veronica or Carmen for help"*)*. Maria gave a rich, descriptive account of the sub-team's interpersonal dynamics that produced their "low cohesion" and oriented to the limited learning opportunities being made available to Samantha within the group's current patterns of work. In this way, Maria recognized that these patterns of interaction were problematic, even if the group was making progress on their design.

In Maria's description of events above, some details about the group's operations and daily routines were made visible, and other aspects were left opaque. The salience of some features of the group's functioning can be understood by articulating some underlying ideological assumptions that might give rise to such descriptions. One ideological assumption that is reflected is Maria's account is that **group-level patterns of work are responsible for the construction of group culture and of individual's roles**. In this way, it is sensible to think about group-level characteristics such as "low cohesion" as emerging for interpersonal dynamics that are elaborated (rather than merely the result of some individuals being "checked out.") Additionally, group roles, such as Veronica as "coding alone" and Samantha as "learning alone through exercises" are seen as emerging from patterns of work, rather than as an inherently natural way for work to unfold. Additionally, this account reflects a sense of **distributed or collective responsibility for individuals' engagement/participation**. In this sense, people's observed behaviors are not seen as solely driven by the individual's motivations, goals, and inclinations, but seen as partially resulting from patterns of collective work. If a team member is not participating, explanations for this are entertained that involve examining what access to opportunities for involvement have existed, including how others have explicitly invited (or NOT invited) that student into collaborative work.

Another ideological assumption that is reflected in Maria's account that **power differences are constructed through interpersonal interactions and particular institutional contexts**. In this way, Maria drew attention to the fact that some acts hold currency within this educational space (e.g. prior coding experience and academic performance on in-class quizzes). Maria suggested

that these dimensions of social capital within this space establish some power differences between team members – Veronica as having social capital based on prior experience coding (in relation to Samantha's low social capital in this regard) and Samantha as having social capital due to her high grades on quizzes (in relation to Veronica's low social capital in this regard). These power differences were entertained as explanations for why Samantha didn't more readily approach Veronica for help, or why Veronica didn't invite Samantha to engage with her.

Taken together these ideological assumptions reflect that the production of technical work is connected to ongoing social process that construct engagement, roles, power differences, etc. The *emergent systems* orientation evident in Maria's scenario shows potential for challenging socio-technical duality narratives that are pervasive in engineering education (Cech, 2014).

However, we found that Maria's scenario was the only one out of 11 that we analyzed which articulated an ES account of the teamwork trouble. Most other scenarios drew on a combination of ideologies linked to IA and DW modes. A few noted that a team has "no positive communication" or that team members aren't "on the same page" without specifying details about what students are communicating about or where communication is breaking down. These general references to team communications are ambiguous in that they may be functioning to support DW narratives, in which the elaboration of relationships are limited to the delegation and completion of work, or they may function to support ES narratives if they are placeholders for more fleshed out notions of relationships between team members.

Data Analysis & Results: LA-generated Instructional Moves and Student Reactions

The analyses above demonstrate that, although LAs had the cognitive and ideological resources to interpret teamwork troubles in terms of group dynamics and collective responsibility, they relied mostly on *individual accountability* and *delegation of work* narratives, and accompanying ideological assumptions based mostly on individual responsibility and blame, when interpreting their own students' teamwork troubles. In this section, we show how brainstorming instructional moves to address the teamwork troubles of students of *other* LAs, and anticipating students' reactions to those moves, elicited a wider mix of IA, DW, and ES narratives and accompanying ideologies. However, the LAs anticipated disproportionately negative reactions to instructional moves that presented a risk of embarrassing an individual student or calling attention to problematic team dynamics.

Introducing the "LA-generated Instructional Moves and Student Reactions" Course Artifacts

During the pedagogy seminar the following week, LAs were arranged into groups of three and handed back their own teamwork trouble scenarios. Within each team, they passed their scenario to their right, and one of their peers was asked to: "List possible instructional moves - things you could say, do, or look out for as an educator." LAs successfully generated 5 or more possible instructional moves for each given scenario. Then students passed their worksheets to the right again, and were asked to consider how those peer-generated instructional moves might be received by students. Specifically, LAs were asked to: "Put yourself in the shoes of the student(s) involved (empathetically). How might the instructional moves (on the left) feel from the perspectives of the students involved."

LAs reject most instructional moves based on the negative student reactions anticipated

In making sense of the instructional moves that students generated, we continued to find our modes of *individual accountability*, *delegation of work,* and *emergent systems* (and related ideological assumptions) useful. In our first example, Emily and Peter were reacting to Molly's teamwork trouble scenario:

> "*Yesterday when I went over to a team working in the lab, I noticed a student not being engaged in the process. I asked him how things were going and what had been accomplished, to which he did not have a response. Rather, he directed me to another student on the team to update me on the team's status. This student could not explain what had been done and therefore likely has not been participating nor has he been keeping up with progress. Therefore, he is likely not being held accountable for anything, meaning the leadership for the team could be too relaxed in delegating responsibility.*" (Molly's Teamwork Trouble Scenario).

We can see in this scenario the themes of IA and DW showing up strongly. Table #1 below displays one example of an instructional move that Emily generated. This instructional move involved "*teaching the student to do something - RF[2], solder, work w/ a certain sensor.*" In this instructional move, we see that Emily addressed Molly's teamwork trouble by developing some technical skill or capacity within a specific individual student. This reflects a focus on an individual, and a sense that the trouble may be arising do to an individual's lacking of technical skills. When Emily and Peter considered how this instructional move might be received by the student, they anticipated three possible student reactions displayed in Table #1 below.

Instructional Move (IM)	**Student Reactions (SR)**
Teach the student to do something - RF, solder, work w/ a certain sensor (Emily)	*May be hard to find a useful task later in the semester that is not already taken care of may feel redundant / pointless* (Emily)
	May feel embarrassed (Peter)
	May take ownership of the skill (Peter)

Table #1: Emily and Peter's reactions to Molly's Teamwork Trouble Scenario taken from in-class written work.

We see that two of these anticipated reactions were seen as negative (e.g. "*may feel embarrassed*," whereas one was seen as positive (e.g. "*may take ownership of the skill*"). We are encouraged that the LAs anticipated a range possible student reactions, rather than assuming some overly deterministic system.

In our next example, we illustrate how the ideological form of the teamwork trouble scenario did not determine the ideological form that the instructional moves embodied. In our second example, the group was reacting to Vincent's teamwork trouble scenario (presented in the

[2]RF here refers to radio frequency communication between the base computer and the over-sand-vehicle (OSV).

previous section on "LA generated TT scenarios"). In our previous analysis we argued that Vincent's scenario was a striking example of individual accountability playing out in the LA-generated scenarios. However we see Thomas generated an instructional move (shown in Table #2) that shifts away from an individual accountability frame – where he imagined inviting the team to reflect on how it is dealing with lack of participation. In this way even though Vincent's scenario foregrounded the individual and the technical, Thomas was able to generate an instructional move that foregrounded social processes. Interestingly, we can see the generation of instructional moves in relation to a particular scenario as either reifying or contesting the socio-technical meanings ascribed to the scenarios.

Instructional Move (IM)	**Student Reactions (SR)**
Asking team how they've been handling lack of participation from individuals (Thomas)	*[Learning Assistant] is talking behind others backs is the same true about me (-)* (Anthony)
	Anger @ 3 [*checked out students*] *(-)* (Anthony)
	Attempts to restructure/compensate (+) (Anthony)

Table #2: Thomas and Anthony's reactions to Vincent's Teamwork Trouble Scenario taken from in-class written work.

Anthony then proceeded to generate three possible student reactions to this instructional move: two that were negative (e.g. "*Anger @ 3 [checked out students]")* and one that was positive (e.g. "*attempts to restructure/compensate*"). Though unprompted, Anthony labeled these student reactions with (+) or (-) to indicate their positive or negative impact.

In other responses, Thomas was able to generate multiple instructional moves that attended more to the systemic nature of the team's work. Another example of this was, "*Getting team to work together in close proximity.*" This demonstrates how there isn't a simple one-to-one mapping between the ideological character of the scenario and the instructional moves that were generated.

We hope that the two examples above give a flavor for the kinds of instructional moves LAs formulated and the student reactions they anticipated. In order to identify patterns, we coded all student reactions as positive/effective, negative/ineffective, or ambiguous. From this analysis we found there were almost twice as many negative/ineffective student reactions anticipated (N=36) as positive/effective student responses anticipated (N=19). This suggests that although LAs could generate and entertain a broad range of possible instructional moves, they also saw the vast majority of these possibilities as likely ineffective or detrimental to students within design teams.

Discussion

We have presented analysis of how peer educators in an engineering design course notice and consider responding to issues of equitable teamwork and participation in the context of a roleplay activity, in articulating teamwork troubles from their observations of engineering design teams, and in imagining possible instructional moves (in response to the teamwork troubles) and students' reactions (in response to the instructional moves).

Our analysis of the roleplay activity shows that LAs demonstrated metalinguistic and paraverbal awareness of the ways in which dominance was constructed in interaction, and that they were able to reframe a "quiet" student as having valuable ideas to contribute. However, it is unclear if and how the peer-educators will bring these sensibilities to bear when they are observing students teams in action and how they will respond to these situations in the classroom. The peer educators in our pedagogy seminar seemed to value that Christian did not explicitly address the problematic dynamic of the "overbearing" and the "quiet" student. Was that for lack of access to instructional strategies for addressing such interactions? Or maybe that reflects a socio-technical duality that values students' technical ideas over the goal of creating safe spaces and envisioning equitable relations? Our current data limits our ability to address this question, but we aim to pursue this in the future.

Through our analysis of teamwork trouble scenarios, we found that LAs primarily drew on notions of *individual accountability* and *delegation of work* as the primary means to evaluate teamwork. Much rarer were accounts where teamwork troubles emerged from the interactional dynamics between teammates and were connected to how teammates were positioned with respect to one another, where some positionings can create unproductive asymmetries in power between team members. We connected these modes of *individual accountability, delegation of work*, and *emergent systems* to the underlying ideological assumptions that have consequences for how meritocracy and technocracy (Slaton, 2015; Cech, 2014) play out in an engineering design classroom and serve to ameliorate or reify engineering mindsets (Riley, 2008). The modes that we document are asymmetric in that *emergent systems* based interpretations hold more potential for elucidating ongoing social processes, for challenging meritocracy, for seeing power differentials within interpersonal and institutional contexts, and for challenging socio-technical duality. As a field, we need a better understanding of the ideological assumptions underlying how peer-educators interpret classroom events.

Earlier, we noted that research on teachers in K-12 classrooms documents how teachers' attention to equitable participation and power dynamics are connected to their ideological stances towards who can do mathematics and science, especially with respect to students from marginalized groups (Louie, 2018; Hand 2012; Gutiérrez, 2002). In our paper, we add to this literature by documenting the connection between how educators interpret classroom events and ideological assumptions drawing on meritocracy and socio-technical duality. Specifically, peer-educators in our study more heavily drew on assumptions that reify rather than challenge meritocracy and socio-technical duality. Slaton (2015) has argued that meritocracy and social-technical duality are significant mechanisms through which the STEM education system continues to discriminate against learners from marginalized backgrounds. For example, race/gender/class are important factors in the technical preparation of students joining undergraduate engineering programs. Meritocracy, by privileging the prior technical expertise tends to exacerbate rather than alleviate the race/gender/class based constraints on opportunities to learn. In other words, when instructors' interpretations of classroom events is guided by ideological assumptions aligned with meritocracy and social-technical duality, that may reproduce race/gender/class based inequities. Given the K-12 literature on noticing for equitable participation, we also wonder if ideological assumptions about meritocracy and social-technical duality themselves are entangled with assumptions about race, class, and gender.

This preliminary analysis also alerts us to instructional challenges that we aim to address in future iterations of the pedagogy seminar. It was rare for the LAs to draw on *emergent systems* interpretations of classroom events. And in imagining instructional moves and students' reactions to those moves, LAs expressed strong reservations about addressing the social dynamics within a team explicitly and had a largely negative evaluation of the instructional moves that they came up with. In seminar conversations about this, they expressed fears that it might further complicate team dynamics, might not be received well by the students, or that they lack adequate skills to address social dynamics. These observations help us identify gaps in our own curriculum design and scaffolding of LAs. For example, in our list of course readings we did not have any article that talks about conceptualizations of power and provides tools for attending to that in interactions, or on meritocracy and socio-technical duality. While we did include one reading that contrasted analysis of events from individual versus systemic lens (Secules, et al, 2016), it came towards the end of the course and we did not use classroom time to translate how these lenses could become tools for making sense of concrete events from LAs' own classrooms. Nor did our seminar activities scaffold LAs in reflecting on the ideological assumptions underlying their own reasoning patterns and interpretations. While these data don't immediately suggest concrete instructional moves or activities to be used in the pedagogy seminar, the identification of these gaps can help us brainstorm possible solutions towards addressing them.

In future implementations of the pedagogy seminar, we aim to better support students in developing emergent systems thinking around classroom events. Given our findings about the context-dependent nature of LAs' ideological assumptions, this will require a more careful consideration of how different elements of the curriculum may afford or constrain ES thinking. For instance, while ES thinking did not consistently emerge in the teamwork trouble scenarios, it was more readily cued in other contexts, such as some roleplay activities (Tanu, et al, 2017) and in one-on-one interviews with LAs. In addition, we can create pedagogical tools for helping peer-educators in engineering design environments draw more heavily on ES-based interpretations of their classroom observations. For example, explicitly naming these "modes" with LAs can help them to identify ES, DW, and IA in their own reasoning as they interpret and respond to their students' teamwork troubles. In addition, we could create more opportunities to make visible the ideologies that Riley, Cech, and Slaton describe such as meritocracy and technocracy and work to identify and trace the harmful effects of these ideologies in ENES100. Finally, we would like to further scaffold peer-educators in developing a toolbox of instructional strategies for recognizing and responding to inequitable interactional dynamics in their own classrooms, for instance, by providing them with talk moves or sentence starters that would help LAs elicit evidence to substantiate ES explanations of events (e.g., "tell me a story of how you got here"; "tell me more about where these feelings are coming from"; "you seem frustrated. Can you say more?") or by helping them brainstorm and practice productive interventions for disrupting inequitable team dynamics.

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