# Board 314: Initial Explorations to Understand How Our Research Teams Think About Knowledge and Make Research Decisions

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# Initial Explorations to Understand how our Research Teams Think about Knowledge and Make Research Decisions

## Introduction and Background

Engineering education strives to transform the field of engineering by integrating research and practice. These efforts often involve groups of individuals from fields such as engineering, sociology, and psychology and from different roles within a university (e.g., faculty, administration, student support staff) [1], [2], [3]. Each of these team members bring their own approaches to the generation, expression, and application of knowledge. These differences in thinking are key to the success of engineering education; however, they create tensions that prevent many groups from achieving their core goals. These tensions are often associated with ineffective communication or project management, which overlook the more fundamental differences around what counts as knowledge and how knowledge is generated [4], [5]. Accordingly, the purpose of this project is to improve the effectiveness of engineering education research (EER) groups striving to make transformative change in engineering.

To meet this goal, we are using an integrated research and education plan to develop a deep understanding of how researchers negotiate differences in how group members think and engage in critical interactions. We are exploring how both individuals and groups approach the generation, application, and expression of knowledge through a multimethod research approach that integrates an ethnographic case study [6], [7], [8] with approaches from grounded theory [9]. The core outcome of the research will be a conceptual model that incorporates epistemic culture and individuals' negotiation of epistemic identities within EER teams. Throughout the project, the research is being integrated with the education plan through a translation plan that includes a series of workshops. The purpose of this Executive Summary is to summarize our current efforts associated with the ethnographic case study and translation plan of our project and describe how we are building on an existing model from philosophy of science.

## Executive Summary

We are currently conducting the first phase of the research, which is an ethnographic study of a research group. We have also conducted two exploratory workshops that were designed to get feedback on our early findings and inform our development of interview and ethnographic questions. We are using Longino's Critical Contextual Empiricism (CCE) model [10] that defines the norms for an idealized knowledge generating community as an initial framing to understand how interdisciplinary EER teams negotiate to make research decisions. This model brings together both the cognitive process and noncognitive factors (e.g., social interactions) associated with knowledge production through four norms of an idealized knowledge community. The four norms are 1) providing venues for criticism, 2) uptaking criticism, 3) recognizing public standards, and 4) maintaining tempered intellectual equality. If satisfied, these norms result in the development and acceptance of theories, ideas, standards, and approaches that are not influenced by idiosyncratic thinking of individuals or communities. These norms can be

partially satisfied resulting in communities that are more or less effective as knowledge producers. The CCE model was developed through the synthesis of literature and ideas across the sociology and philosophy of science. In order to support EER groups, there is a need to operationalize and expand this model based on the context of engineering education. Below we present our preliminary work to operationalize the CCE model in the context of engineering education through our ethnographic case study and exploratory workshops.

***Overview of the Ethnographic Case Study***

Thus far, the ethnographic study has involved observations of group meetings that occurred across two different engineering education research groups. These two teams (Team X and Team Y) are both composed of faculty from engineering and engineering education. Team X also includes an organizational psychologist, and Team Y includes multiple student researchers who joined the project at the start of our observations. Both teams meet virtually on a weekly basis, and we are conducting ethnographic observations of these meetings. As we observe each meeting, we construct fieldnotes to record our observations and impressions. We also make note of instances when the team is making a research decision, such as deciding the type of research approach to use, defining the details of the research approach, or discussing when, where, and how to share findings. The associated sections of the fieldnotes and meeting transcript that correspond to a single epistemic instance are compiled into one document for coding. We are following Charmaz's [9] initial coding approach, identifying phrases and defining codes that are action oriented and close to the participants' own words. We are coding phrases that help us understand the epistemic culture of the team and how they go about making research decisions. After coding, we collaboratively construct memos that describe how the CCE norms are showing up and what is not being captured by CCE but is important to the team's negotiation.

Our preliminary analysis revealed multiple instances of epistemic and nearly epistemic negotiations. The epistemic negotiations involved conversations about specific project decisions during which different views about research goals and approaches were discussed and interacted with by members of the team in a productive manner. The nearly epistemic negotiations included conversations that stemmed from a question rooted in research goals or approaches but did not involve individuals interacting with one another's ideas. Both types of negotiations are being analyzed using Longino's CCE model and used to inform our operationalization of the CCE model in engineering education.

***The Translation Plan***

The purpose of the translation plan is to ensure that the outcomes of our research are valuable to the teams and individuals in our field. We plan to run at least four workshops over the course of the project. The initial workshops are exploratory and focus on gathering information to help our data collection and expand the contextualized model we are generating in the research.

We ran two exploratory workshops this semester. The first one was at the First-Year Engineering Experience Conference held in August at the University of Tennessee, Knoxville. In this

workshop, we focused on piloting the use of systems thinking and ethnographic research methods for individuals to think about a collaboration they are part of. The individuals identified the actors and activities in their collaboration and used these to create a map of their group's culture. They then used tools from systems thinking (e.g. inputs/outputs/feedback loops) to analyze their team's culture. Finally, they identified strengths and threats to the integration of ideas and approaches within that culture.

Our second workshop was held at NSF Revolutionizing Engineering and Computer Science Departments Consortium Meeting (REDCON) in September. This workshop focused on having individuals on teams apply systems thinking and ethnographic approaches to analyze their RED Team's approach to generating, applying, and disseminating knowledge. We also discussed the four norms from the CCE model and how teams saw these norms showing up.

**Preliminary Findings - Operationalization of the CCE Model for EER Teams**

The CCE model was conceptualized to identify the criteria necessary to ensure the effectiveness of critical interactions within a field of knowledge. Critical interactions are discussions about research ideas, approaches, or questions among team members. Our initial findings presented here center on operationalizing the CCE model within the context of a single EER team. Below we provide our current description of each norm. These descriptions were constructed based on our initial ethnographic analysis and conversations with EER teams during our workshops.

***Providing Venues for Critique and Idea Sharing***

Venues within team meetings are the places and time periods where ideas, methods, assumptions, and reasoning can be discussed, evaluated, and critiqued by the team. Ideally, in these spaces, there would be deep engagement with the various ideas and negotiation among team members to ensure the critique of ideas and approaches across the research process - a critical interaction. The place is defined by the physical or virtual location of the meeting. Team X and Y both met virtually over Zoom with all of the team members on their individual computers. The place also includes any shared, collaborative documents that team members could annotate in real-time. For both Team X and Y, their meetings were structured by an agenda. These agendas defined what would be discussed and how long each topic would be discussed. In some cases, the agenda was structured as a list of to-do items and did not facilitate the discussion of ideas or methods [11].

Within a single meeting, venues are opened and closed to allow discussion of various topics. We saw venues opened by team members posing questions that opened another thread for discussion or by passing the facilitation of the meeting to another team member. For example, in a discussion about whether more data should be collected, Hudson on Team X asks, "does including the online classroom observations add noise to the data set?". By asking a question related to his concern rather than stating a declarative sentence, he opened a venue by creating an opportunity for dialogue and discussion. Venues can be indirectly closed when a new venue is opened by a question or other topic change. Venues can also be directly closed by the end of the

meeting or the end of the time for that topic to be discussed. For example, Dr. Peters and Dr. Johnson on Team Y close the current discussion (a venue) by acknowledging that time is up and proposing a plan to revisit it next meeting:

> *Dr. Johnson says, "I know we only have 7 more minutes. Should we kind of reflect more on these, make a decision next week, probably?"*
> *Dr. Peters adds, "exactly what I was going to say, let's make it we'll make it as we will make a decision next week, and then in the seven minutes remaining, I will slide over the Teams [Microsoft software]."*

***Uptaking Critiques and Ideas***

Uptake are the actions, responses, and questions to critiques/concerns, comments, questions, and ideas that are brought up by team members and/or individuals external to the team. The actions can include listening, accepting, incorporating, expressing the opposite view, and acknowledging. Ideally, the team will directly engage with one another's critiques and ideas, leading to epistemic negotiations. These epistemic negotiations are where interdisciplinary approaches can be generated. We previously described a nearly epistemic negotiation that occurred on Team X because of indirect engagement with a series of questions raised by a team member [11].

The members of Team Y are particularly strong at acknowledging, affirming, and/or building on others' statements and ideas. During a discussion of how to word a prompt for an upcoming workshop, team members acknowledged ways they agreed or made the point to affirm what was said before sharing an opposing view. For example, after two team members share their opinion that the prompt should be specific to their project context, Dr. Peters responds by saying,

> *"But what is ...I'm not ....what is the value of focusing on [specific project name]? And I go, I like [Team member name] reminder about we heard last week, it was just a week ago and I remember one of the guys on the second day saying we're really pressing on what is the challenge, what is the challenge, what is the challenge? And it feels like if this were about what is the gap you see out there that that would help us very clearly, that'd be very useful to us to identify what is the need."*

***Recognizing Public Standards***

Standards are the guiding principles, ideals, and goals that the team uses to evaluate knowledge, plans, outcomes, theories, and observations. These standards are dynamic and are not defined by a single act but rather by a set of small actions. As such, it is possible that teams hold standards that they are not explicitly aware of and/or did not aim to set. The small decisions and consistent actions a team makes will set the standards of the team. For example, Team X had a standard of productivity, which was apparent to us in their design of team meetings around project management and their desire to get things done [11]. One of Team Y's standards was making

space to ensure that all team members can contribute and their voices are heard. This standard was seen in the multiple small actions by different members of the team which included, voting to make a decision, individuals inviting members who had not yet shared to share, team members putting their question or statement on hold to make space for others to speak, and members adding background information to their statements to provide context that some members might not know. For example, one team member apologizes for speaking about a meeting that not all team members attended and then gives some background context for them.

> *"I'm sorry, [team member names who were not at the meeting]. I have been referring to this meeting with the program officers. Just to give you a background, last week, the four of us were in Arlington, VA, and we had the opportunity to meet with the NSF program officers, and that was a great conversation. So we got a lot of other things that we were not thinking about. So that's just to give you some ideas [of] where I am coming from with my reflection."*

***Maintaining Tempered Intellectual Equality***

Tempered intellectual equality considers the value of all team members' contributions to the team as knowers allowing for diversity of perspectives and discourse. It is important that the social, economic, disciplinary, and/or institutional power of an individual does not determine what perspectives are considered. Many EER teams include individuals who have different power with respect to one another. These power differences can lead to unequal valuing and sharing of opinions and ideas. Within these teams, the power differences can be the result of different roles (e.g., student, faculty, administration, staff), disciplines (e.g., engineering, social sciences), institution types (e.g., research-focused, teaching-focused, liberal arts), and social identities (e.g., race, gender, age). Of the teams we have studied, Team Y was the most diverse in terms of roles, institution types, and social identities. We consistently observed team members with the most power make space and invite those with less power to share their ideas. For example, Dr. Peters invites the undergraduate researchers to share their ideas by saying,

> *"Maybe a fresh perspective, do any of the students wish to speak up about [the prompt]? We value your fresh new perspective on this because you weren't... you haven't thought about this as much as we have so that might be helpful."*

We also observed the team members with more power acknowledging and affirming the contributions of the team members with less power. For example, when the undergraduate researchers on Team Y all shared their responses to a question, multiple faculty researchers thanked them for their contribution and acknowledged their added value.

**Implications for Research Teams**

Based on these preliminary findings, we believe that the general structure of a team's weekly meeting venue is key to allowing for critical interactions to occur. It is important to pose critical questions, allow time for multiple discussions to occur, have a mechanism for the team members

to communicate what should be discussed, and circle back to discussions that were not finished in previous meetings. We also encourage team members to share partially developed ideas to encourage the integration of ideas. We observed how people's uptake of ideas do not need to be refined or polished before sharing them. This thinking out loud rather than giving a definitive response can provide an opportunity for other team members to build off of their ideas. Our final recommendation is for team members who are in positions of power to create a space for those with less power to share their ideas. Team members who hold more power can delay sharing their own ideas until other team members have contributed, directly ask for the input of others, and affirm the contributions made by others.

**Future Work**

We are continuing our ethnographic analysis of Team Y's weekly research meetings, which will include interviews with every team member this semester. Our analysis of the remaining research meetings and interviews will allow us to expand our current definitions of the CCE model norms and make inferences about how aspects of an individual's epistemic identity contribute to the research team's epistemic culture. Based on this analysis, we will construct an initial model of how EER teams negotiate differences in thinking. This model will be expanded by applying approaches from grounded theory and seeking feedback from the EER community in additional exploratory workshops.

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