Work-in-Progress: Describing the Epistemic Culture of our Research Teams from Ethnographic Observations

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Introduction

In the field of engineering education, our research teams are foundational to promoting change in engineering. These teams seek to address complex problems that require interdisciplinary solutions. Many of these teams work across disciplinary boundaries and include individuals from different disciplinary backgrounds (e.g., engineering, engineering education, psychology) [1], [2], [3]. Each of these disciplines have their own norms around the generation, expression, and application of knowledge. It is important that these teams are able to navigate differences in thinking. Failure to acknowledge, address, and integrate these differences can lead to tensions that negatively impact their ability to have their desired impact. A team's norms and approaches around the generation, expression, and application of knowledge define their epistemic culture [4]. A team's epistemic culture affects all aspects of the research process: the types of questions they answer, knowledge they generate, knowers they recognize, and knowledge they share.

Existing work across Team Science and philosophy of science has primarily focused on the broader processes of research integration [5], [6], [7], [8], [9], the structure of knowledge generation [6], [7], [8], [10], and the influence of the nature of science on current approaches within interdisciplinary research collaborations [11], [12], [13]. Due to the complexities surrounding differences in thinking, findings cannot be translated from one interdisciplinary context to another without careful consideration of contextual features and interactions. While engineering education is similar to disciplines that have been studied (e.g., science and engineering), it is unique in that the researchers are often embedded in the field they are trying to impact (engineering) and integrate research approaches across fields that are cognitively divergent (e.g., engineering and sociology) [14], [15], [16], [17]. Accordingly, the purpose of this work is to investigate the epistemic culture of engineering education research teams.

To meet this goal, we are conducting an ethnographic case study of a single engineering education research team (Team Y). This work-in-progress paper presents an ethnographic description of Team Y's a critical interaction where the team was making a research decision. The ethnographic description addresses two ethnographic questions: what values, goals, and feelings were expressed? and how do the actors engage with each other? We also present our analysis of the critical interaction using Longino's Critical Contextual Empiricism framework [18] that defines the norms for an idealized knowledge generating community. Through this analysis, we describe Team Y's epistemic culture based on their venues, uptake of critiques, standards, and intellectual equality.

Theoretical Framework

We used Longino's CCE model [18] as a lens to characterize Team Y's epistemic culture and understand how this team approached a critical interaction (e.g., research decision). Longino argues that knowledge is generated through critical interactions across multiple points of view which work to "transform the subjective to the objective" [18, p. 129]. The CCE model defines four norms of an idealized knowledge community that foster critical interactions and lead to the development of theories, methods, and ideas that are not based solely on the idiosyncratic thinking of individuals or communities. These four norms are 1) providing venues for criticism, 2) uptaking criticism, 3) recognizing public standards, and 4) maintaining tempered intellectual equality.

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. The place is defined by the physical or virtual location of the meeting. The place also includes any shared, collaborative documents that team members can annotate in real-time. Within a single meeting, venues are opened and closed to allow discussion of various topics. Venues can be indirectly closed when a new venue is opened by a question or other topic change. Venues are directly closed by a meeting ending or the time allocated to a specific topic ending.

Uptake of criticism are the actions, responses, and questions to critiques, 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, opposing, and affirming. Ideally, the team will directly engage with one another's critiques and ideas, leading to epistemic negotiations. These epistemic negotiations are where new interdisciplinary approaches, reasons, and arguments can be generated.

Public 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 a set of small actions. As such, it is possible that teams hold standards that they are not explicitly aware of or did not aim to set. The small decisions and consistent actions a team makes will set the standards of the team.

Maintaining tempered intellectual equality considers the value of all team members' contribution to the team as knowers and allows for diversity of perspectives and discourse. It is important that the social, economic, disciplinary, and/or institutional power of an individual does not determine if their 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 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).

Method

We used an ethnographic case study approach [19], [20], [21] to deeply explore the epistemic culture of a single interdisciplinary engineering education research team. This paper focuses on our observations of a single research team's (Team Y) weekly meetings. More specifically, we focus on a single critical interaction in which the team is making a research decision. This interaction occurred across two sequential team meetings, referred to as Day 1 and Day 2.

Participants

Team Y is working on a multi-year, nationally funded research project. The team members are located at multiple institutions across the United States. The team includes four faculty (Dr. Peters, Dr. Wilson, Dr. Johnson, and Dr. Roberts) three undergraduate student researchers (Riley, Avery, and Alex), and one graduate student researcher (Eliana). The faculty are the 'permanent' group members and wrote the initial grant that funds their current work. The three undergraduate students are the newest team members and all recently joined the project.

Team Y's research project is a large, multi-component project in which there are multiple activities that are occurring simultaneously. The project includes elements of both research and practice and seeks to develop and support a community of practice focused on addressing systemic issues in engineering education. While individual faculty lead specific efforts, the team makes a point to collaboratively make decisions and ensure alignment with their larger goals.

There are a few specific roles that are important to the critical interaction we present here. Dr. Peters facilitates the team meetings by creating the initial agenda and guiding discussion. Dr. Johnson is leading the activity that is being discussed in this critical interaction. Dr. Wilson and Dr. Roberts lead the activities that the undergraduate researchers are working on, and Dr. Wilson is at the same institution as the students (Riley, Avery, and Alex).

Data Collection and Analysis

Our data for this paper include the video recording, transcript, and ethnographic fieldnotes associated with the critical interaction. The ethnographic fieldnotes described what was happening in the video, the emotion around the conversations, and any other impressions that might not be captured by the transcript alone. We constructed these fieldnotes using a multi-step process. One researcher generated the initial draft of the fieldnotes and a second researcher reviewed the fieldnotes, adding additional details, making any needed corrections, and adding screenshots from the video to support future analysis. After finalizing the fieldnotes, we constructed a single two-column document. One column had the audio transcript and the other

had the fieldnotes. We matched timestamps together to link sections of the fieldnotes with corresponding sections of the transcript.

We deductively coded the transcript and fieldnote segments. We individually coded and then met to discuss our coding. We checked for alignment, added new codes to the codebook, and reached consensus on any areas of disagreement. We followed Charmaz's [22] approach to coding, identifying segments of text that aligned with our research question and defining codes using a verb and the participant's own language. As we defined our codes, we also connected them to relevant CCE norms [18]; these norms served as categories for our codes. All coding was done in Microsoft Word using comments. Our codebook was constructed in Microsoft Excel.

After coding, we collaboratively constructed an initial draft of the Structured Analytic Memo (SAM). This memo was divided into the following sections:

- Section 1: General overview of the instance – what is the conversation about, what background information is important to know;
- Section 2: Description of how each norm shows up – divided into 4 subsections;
- Section 3: Discussion of takeaways and overall norms for the team;
- Section 4: Description of what showing up as important to the team's negotiation but don't necessarily show up in the CCE norms.

This memo served as thre draft of our findings section and helped us make sense of the team's epistemic culture.

Preliminary Findings and Discussion

Below we present our ethnographic description of Team Y's research decision process in this critical interaction. This ethnographic description addresses two ethnographic questions: what values, goals, and feelings were expressed? and how do the actors engage with each other? Next, we present our analysis of the critical interaction using Longino's CCE framework [18].

Description of the Critical Interaction

We focus on a critical interaction that took place over two days (Day 1 and Day 2) and lasted 32 minutes. During this interaction, the team discusses the wording of a prompt they are going to use to guide a collaborative brainstorming activity at an upcoming conference. Dr. Johnson is the lead of this activity and facilitates the discussion along with Dr. Peters. The team starts by reviewing external feedback they got on a draft of their prompts. Much of their discussion centers around determining the goal of the activity with respect to the rest of the project and their pursuit of a future grant to expand their efforts.

For most of the critical interaction during Day 1, the four faculty are the primary voices in the discussion and there are two sides: those who think the focus should be general to engineering education (Dr. Peters and Dr. Wilson) and those who think the focus should be specific to their community of practice (Dr. Johnson and Dr. Roberts). Both sides ground their reasoning in how

the activity will support their future efforts. Dr. Peters and Dr. Wilson express that the more general framing may be easier for non- or new community members to contribute and will better guide the team's future efforts. Dr. Johnson and Dr. Roberts express that the more specific framing will provide information that better supports their efforts as they look to prepare the next grant and note that the team's unique piece is their community of practice. After dialogue among the four faculty, Dr. Peters invites Eliana, the graduate student researcher on the project, to share her thoughts. Eliana zooms in on a specific phrase in the prompt and asks what depth they are wanting to capture surrounding this construct. She points out that it can be on an individual, organizational, or structural level. There is limited dialogue around her specific question, and Dr. Johnson asks to capture her point so that they can revisit it. A consensus is not reached during Day 1 and the team decides to think about things and revisit the next meeting (Day 2) to make a decision. They were conscious of the amount of time they had spent on the discussion and wanted to ensure they could discuss other project efforts during the meeting.

The primary goal on Day 2 is to make a decision about what prompt to use. While every team member contributed to the conversation during the meeting, there is less dialogue and direct discussion of ideas. The critical interaction continues in the second meeting when Dr. Peters passes the floor to Dr. Johnson and everyone takes a few minutes to review the prompts written in the agenda. At the request of Dr. Wilson, Dr. Johnson spends a few minutes discussing how the collaborative brainstorming activity will be structured to give background to the undergraduate student researchers who recently joined the project. Dr. Johnson then asks Eliana to elaborate on her points from the previous meeting about the systemic nature of a specific phrase in their prompt. After she elaborates, Eliana discusses the importance of intersectionality and poses a series of questions about how the team will consider this complexity in the activity and/or the prompts. Dr. Wilson briefly responds to these questions raised by Eliana but there is limited dialogue and the conversation moves in a different direction. Dr. Peters and then Dr. Roberts both directly ask the undergraduate student researchers to share their perspectives. Riley, Avery, and Alex, the undergraduate student researchers, each respond to Dr. Roberts's question about how they would respond to one of the prompts. After they each respond, Dr. Peters asks Dr. Johnson how he wants to proceed to make a decision and Dr. Johnson suggests voting. Before they move to voting, Dr. Roberts is asked to give his input because he was the only team member who had not said anything yet. He makes a brief comment about how groupthink can occur with voting and then makes a brief argument for the prompt with language specific to their community of practice. After his response, the team moves forward with the voting process, which is led by Dr. Peters. The process has two stages: 1) an initial vote for the prompt they think should be used and 2) a consensus check to ensure that everyone is in agreement to move forward. There is a tie with the initial vote – it is split between one of the more general and one of the more specific prompts. Dr. Peters proposes a decision of going with the more specific prompt and then does a consensus check to ensure everyone is okay with that decision. There is no discussion of the split vote or about Dr. Peters' decision to go with the prompt with the

community of practice specific language. With the wording decided on, the team moves on to discuss the next topic on their agenda.

Analysis of the Critical Interaction Using CCE Model

Below we discuss the critical interaction through the lens of the norms of the CCE Model. We will not fully discuss all aspects of each norm, but rather, focus on the aspects of each norm that were most prominent or key to this critical interaction.

Venues. We characterized two dimensions of the venue for this instance: the physical/virtual attributes and the acts that shape its nature or direction. The Zoom meeting room, shared agenda, and write-up of the collaborative prompts with feedback from an external consultant make up the physical/virtual aspects of the venue. The shared agenda and write-up with the prompts extend the meeting space for the team. The agenda is used to document emerging ideas and serves as a holding place for ideas that individuals on the team want to revisit and discuss further. For example, all of the prompts that are being considered are added to the agenda. Between Day 1 and 2, Dr. Peters adds an additional prompt based on the discussion from Day 1.

The nature and direction of the venue were shaped by the actions of team members. These actions included opening and closing the venue (e.g. proposing new topic to be discussed or tabling a discussion for a future meeting); setting the stage for the venue by priming and providing additional information/context (e.g. presenting external feedback); deepening or expanding the venue to discuss a topic further (e.g. asking how the group is addressing the complexity of the topic being discussed); and changing or shifting the venue to discuss other topics (e.g. proposing that they should rethink the purpose of a project). We consider these acts to be venues because they made the space and opportunity for dialogue to occur. Questions were most commonly used to shape nature and direction of the venue. The use of questions provided a space for discussions to start or continue in ways that may not have happened if declarative statements were used.

Uptake. We categorized the codes that relate to uptake into two groups: 1) posing new questions, comments, ideas, and concerns for the group to discuss and 2) responding to the questions, comments, ideas, and concerns presented by other team members. The most prominent aspects related to uptake in this critical interaction are how the team members thought out loud, expanded others' statements, handled disagreements, and moved to make a decision.

Throughout the first meeting, we observed Team Y actively listening to and engaging with the ideas, questions, and comments posed by other members of the team. When asked for more general thoughts, they often responded by thinking out loud about a topic. These less formalized statements led to both the generation of new topics for the group (e.g. Dr. Peters's question about the purpose of the collaborative brainstorming activity) and expansion of the current topics (e.g. Dr. Johnson thinking back on the team's meeting with the NSF program officers, and then Dr. Peters building off of this comment as a point for the group to consider).

In cases of agreement, many of the team members affirmed and added to others' contributions (e.g. Dr. Peters saying "he liked Dr. Johnson's reminder of what [they] heard last week" and using it to argue that focusing on the needs of the community would answer the question from one of the NSF officers of "what is the challenge" or what is the gap). Another notable instance of affirmation was Dr. Johnson responding to Eliana's question of how they were educating engineers about a specific concept by saying "those are all really good points and I want to capture that". He then asked her to expand on her point during the next meeting. Dr. Wilson also noted the importance of Eliana's comments and made some suggestions on how they could incorporate the concept into the collaborative brainstorming activity.

In cases of disagreement, the team never dismissed another team member's point of view. Instead, they directly, but respectfully responded with their own opinions or by asking questions (e.g. Dr. Peters asking, "What is the value of focusing on the specific community of practice?"). When providing a counter idea, most of the arguments made by team members related to alignment with the team's overall goal and purpose; alignment with the current project or grant; and alignment with external feedback. At one point, Dr. Roberts directly acknowledges the value in Dr. Peters and Dr. Wilson's argument for the broader language, "in terms of "basic knowledge generation about how systemic racism could be shifted in other contexts," but followed up with, "but for this grant, this is a great opportunity to see what happens when we do focus in". They also provided suggestions for how to resolve the concerns brought up by other team members. For example, Dr. Peters was concerned about how new members of the community of practice would be able to engage in discussion. In response, Dr. Roberts and Dr. Johnson suggested providing additional information about the work the community has already done in the invitation to participate so that new members could be better informed going into the discussion.

When moving towards making a decision, Dr. Peters took their discussion from the first meeting and developed a new, fourth prompt for the team to deliberate on. After everyone had a chance to make final comments, Dr. Peters and Dr. Johnson moved the team towards making a decision on which prompt to use. Despite some reservations, the team voted. Since the vote ended in a tie, Dr. Peters proposed a decision and selected the hybrid prompt which used the community of practice specific language, citing both the external feedback that it might be more accessible and Dr. Roberts's argument for keeping the community of practice focused language. He ensured acceptance of this decision using a "red, yellow, green" system, with red meaning 'no, don't move forward' and green indicating agreement to move forward.

Tempered intellectual equality. We created ten codes related to valuing all team members' contribution to the team as knowers and allowing for diversity of perspectives and discourse. These codes include (1) shared facilitation, (2) hold their own opinion or question to allow others to speak or let the discussion move on, (3) directly ask students to share ideas and acknowledge contribution, (4) affirm and acknowledge what others say and the merit of their ideas and experiences, and (5) apologize for small missteps. The actions that made up these codes were

primarily taken by the individuals on the team with the most power - the faculty. They created the space for others to share their ideas, affirm the contributions made by others, and apologized for small missteps when necessary.

Throughout the instance, we see the faculty hold their own opinion or question to allow others to speak or let the discussion move on. There are not dominating voices on the team and it is clear that everyone cares about hearing from one another. Likewise, we see team members who hold more power directly yield the floor to members with less power. During the Day 2 discussion, we see Dr. Peters and Dr. Roberts both ask the students for their thoughts. Earlier, Dr. Johnson asks Eliana, a graduate student researcher, to prepare to reiterate a previous point that she made in the Day 1 meeting. This heads-up prevented her from being blindsided and allowed her to prepare what she was going to say to the group. It also acknowledged the importance of her contribution to the team.

Throughout the discussion, the team affirms and acknowledges what others say and the merit of their ideas and experiences. There are multiple instances where a team member affirms or states agreement with what someone else has said. In Day 1, there was a lot of discussion with the faculty each sharing their ideas and discussing their alternate perspectives. We observed faculty agreeing with aspects of what someone said and using that to further the discussion even when they did not hold the same core opinion. For example, Dr. Peters directly acknowledges that he likes Dr. Johnson's reminder about the meeting with NSF and then goes on to argue that the focus of the prompt should be general, which is the opposite view compared to Dr. Johnson.

There are a few small missteps or minor disagreements that occur in this instance. Both Dr. Peters and Dr. Johnson apologize for small missteps. For example, Dr. Johnson apologizes for not giving background information sooner, and Dr. Peters provides clarification to correct a minor misunderstanding.

Standards. There are four initial team standards that we identified in this instance. These standards represent the general values of the team based on actions that were taken by multiple team members throughout this instance. We expect that some of these values will show up in other instances, especially if the nature of the discussion is similar. The four standards are:

1. The team has a standard of clearly defining goals for the project and activities and ensuring that their efforts are in alignment with these goals.
2. The team has a standard of valuing and seeking external feedback to inform their work.
3. The team has a standard of making space to ensure that all team members can contribute, and their voices are heard.
4. The team creates space during meetings to discuss multiple project activities.

The third standard, making space to ensure that all team members can contribute and their voices are heard, was the most prominent standard in this instance. The actions taken during this instance that align with this standard included voting, consensus check after the vote, Dr. Peters

calling on members who have not spoken or might have a unique perspective, team members putting their question on hold to allow another team member to voice their opinion, and the review of background information and details.

Emerging Ideas and Future Work

While we presented the norms individually, they are integrated with one another. For example, each of the team standards overlap with at least one other norm. Given that team standards are made of consistent small actions taken by the team, this overlap is to be expected. The team's standard of 'making space to ensure that all team members can contribute, and their voices are heard' is defined by the team using a collaborative meeting agenda and questions to invite others to offer their perspective (venue) and recognition of individual team members as knowledge generators (intellectual equality). As we continue this work, we want to find ways to more fully represent the overlap across the norms and the connections that exist for Team Y and more generally. We are interested in hearing how members of the ERM community have made sense of connections across individual elements of other theoretical models.

While we captured many aspects of the epistemic culture of Team Y using the CCE Model and our ethnographic observations, we did not fully capture how divergent ideas from individual team members were integrated to make the decision in this critical interaction. From our observation, it was clear that while the team did not strive to make the decision unanimously (Dr. Peters broke the tie by proposing a decision), they did make sure that everyone was okay with the decision (e.g., the consensus check). Based on our observation, it is not clear how individual team members viewed the process and if it aligned with the larger epistemic culture of the team. In future work, we will interview individual members of Team Y to gain an understanding of individual perspectives and thought processes that we were not able to observe. Much of the final decision process seemed counter to how the team previously discussed the initial prompt ideas during Day 1.

The CCE Model defines the norms around an idealized knowledge generating community but does not give a lens into how decisions are made and individual perspectives are integrated. As we continue this work, we will stay attentive to other theoretical models that will provide more granularity focused on interdisciplinary decision making and integration of multiple perspectives. Our initial plans are to use the epistemic identity framework developed by Osbeck and Nersessian [13] to explore the individual level and how individuals enact their epistemic identities on EER teams. We are interested in hearing how our emerging findings and overall research goals align with other theoretical models and research areas that the ERM community is familiar with.

While the CCE Model may not provide some of the granularity we need to explore how interdisciplinary EER teams negotiate epistemic differences, it does provide a way to describe

the overall epistemic culture of a research team. We found the model helpful as we analyzed this critical interaction. It focused our analysis of the interaction and provided a structure for us to think about Team Y's culture around knowledge generation, application, and expression. As such, we plan to continue using the CCE Model as a way to describe the epistemic culture of EER teams. We anticipate that as we continue this work we will be able to add more granularity to the individual norms and identify connections across the norms. We are also interested in learning about how individuals within the ERM community have seen the elements of the CCE Model within their own research teams.

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