

Work-In-Progress: How an Engineering Education Research Team's Culture Impacts the Undergraduate Research Experience

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Introduction

The impact of undergraduate research experiences (URE's) on students' development as researchers and STEM professionals has been studied since the early 2000s [1]. Students who participate in UREs have reported that such experiences helped them clarify and confirm their career choices and direction and develop skills for graduate school and work. In addition to benefiting their general personal, professional, and intellectual development [2]. UREs are widely considered high impact practices in that they promote retention in STEM programs and persistence in STEM careers - particularly for marginalized students [3], [4]. While the outcomes of UREs have been established, there is little literature exploring the experiences of undergraduate researchers while they engage in research activities.

This work-in-progress paper seeks to understand how the knowledge generating culture created by an engineering education research team impacts the way undergraduate student researchers engage in research activities (e.g. contributing ideas to discussions, asking questions, conducting literature reviews). Culture is a shared system of meaning which people have learned or created to *organize their behavior* (e.g. How should I respond when I disagree with something another team member says?), *understand themselves and others* (e.g. Who do I feel comfortable going to for advice or questions?), and *make sense of their world* (e.g. What is the purpose of the work we're doing?) [5]. We took an ethnographic approach to investigate this culture. We used Power as a lens to examine the relationship between the culture of the research team and the ways the undergraduate researchers engage within that culture. Our specific research questions are:

1. How and when do undergraduate students engage in research activities within the team's knowledge generating culture?
2. How do senior members of an engineering education research team (faculty members, graduate students) assert power-over or share power-with the undergraduate researchers within their knowledge generating culture?
3. How do the expressions of power by the senior members of the team impact the undergraduates power-to authentically engage in research activities?

Data and Analysis Methods

The data for this study consisted of five recorded Zoom meetings of an engineering education research team; we will refer to them as Team Y. The team is spread across several institutions and consists of one engineering administrator, three faculty members, one graduate student, and three undergraduate students. The meetings we observed took place over the course of five weeks. We used the Zoom recordings and transcriptions of these meetings as well as our team's field notes to create an ethnographic record. We used Spradley (1980)'s Developmental Research Sequence (D.R.S.) to guide our analysis of the ethnographic record [5].

First, we conducted a grand tour (i.e., high level) observation of the ethnographic record to identify key components of Team Y's culture. We focused our observations by identifying the activities, places, goals, time frames, and feelings expressed in relation to the engagement of the undergraduate members of Team Y. Following this grand tour description, we conducted three domain analyses: the ways undergraduates engage in research, the ways the faculty members engage with the undergraduate researchers, and the types of power used by the team members. These analyses allowed us to systematically move from observing the components of culture to understanding the relationships between the components and their cultural significance [5].

Finally, we performed a taxonomic analysis to identify connections between the cultural domains identified in our domain analysis [5]. We used Amy Allen's (1998) conception of Power to understand how the intentional and unintentional actions of the faculty on Team Y impacted the undergraduate members' ability and capacity to engage in authentic research activities (e.g. participating in discussions, developing and pursuing their own research interests, presenting their work) [6]. We then organized our analysis into two interconnected taxonomies shown in Figure 2. Finally, we examined the connections between the two taxonomies to draw conclusions about how the faculty member's assertion or sharing of power-with the undergraduate students impacted the students' power-to engage in research activities.

Preliminary Results and Initial Findings

Below we present our domain analysis of the kinds of power that manifested on Team Y. We also present our taxonomic analysis of the actions taken by the members of Team Y, what kinds of power they used to take these actions, and how that power was transferred.

Manifestations of Power on Team Y

Through our domain analyses of both the actions taken by the students to engage in research activities and the actions of the faculty to engage with the students, we found that the members of Team Y used four kinds of power, shown in Figure 1.

Semantic Relationship: Strict Inclusion (A is a kind of B)

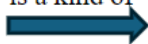
<u>Included Terms</u>	<u>Semantic Relationship</u>	<u>Cover Term</u>
Knowledge Resources Authority Legitimacy	is a kind of 	power being transferred between the undergraduate researchers and faculty members of Team Y
Structural Question: Which activities involve which kinds of power? What are attributes and examples of each kind of power?		

Figure 1: A strict inclusion domain analysis of the power yielded by the members of Team Y

We defined these four kinds of power as follows. Knowledge refers to the power that comes from the generation of new ideas or the use of other's knowledge or ideas (e.g. faculty members

suggesting the use of a particular method to the undergraduate researchers based on their knowledge of and prior use of the method). Resources are tangible sources of power (e.g. introducing the students to a researcher they know who could be interviewed for their study). Authority refers to power that comes from a person's status and/or position in the culture (e.g. a faculty advisor assigning their advisee a task to complete). Legitimacy refers to power that comes from being recognized for one's knowledge, experience, skills, or other relevant qualities (e.g. a well respected faculty member recognizing the quality of an undergraduate researcher's work).

Taxonomy of Actions Taken by Faculty Members and Undergraduate Students

We used our domain analyses to create two taxonomies (Figure 2). The left hand side taxonomy shows the actions taken by the faculty members and the kinds of power they have. The right hand side taxonomy shows the actions taken by the undergraduate students and the kinds of power they have. The lines connecting the two taxonomies represent how the actions of the faculty appeared to impact the actions taken by the undergraduate students. Below we describe the three key insights we gained from this taxonomic analysis.

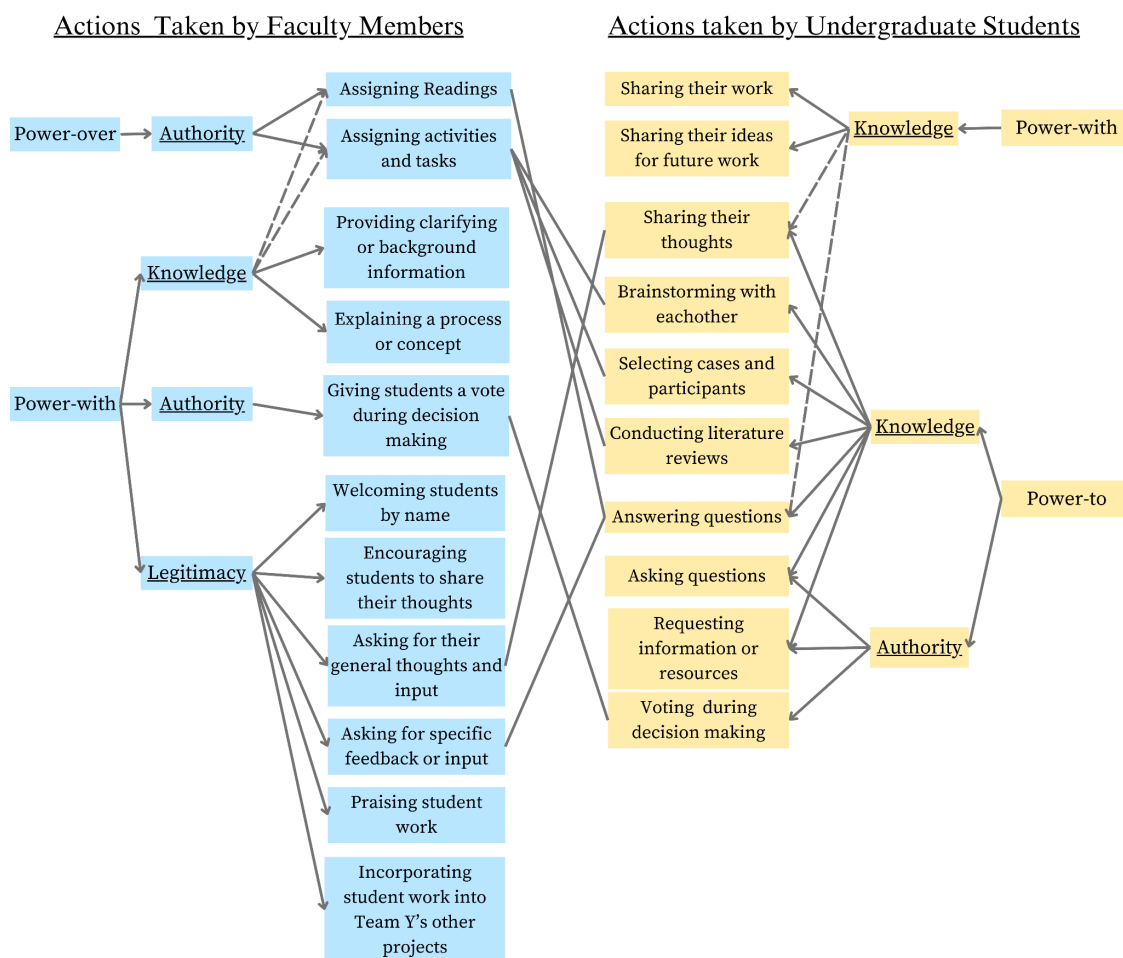


Figure 2: Taxonomic Analysis of Actions by Faculty and Undergraduate Students

Insight 1: The faculty members of Team Y assert power-over and share power-with the undergraduate members of Team Y in order to supplement their knowledge and build their research skills. As shown in Figure 2, the faculty members assert their power of authority over the undergraduate members in two ways: assigning readings and assigning research activities and tasks. It is clear they are not asserting this power-over the students purely to give them something to do or to have them accomplish some task they do not want to complete themselves. Rather, they are using these assignments to share knowledge of relevant subjects. Thus, this action serves to simultaneously assert power-over and share power-with the students. For example, Dr. Roberts discusses the following with Dr. Wilson,

"[I was] looking at the Journal of Diversity in Higher Education in the American Education Research Journal on the teaching [of] higher education. I don't know if [the students] have done any like paper critiques. That might be another really useful exercise for them... a good research development skill, particularly. If they [look in one of these journals] and did a critique of someone else's case study, that can help you move your thinking forward about how you want your case studies to look."

In this case, Dr. Roberts is drawing on his knowledge of studies in these journals and suggesting that this exercise will benefit the students as researchers and help them as they work on their case study project. This sharing of power seems to have a positive impact on the undergraduate students' power-to engage in research activities. This manifests in the work the students reference in their responses to questions posed by the team as well as the suggestions they make during the meeting. For example, Alex responds to a question posed by Dr. Roberts, by saying,

"Something that's really needed is like, kind of a sense of like teamwork and collaboration... One of the um... Professor Wilson and us, we were reading some like articles that people pulled last semester about like, initiatives [in engineering] education. And one of the things I was reading about was like, about indigenous professors in like Canada and part of their struggle for the faculty is that they um, the indigenous Professors often feel kind of like overburdened and that they're already working with like a lot of diversity initiatives."

Insight 2: The faculty members of Team Y share power-with the undergraduate students by legitimizing their contributions. The faculty members have power through legitimacy due to their status, knowledge, experience, and expertise in the field. The undergraduate students, comparatively, are novices. They are in the early stages of building their skills and therefore may not feel as qualified to contribute to conversations and research efforts. We observed that the faculty members work to bridge that gap in power by legitimizing their efforts through actions like praising the work they have done, recognizing and expressing how their perspectives have value, supplementing gaps in their knowledge, and frequently asking them for their input and ideas.

This legitimization of student work not only benefits the students, but also benefits the team. Dr. Wilson's comment best exemplifies this benefit when she says,

"some of the ideas [the undergraduate students] had [are] things that I never would have thought of as a faculty member, which is one of the big benefits of having them involved in the project to bring those different perspectives, different questions, you know, not just different answers to questions, but different questions."

Insight 3: The undergraduate members of Team Y share their power-with the team by contributing meaningfully to project efforts. The undergraduate student researchers have their own power beyond the knowledge, authority, and legitimacy the faculty members share with them. As Dr. Wilson and Dr. Peters note, they have fresh perspectives and may ask new questions that someone more familiar with a subject area may not have thought of. Additionally, despite only working on this project for a few weeks, the students seem to work with a high degree of autonomy and competence. In the following instance, Dr. Wilson, Dr. Roberts, and the students are discussing the students recent work in a team meeting. Dr. Wilson kicks off the conversation by describing the students' efforts leading their project as well as her role as their mentor.

*Last Thursday, we met briefly when I was in [out of town]. And they started **thinking on their own** about some things around DEI, at [their institution]. And then **they met together** on Tuesday morning, to **put their heads together**. And then I met with them Tuesday afternoon, to look at what they collectively were thinking about. So the idea was they were going to go back and **do some refining of that**. And then we're going to meet again this afternoon, so that they can hopefully spend the next week or so... **putting it together**.*

Riley, one of the undergraduate researchers, expands on this by describing the results of the undergraduate researchers' collaboration.

Riley: *I also just shared with you, the data sheet that we've been like compiling all of our, like [institution] specific case study information in... It's kind of a little clunky right now. But if you wanted to take a look at the preliminary data, we have like percentages of offered classes in academic year 2022 - 2023 that have [DEI related course outcomes]. We did that by department and division. And then you also have our drafts for interview questions.*

Dr. Roberts and Dr. Wilson respond by discussing the quality of their work.

Dr. Roberts: *I like a lot. I like what I'm seeing here. This looks good.*

Dr. Wilson: *Yeah, I think they they've been doing a really nice job with this. And the initial sort of proposal they had, they had some really creative ideas, a lot of which would be like if we were going to do this over the next year or a year plus.*

Based on this report by Riley, the students are engaging in authentic engineering education research activities: searching through institutional data, performing descriptive analyses, proposing project ideas, and developing interview protocols. It is clear that their faculty on Team Y are impressed by what they have put together, praising both its quality and creativity. They also note that their ideas are forward thinking and could be pursued by the team in the long term.

Conclusion, Limitations, and Future Work

In this work-in-progress paper, we sought to gain insight into the knowledge generating culture of an engineering education research team and how that culture impacts how undergraduate students engage in research. We identified three insights from our analysis: 1) The faculty members of Team Y assert power-over and share power-with the undergraduate members of Team Y to supplement their knowledge and develop their research skills, 2) The faculty members of Team Y share power-with the undergraduate students by legitimizing their contributions, 3) The undergraduate members of team Y share their power-with the team by contributing meaningfully to project efforts. Our preliminary results indicate that when students are supported by their advisors and given the space to engage authentically in research - they can contribute meaningfully to the team's efforts.

This work in study study was limited because our insights are based on five team meetings and, while we observed some interactions across the faculty and students, these meetings were not specific to the students' project. As such, we did not observe all the ways the students engaged on the project. Much of our knowledge of how the students shared power-with came from comments made by the faculty about how the students contributed. In future work, we hope to observe both the main Team Y meetings and the student project meetings. As we conduct more observations, we will look for more instances when the assertion of power-over and the sharing of knowledge with the students helps to bolster the students' ability to engage in research activities. We will also look to see how the student researchers share their unique insights and contribute to the team's research efforts. We plan to conduct ethnographic interviews of the students and their faculty advisors. These interviews will allow us to capture how the students and faculty made meaning out of the expressions of power within their team's culture. In particular, we want to understand how the faculty's efforts to legitimize the students' contributions impact how the students feel about themselves as researchers and how they can contribute to the group.

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