

Board 48: Dynamics of Researcher Identity and Epistemology: The Development of a Grounded-Theory Model

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Introduction

Studies on undergraduate research experiences (UREs) have shown that these programs lead to positive gains including increased retention in STEM majors [1], [2], clarification of career goals [3]–[5], establishment of collegial working relationships [3], [6], [7], increased understanding of how science research is done [8], increased ability to work and think independently from faculty [8], and increased problem-solving skills [9]. Because of these gains, URE has been identified as a high-impact educational practice [10], [11]. Unfortunately, many undergraduate students are not able to reap the benefits of authentic research experiences due to curricular limitations, exclusive criteria for participating in UREs, and conflicts with work schedules or family responsibilities. *This work seeks to understand how undergraduate students in UREs develop their researcher identities and build their engineering knowledge to propose effective practices that can be integrated into engineering courses and curricula.*

To meet this goal, we are conducting a multi-institution, three-phase, mixed methods grounded-theory study to answer our overall research question: How do undergraduate engineering students develop their identities as researcher and their ways of knowing engineering through research experiences? The primary outcome of the first two phases of this work is a grounded-theory model. The Dynamics of Researcher Identity and Epistemology Model (DRIEM) adds to our understanding of the outcomes of undergraduate research experiences and the relationships between identity and epistemology in this context. In Phase 3, DRIEM is being used to develop workshops that will support the integration of our work into engineering classrooms and inform the practices in undergraduate research experiences. This paper focuses on the final stages of Phase 2 – the development of a grounded-theory model.

Summary of Phase 1

In Phase 1 of this project, we collected survey responses (open and closed-ended items) from Biomedical Engineering and Mechanical Engineering students who self-identified as having undergraduate research experience. Data was collected across five institutions that represent a range of Carnegie ClassificationTM, settings, and profiles. A total of 154 participants submitted at least one answer to the open-ended survey and 113 participants completed all the open-ended items. The survey items sought to understand how students see themselves as researchers, their perceptions of research, and beliefs about knowledge in engineering. The results of the surveys were used to inform the interview questions that were developed to further explore students' experiences and perceptions in Phase 2. The data from the open-ended items were also analyzed qualitatively to understand how undergraduate students conceptualize research and what it means to be a researcher. Four themes emerged that capture students' beliefs and perceptions about research: 1) conceptualization of research as novel or new, 2) dissemination of research, 3) integrating research into society, and 4) self-regulation of research practices. Details of our Phase 1 analysis and connections to the development of Phase 2 are presented in our earlier publications [12]–[17].

Executive Summary

Research Methods

In Phase 2, we conducted 20 interviews with participants from six institutions, recruited from students who completed a survey in Phase 1. All interview transcripts were coded using the coding scheme that was initially developed from open-ended questions in the survey [12], [14], [18]. From the coded transcripts, we developed structured memos that included a participant description, summary of salient concepts from theoretical frameworks and/or themes, and connections to other participants (cross-case analysis). These structured memos served as the data set that was used to develop our conceptual model showing how researcher identity and epistemic thinking [19] (e.g. beliefs about knowledge, processes for generating knowledge, and justification of knowledge) emerge through participants' experiences in UREs.

The process of developing our grounded-theory conceptual model from our structured memos started with four coders independently reading a subset of memos to develop an initial list of potential themes. Each coder further refined their themes by testing their salience across participants. Once each coder finalized their own core set of themes, a single list of emerging themes was generated by coders combining and refining their individual lists. This process led to the generation of six final themes: independence, response to failure, nature/dimensions of research, personal gains from research, social aspects of research, and outcomes of research.

The coding, memos, and themes laid the groundwork for our research team to collaboratively develop and visualize our conceptual model based on the key components of a grounded theory. Each of us brought our knowledge of the data and our own expertise in the theoretical constructs that guided our work. The construction of the model occurred during a two-day in person meeting, in which the research team discussed and refined connections between themes to create an initial draft of the model. Once we constructed our conceptual model, we assessed its validity by testing it with individual cases from our data, allowing us to refine the model and the language used to label key components. This initial testing of our model occurred during our two-day meeting but continued beyond this meeting to include multi-layers of assessment. A key component of testing the model included the development of model-fit memos that were written for a set of the participants that were selected to include extreme and negative cases. For these memos, we analyzed the participants' experiences based on the model and compared this description with original memo for the participant to identify aspects that may not have been captured by the model. There were no significant modifications to our model based on this analysis.

Description of DRIEM

Students complete a variety of activities within the context of their research experiences. These activities include reading journal articles, running experiments, preparing materials for experiments, writing up the results of their work, presenting research findings, repeating experiments, developing plans for data collection and analysis, and analyzing data. Some of these activities are epistemic practices because they are directed towards gaining knowledge or increasing understanding. Through reflection, epistemic metacognitive skills (EMS), on their research activities and social interactions, students build and refine their knowledge of how research works. This knowledge of how research works affects students' existing and developing beliefs and perceptions about what a researcher does and about knowledge and knowing concepts in their fields, epistemic metacognitive knowledge (EMK).

Students come to form their identities as researchers by assessing the alignment between their ideas about what a researcher does and what they are doing during the research experience. Students can also come to understand themselves as researchers through feelings and emotions of excitement and frustration (epistemic metacognitive experiences [19]) while doing research. This researcher identity feeds back into their research activities, influencing their dispositions and approaches towards these activities. Students' researcher identities do not exist in isolation and are perceived with respect to and are affected by their multiple other identities, such as, their identity as a student, engineer, or future roles (parent, bread-winner, etc.). See Figure 1 for an initial graphic representation of this model.

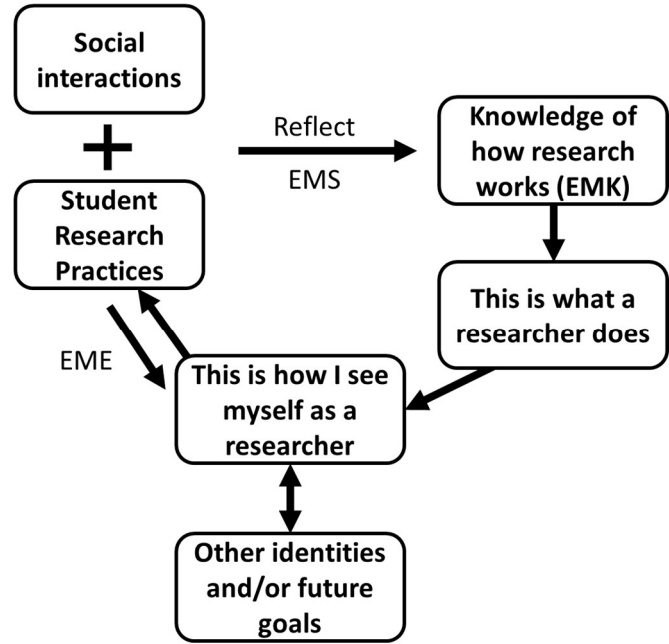


Figure 1: Graphic representation of Dynamics of Researcher Identity and Epistemology Model (DRIEM)

Description of a Student's Experience

While DRIEM was not developed based on one participant's experience, the connections in the model are evident in all our participants' experiences. As such, we have selected one of our participants experiences to highlight and explain DRIEM. We provide examples below, using students' self-selected pseudonyms.

Riley defines research as “the process of coming up with new ideas after reading many past publications in order to develop a new method and putting it to the test for a common goal.” In their research field, that common goal is “trying to help people.” To Riley, it is important to be situated within research and to be aware of the work that has already been done so they know they are building on that previous knowledge instead of repeating something that has already been documented. Riley's identity as a researcher is dependent on their perception of the need of the research. In some of Riley's research experiences, they felt like the research was not needed, which made them feel less like a researcher because their contributions to knowledge were not considered important or useful.

Riley's identity as a researcher is strengthened through their experience with failure because they see failure as an integral part of research. When discussing what has made Riley not feel like a researcher they state, “... I've experienced failure in research, but I think that's also made me felt like a researcher, because that's always what people say. Like it's never going to work out exactly how you want it. Um, so I think that that's made me feel like it.” Riley identifies that their view towards failure extends beyond research experiences to their general disposition, refusing to allow problems to get in the way of their end goals.

I feel like all of those times you can learn something from [failure] and to get better you are going to fail some. So I felt like a researcher, because I'm someone who really like – I get more determined by failure I would say. Like the first day, if my experiment's going to fail, I will move on. Yep, so I'm trying to figure out exactly what went wrong. And I'm like that just in general too. Like if someone says, "Oh, you can't do this." I'm definitely going to do it.

Riley's perceptions of what it means to be a researcher includes making a sacrifice to do research, working in a specific type of environment, being recognized by others outside of their lab, and earning a PhD. Riley identifies that there are sacrifices they will have to make to do research and their willingness to embrace these sacrifices indicates that their commitment to research is high, strengthening their researcher identity. When Riley talks about one of their summer research experiences, they mention that they were surrounded by researchers: "this summer I really felt like [a researcher], but I think it was especially the environment that I was in, being in the [national lab], literally everyone's a researcher." Being surrounded by others Riley deems a "researcher" positively reinforces Riley's identity. Two things that are important to Riley's researcher identity that they have yet to achieve fully is feeling recognized by researchers beyond the lab and earning a PhD. The PhD is very important to Riley and earning a PhD is imperative to becoming a full researcher. Their desire to complete a Ph.D. program and confidence to do so was strengthened by a 'bad research experience' that directly contributed to Riley's identity as a researcher and their views on research itself.

[The international internship] was not the best experience as far as my relationship with my mentor, and everything like that, but I still really enjoyed the process of trying to discover something that I knew that I could do a PhD, and felt like you almost have to have a bad lab experience to know, "yeah, I can still do it".

Conclusions

Based on our analysis, we have identified four key takeaways from our model that have implications for framing undergraduate research experiences and structuring classroom practices. These takeaways are:

- 1) Researcher identity affects and is affected by reflection on research actions
- 2) Researcher identity is fluid and can dissolve or solidify
- 3) Researcher identity and interest in research are influenced by social context
- 4) Students' researcher identity and perceptions of research are influenced by their initial dispositions and beliefs about researchers

Each of these takeaways are being detailed in future publications that will include a journal article presenting the details our of grounded theory model and a paper that explores the fluid nature of researcher identity.

Phase Three – Project Status and Future Work

These takeaways and DRIEM are also being used to guide the development of a series of workshops to help educators identify ways they can develop their undergraduate students' epistemic practices, i.e., their approaches used to evaluate, communicate, justify, and legitimize

knowledge, in their courses. Workshop participants will be guided through an overview of our model and four key takeaways and then asked to explore how DRIEM can translate into classroom practices through a combination of reflective and role-playing activities. Participants will help identify what classroom practices are supported by DRIEM and expand on them such that others can envision how to implement the classroom practices and what outcomes instructors might anticipate in terms of students' epistemic practices. Outcomes from the workshops planned for this year will add to our initial list of practices developed based on our research teams' experiences as undergraduate research mentors and engineering instructors [12]. We will vary the workshop venues and formats to reach a range of faculty types and disciplines. In addition, a second workshop will be conducted to help identify best practices in URE program design and mentoring. This workshop will be open to current URE administrators. We anticipate that their reflections on our model and findings will lead to additional 'best practices' for URE implementation that can be distributed for first time administrators.

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