Applying User Experience (UX) Methods to Understand Identity Development in Doctoral Engineering Students

Dr. Kelli Cargile Cook, Texas Tech University

Kelli Cargile Cook is a Professor and Founding Chair of the Professional Communication Department at Texas Tech University. Previously, she served as Professor and Director of Technical Communication and Rhetoric at Texas Tech and as Associate Professor at Utah State University. Her scholarship focuses on online education, program development and assessment, and user-experience design.

Fabiola Liliana Carrion-Anampa, Texas Tech University

Fabiola Carrion-Anampa is a Master's student in the Mass Communication program at the College of Media and Communication at Texas Tech University. She got her Bachelor's degree in Social Communication from Universidad Nacional Mayor de San Marcos (UNMSM). Her research interests are intercultural communication, diversity in the workplace, and the depiction of underrepresented communities in the media.

Diego Alejandro Polanco-Lahoz, Texas Tech University

Diego A. Polanco-Lahoz is a Ph.D. student, from the program of Systems and Engineering Management, in the Department of Industrial, Manufacturing & Systems Engineering at Texas Tech University. He received his BS in Industrial Engineering from the Pontificia Universidad Católica de Valparaíso (PUCV). His research interests are organizational factors research, organizational assessment/performance measurement, and engineering education.

Dr. Jennifer A. Cross, Texas Tech University

Jennifer Cross is an Associate Professor in the Department of Industrial, Manufacturing & Systems Engineering at Texas Tech University. She received her BS in Industrial Engineering from the University of Arkansas and her MS and PhD in Industrial and Systems Engineering from Virginia Tech, where she also served as a Postdoctoral Associate in the Enterprise Engineering Research Lab. Her research interests are organizational assessment/performance measurement, teams, performance improvement methodologies, and engineering education.

Dr. Mario G. Beruvides P.E., Nanyang Technological University

Dr. Mario G. Beruvides is the AT&T Professor of Industrial Engineering and Director of the Laboratory for Systems Solutions in the Industrial Engineering Department at Texas Tech University. He is a registered professional engineer in the state of Texas. He holds a BS in mechanical engineering and an MSIE from the University of Miami in Coral Gables, Florida and a PhD in Industrial and Systems Engineering from Virginia Polytechnic Institute and State University (Virginia Tech) in Blacksburg, Virginia.

Applying User Experience (UX) Methods to Understand Identity Development in Doctoral Engineering Students

This work-in-progress (WIP) research addresses gaps in the current understanding of engineering doctoral student identity development. Specifically, this NSF-funded research study explores the application of user experience (UX) methods to examine several issues involved in the process of developing engineering identity in doctoral students (primarily, researcher identity), including the differences that may be present in the process of identity formation of on-campus versus online doctoral students as well as other factors (e.g., gender, ethno-racial background, previous professional experience, etc.) that may contribute to researcher identity formation. It also provides insights generated from the initial implementation of a journey mapping methodology and this methodology's ability to inform doctoral program design and assessment.

This paper explores journey mapping as a UX method for researching and assessing doctoral engineering programs and offers preliminary findings from journey mapping data collection. As research participants, doctoral engineering students create journey maps to identify program experiences that range from highly positive to highly negative in their personal identity development as engineering researchers. Among the most frequent experiences identified as developmental were courses, projects and assignments, and individual research; less frequent but nevertheless key experiences were mentorship, scholarship, and external factors. Over the next two years, additional data will be collected to determine how students' perceptions of themselves as researchers change as these doctoral students progress through their program.

This research addresses three key gaps in the current literature on engineering identity development: 1) the limited existing longitudinal research on the topic of engineering identity development; 2) the limited existing research on engineering identity development in doctoral students, and 3) the limited existing research on the process of engineering identity development. The practical impacts of this study relate to understanding the way engineering doctoral programs are designed and how this design may be improved to support student mental health, reduce attrition rates, and bridge the gender and ethno-racial gaps in graduation rates, making doctoral education a more viable career path for engineers.

Identity development in engineering doctoral students

Research on identity development in engineering students has primarily focused on undergraduates, and only a handful have considered identity development in graduate students [1], [2], [3], [4]. Because engineering graduate students, and especially doctoral students, often matriculate with professional experience, researchers have assumed that graduate students enter doctoral programs with a ready-made professional identity as engineers. However, training in doctoral engineering programs requires graduate students to extend beyond this professional identity in order to develop identities as engineering researchers. This identity turn requires the development of a researcher identity [2], [5], [6]. Three studies, in particular, have devised frameworks for describing this transformation. The GRADs project proposed an identity-based motivation model by integrating the future time perspective and identity frameworks; this model joins the future time perspective framework and adds the influences in the past (how identities were developed) on goal-setting processes [7], [8]. In 2021, Bahnson et al identified three

identity references to understand identity development: engineer, scientist, and researcher [2]. A third framework, the Role Identities of Doctoral Engineering Students (RIDES), approaches identity development in terms of multiple systems, both personal (ethnoracial, gender, and other) and professional (student, engineer, researcher, educator) [9]. The RIDES framework, however, does not appear to have been empirically or longitudinally tested.

In terms of practical outcomes, previous literature has shown the importance of engineering identity as a significant concept [6], [9]. Godwin, et al, [6] state that "the risks of ignoring or glossing over identity construction at both programmatic and interpersonal levels are too high. Absent a clear theoretical framework, traditional mentoring relationships may limit the growth of the profession despite their intended generative functions". Similarly, McAlister, et al, [9] state that "in order to improve persistence in doctoral studies, it is necessary to understand identity development at the doctoral level". Also McAlister, et al, [9] show that "the attrition rate of doctoral students, in general, is close to 50%", which contrasts with the rigorous requirements for entrance. Finally, the same study states that "understanding engineering identity, specifically, is essential for expanding the common perception that engineering is elite, demanding, and lacking in emotion, a perception that causes students to leave engineering" [9].

Although the associated study addresses four specific research questions, the first research question—What is the process of developing engineering identity in doctoral students (primarily, researcher identity)?—is most salient to the findings presented here. The rest of this paper describes the journey mapping UX method that the study uses to answer this question. It also reports preliminary findings from the first round of journey mapping data collection.

UX methods and journey mapping

To address its research questions, this research employed user experience (UX) methods to document and understand the experience of identity development in doctoral engineering students. A methodology that encompasses many methods, UX is a theory and a practice that emphasizes the need for functional products that integrate the users' needs and experiences. Similarly, UX, as defined by the International Organization for Standardization [12], is a means of discovering "users' emotions, beliefs, preferences, perceptions, comfort, behaviors, and accomplishments that occur before, during and after use" (sec. 3.2.3). UX, with its multiplicity of methods, allows researchers to look beyond tangible and concrete measures of the "what," "when," and "how" of use. In doing so, UX methods provide answers to more subtle but complex questions, such as "why," "wherefore," and "what if."

Initially developed in industry settings, UX methods were first applied in manufacturing, industrial engineering, and automotive design practices [13]. Industry designers developed these practices to engage consumers or users in testing a product's usability. Usability, which developed first but now is considered as one among many UX methods, "was used to ensure that end-users (or those who would use the designed product) could actually use the product to complete the intended task….The problem with this model is that users were only part of the design process once the design was complete, and their usability data only applied when tweaking final designs before being sent to the workplace, the marketplace, or classroom" [14, pp. 5-6].

As noted above, usability was typically deployed at the end of a waterfall design process. As a design method, usability captured usefulness, but it could not account for the complexity of user experience with a product. In other words, as Potts and Salvo [15] write, a new method of engaging with "products" was needed, one that would "focus less on single activities that envelop us in technology, and more on creating experiences that are augmented by technology. Meaningful, rich, humane and valuable technologically mediated experiences," as they argue, require different methods and measures to identify, create, and understand (p. 4). UX studies, therefore, evolved to engage with, discover, and explain users' more holistic experiences. This research builds on Potts and Salvo's premise [15] as applied to academic program design: doctoral students in engineering experience identity changes and growth based on programmatic decisions and opportunities; UX methods provide a means to trace those changes and growth.

Until recently, UX methods have rarely been applied in academic research, including programmatic assessment and curriculum design. However, recent literature suggests that academics are observers of user experience, but not necessarily practitioners. In other words, academics study user experience, but they do not actively practice user experience as a process for developing new frameworks, such as program design, curriculum, and technologies [16], [17]. Typically, programmatic decisions are made within academic committees composed of faculty with expertise in the subject matter; students—the actual users engaged with the program—are not included. Rarely do teachers, program directors, and other administrators engage students as other than functional by-products of curricula. Rather, in typical waterfall practice, students' functionality is measured at the end of the instructional unit in terms of what they can and cannot do. In the past five years, however, more scholars are applying these methods to academic practice. For example, in 2022, Crane and Cargile Cook [18] published a collection entitled *User Experience as Innovative Academic Practice*. Included in the collection's thirteen chapters are examples of faculty and their students, both undergraduate and graduate, employing a wide variety of UX methods including surveys, affinity clustering, rapid iteration, operative imaging, user profiles and personas, and journey mapping, to name a few. With these methods, faculty have engaged students as co-creators of curricula ranging from single activities to entire programs.

From the many methods used in UX research, this research has initially relied on journey mapping, surveys, and focus groups; however, only the results related to journey maps are the focus of this paper. Journey maps are a "visual depiction of what users need and what steps they take to fulfill those needs as they interact with a product" [19, p. 95] from the first interaction to the last. Journey maps generated in this study focus on how participants initiate their journey at matriculation into a doctoral program and conclude when they leave the program or graduate. Through journey mapping, the researchers engaged participants longitudinally and ask them over time to explore their identity development, tracing the engineering identity development process as well as how student interactions with programmatic components—e.g., advisors, faculty, curriculum, extracurricular activities—support or deter them from forming identities as researchers.

Collecting and analyzing researcher identity data with journey maps

The researchers have thus far used journey maps twice to collect data on doctoral engineering students' research identity development. Data collection was first piloted in June 2021; the data

from the pilot study was used only for codebook development. The second use was one year later in June 2022. Preliminary analysis of the 2022 data is provided following this discussion of journey mapping data collection.

June 2021: Piloting journey mapping data collection

Prior to receiving NSF funding, the researchers piloted the journey mapping methodology with a small group (n=8) of doctoral students attending a summer seminar in June 2021 at a Research-Intensive state university in the Southwest United States (#IRB2019-58). Doctoral students in two graduate engineering programs housed within the same department were invited to participate. (The course in which the research was conducted is required for one of the degrees while students in the second doctoral program may take the course as an elective.) After students were informed of the research goals and methods, they were asked for consent to participate. After they consented, one researcher, who is not a member of the students' program or the department in which they are housed, provided students with an overview of journey mapping methods and modeled the journey mapping process using a persona the researchers developed. Participants were then asked to map their researcher identity development by semester. The maps were designed to be completed in table form with columns for the semester, activity, emotional response (ranging from very negative to very positive), and explanation of how this activity promoted or hindered researcher identity development. (Figure 1 is a screenshot of a journey map students created during the persona training session.)

Mapping your Researcher Identity

Write name here

This table will help researchers create a journey map of the activities that developed your identity as a researcher. This exercise asks you to review the ACTIVITIES that you think have developed your identity as a researcher in your field. For each semester, you'll list the activities. Then you'll use a short phrase to describe whether the activity was a positive or negative experience. Finally, in words, you'll explain what made this activity memorable (either positively or negatively) and discuss how it shaped your research identity. You may use as many rows as necessary for each semester.

SEMESTER	ACTIVITIES	EMOTIONAL RESPONSE	HOW THIS ACTIVITY BUILT RESEARCHER IDENTITY
Semester 3	Core course-C6	SOMEWHAT NEGATIVE	Software for the course stopped working mid-course. Being a distance student I felt like I was caught in a track where I couldn't win.
	Core course-C7	SOMEWHAT POSITIVE	Applicable content, first professor that actually taught to a book and had clear expectations, prof. would respond promptly
	class project-PA2	VERY NEGATIVE	The team project was awful. Two people did virtually nothing and all the work they had to do had to be corrected.

Figure 1: Sample journey map for a participant's third semester in a doctoral program.

Following this assignment, participants completed their individual maps overnight and met with the researcher again the next day to debrief, ask questions, and finalize their maps. When participants were satisfied with their maps, they emailed them to the researcher. The journey mapping data was then de-identified before analysis, and all participant responses were aggregated into semester-by-semester lists of activities. In other words, all of the first semester events were aggregated, all of the second, and so forth.

When the summer seminar concluded, and grades were posted, all three researchers met to begin the initial coding of the pilot study's maps. Each activity was given an preliminary code. After several rounds of coding, the project's initial codebook include the following codes:

- **Overall Program (OP):** comments with this code reference program recruitment, enrollment, matriculation, or other overall curricular design
- **Projects & Assignments (PA):** comments with this code reference projects and assignments students completed in a course and may include class activities, readings, tests, papers, etc.
- **Scholarship (S):** comments with this code reference publications or presentations students have published or submitted for publication.
- **Research Experience (R):** comments with this code reference research experiences in classes or with faculty (but not specific to publications or presentations)
- **Courses (CO):** comments with this code reference specific courses taken, not assignments or projects within a course
- **Advising (A):** comments with this code reference advisors (staff or faculty) who impacted student research identity
  Mentoring (M): comments with this code reference individuals who mentor students and may include faculty, advisors, other students, workplace colleagues, family, etc.

These codes were then used for the initial analysis of the first round of NSF-funded research that followed in June 2022.

Collecting NSF-funded first-round journey mapping data in June 2022

For the first round of funded research (#IRB2021-856) in June 2022, another set of doctoral students was invited orally to participate in the study by one of the research team members during a doctoral summer course. They were asked to consent to participate, and ten participants agreed (n=10). In this round, participants were assigned a participant ID number to protect their anonymity and expedite de-identification.

As with the pilot study, participants received instructions on how to complete the journey maps and were assigned to complete their journey maps before the second meeting. The journey maps required approximately one to two hours to complete per participant. In the second meeting, participants were allowed to ask questions related to their journey maps and had additional time to complete them. When participants were satisfied that their maps were completed, they emailed them to the researcher leading the session.

After all the journey maps were collected, the data was collated in a single Excel spreadsheet and divided into different sheets according to semesters (semester 1, semester 2, semester 3, etc.). The worksheet was divided into columns as follows:

- Participant number,
- Activity as student described it,
- Activity code from the pilot codebook,
- Response code (very positive, positive, negative, very negative and neutral), and comment as the student described it

Participant data (activity description and response code) were transferred into the spreadsheet. Seven different response codes from students' maps were transferred to the spreadsheet: very negative (VN), negative (NG), somewhat negative (SN), neutral (N), somewhat positive (SP), positive (P), and very positive (VP). In some cases, activity descriptions were applied to more than one code. For example, an activity description might list a specific assignment that promoted a student's research identity development; however, within that description, the student might also mention the positive influence of a workplace mentor who helped the student complete the assignment successfully. In this case, the activity was code as PA (project and assignments) and M (mentorship). In these cases, coders worked independently to parse the descriptions so that more than one code could be accurately applied per activity. After parsing descriptions, two coders worked independently to read through all the aggregated semester journey map activities and assign activity codes.

At the conclusion of this first round of analysis, two additional codes were added to the seven from the pilot study analysis:

- EF (external factors): comments with this code reference outside factors that helped or hindered identity development; most activities coded EF related to the Covid-19 pandemic and its impacts on students
- UN (unclear): comments with this code reference typically were incomplete or so abbreviated that they could not be assigned a more specific code.

After coders individually coded the journey maps, they compared their coding results and reached a consensus on any differently coded activities. If consensus was unreachable, a third coder reviewed the activities and helped the team to reach a consensus. For activities coded UN, all three coders determined that these items could not be successfully coded; approximately ten (10) items were then removed from the findings. With UN codes deleted, all activities were coded into the eight (8) remaining coding categories.

Preliminary findings from the first round of coding and analysis

At the conclusion of coding rounds, a total of 205 activities were categorized from the ten (10) participants. In order to understand where participants were located on their doctoral program journeys, we first counted the number of responses per semester. Semesters were coded according to how participants identified them; therefore, some students' Semester 1 might have been Fall 2020 while others' might have been Spring 2019. Because students were not from a single cohort, the labels they used to designate semesters relied on their retrospective recall of

events during that time, not on a group or cohort calendar or common experience. Table 1 provides the number of activities we received per semester.

Semester	Activities Mapped	Total %
1	44	21%
2	41	20%
3	38	19%
4	35	17%
5	17	8%
6	14	7%
7	9	4%
8	2	1%
9	3	1%
10	2	1%
Total	205	100%

Table 1: Activities per semester, as identified by participants.

Over three-quarters (77%) of all comments we received addressed research identity development in semesters 1-4 of the participants' doctoral program. For students in these programs, four semesters typically account for three long semester terms (e.g., Fall of Year 1, Spring of Year 1, and Fall of Year 2) and one summer term (Year 1). Fewer than 3% of all responses were mapped into the final three terms we analyzed. Because researchers do not know, at this time, exactly where all ten participants were situated in their doctoral programs, the reason for more activities in semesters 1-4 is still unknown; however, we speculate that all ten participants had, at least, three semesters completed while fewer had fully completed their second year or longer as doctoral students. The semesterly data also allowed us to map whether students perceived their mapped experiences as positive or negative. (See Table 2.)

Semesters	VN	NG	SN	N	SP	P	VP	Totals
1		1	4	1	13	3	22	44
2	3	1	8	3	11	5	10	41
3	4	1	3		13		17	38
4	6	7		1	2	5	14	35
5			4		2	7	4	17
6		4				6	4	14
7	1			1		6	1	9
8				1		1		2
9		3						3
10		1				1		2
Totals	14	18	19	7	41	34	72	205
Total %	7%	9%	9%	3%	20%	17%	35%	100%

Table 2: Response rate frequencies by semester, as identified by participants.

Viewing semesterly activities in this way, participants mapped their activities positively in almost all semesters. Only 25% of all comments were identified as very negative to somewhat negative; 3%, neutral; and 72%, somewhat to very positive.

Figure 3 provides a different snapshot of students' emotional responses by semester. Gradients within each column range from the darkest ("Very Negative") at the bottom to the lightest ("Very Positive") at the top. This figure clearly illustrates the higher frequency of comments in Semesters 1-4 as well as the majority of the emotional responses falling into the positive range across all semesters.

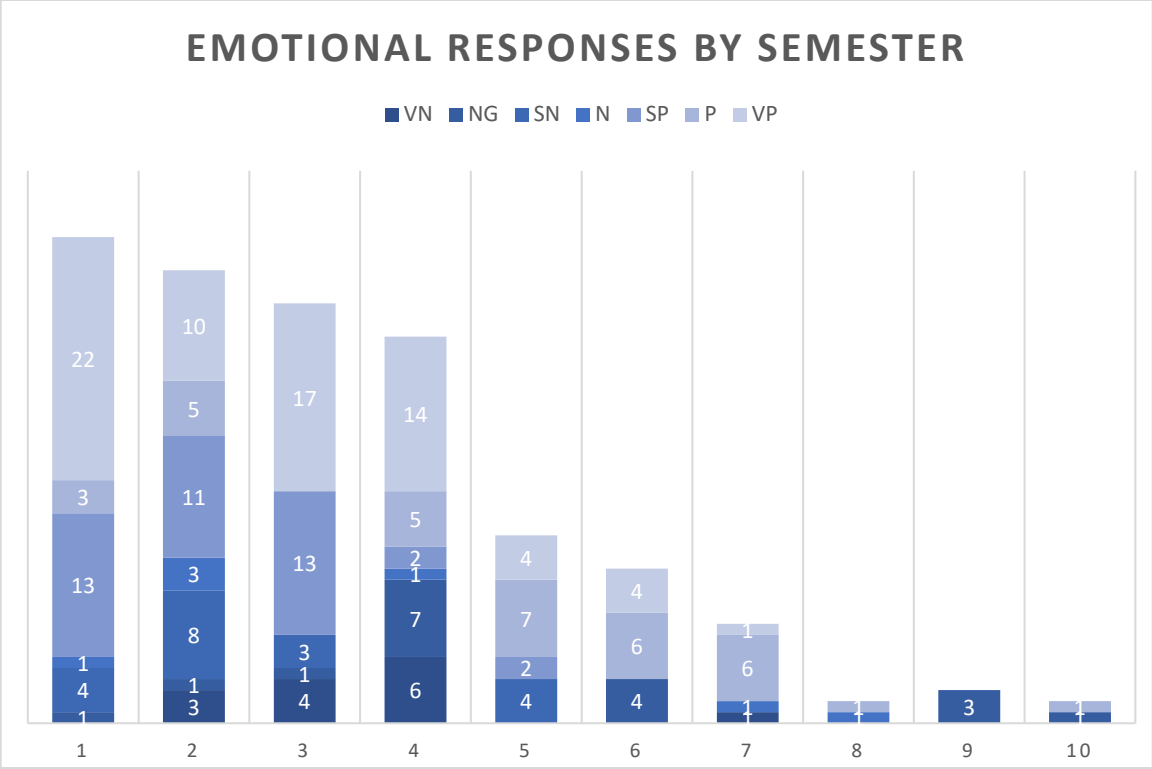

Figure 3: Emotional response rates distribution by semester.

After analyzing comments by semester, the next set of findings considers activity codes that participants mapped as promoting (positive) or hindering (negative) their research identity development. Among all codes, Courses (CO) was the most frequently mentioned by the participants. Following Courses (CO) in frequency were Projects and Assignments (PA) and Research (R). Less frequently mentioned were External Factors (EF), Scholarship (S), and Mentoring (M). The reason for the preponderance of responses in these codes is unknown at this time, but the researchers expect the reason may result from most participants being relatively early in their graduate coursework. Figure 4 provides an overview of the frequency distribution across activity codes.

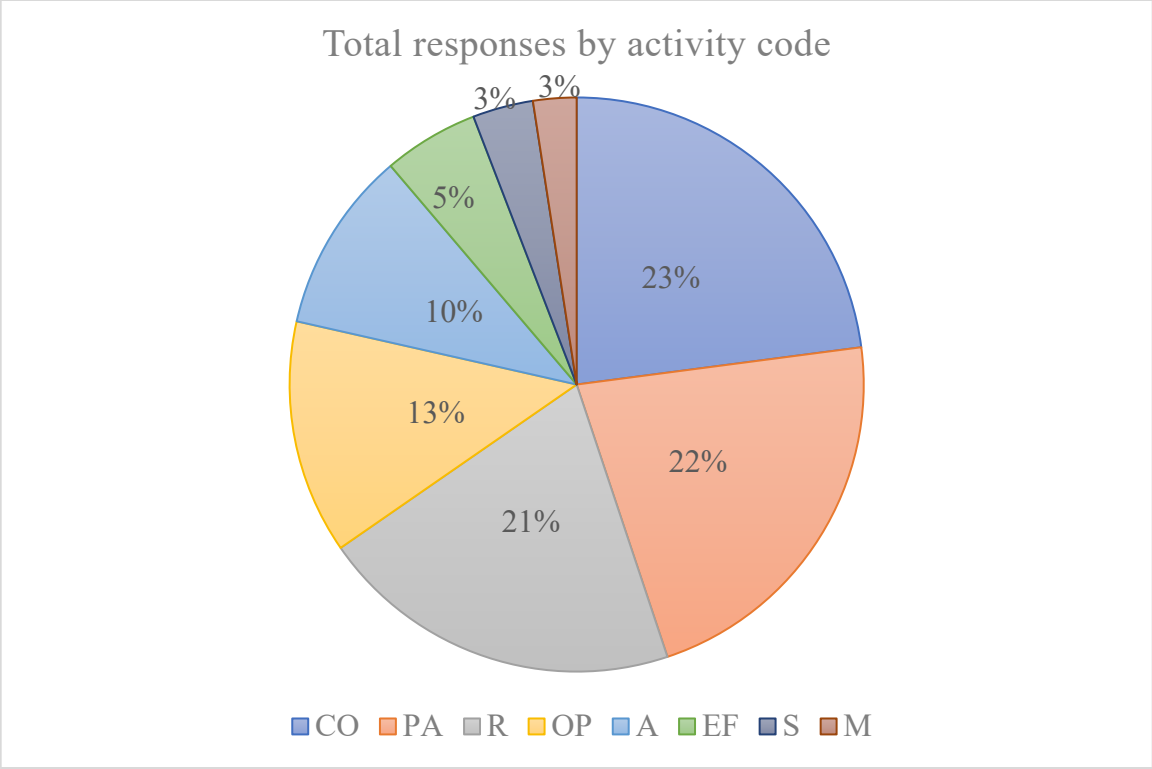

Figure 4. Frequency of Activity Codes (n=205).

As Figure 4 illustrates, Course (CO) content, course Projects and Assignments (PA), and Research (R) were the most frequently mentioned activity codes that affect researcher identity development with these participants. Less frequent activities related to identity development are Mentoring (M) and Scholarship (S).

For a more nuanced view of the activity codes and participants' response codes to each one, Table 3 details how activities were distributed across the eight response codes:

Activity Codes		Response Codes						Grand Total	Total %
	VN	NG	SN	N	SP	P	VP		
CO	1	3	1	2	13	16	11	47	23%
PA	3	1	6	1	10	1	23	45	22%
R	2	2	5		7	6	20	42	21%
OP	3	5	3	1	3	4	8	27	13%
A	2	5	3	1	5	2	3	21	10%
EF	3	2	1	1		2	2	11	5%
S				1	1	1	4	7	3%
M					2	2	1	5	3%
Grand Total	14	18	19	7	41	34	72	205	100%
% of Total	7%	9%	9%	3%	20%	17%	35%		

Table 3. Summary of total comments by Activity Code and Type of Response.

Positive response codes were present in all activity code categories. In total, 72% of all activities mapped were positive. Forty or 20% of all positive comments were coded as CO, 17% as PA, 16% as R, and 7% as OP. The majority of negative response comments were among Overall Program (OP) with 11 (5%), PA and Advisor (A) with 10 (5% each), and R with 9 (4%). Thirty-four percent (34%) of all negative comments resided in these categories. Figure 5 overviews how participants rated their emotional responses to mapped activities.

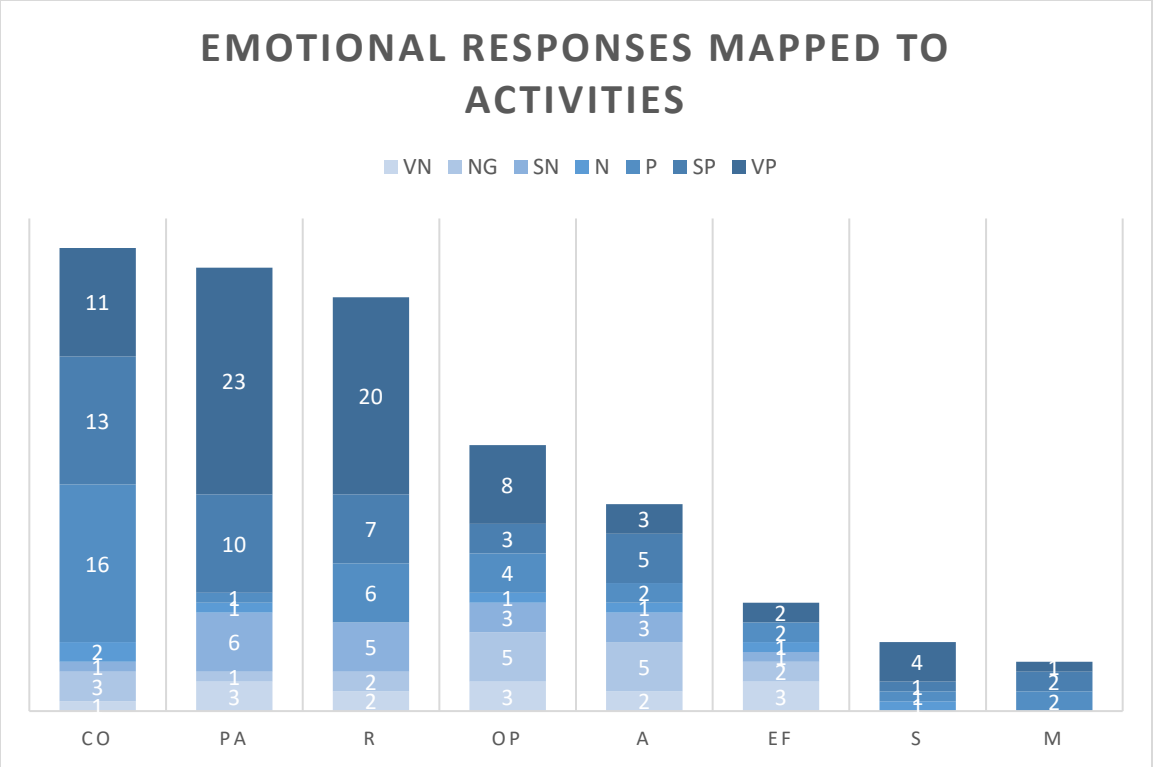

Figure 5: Emotional Responses Mapped to Activity Codes.

Doctoral student activities and their impacts on researcher identity development

Considering the number of activities mapped and participants' emotional response to them, courses, projects and assignments, and research clearly impact these participants' researcher identity most positively in their first semesters of study. Within these early semesters, course content, course assignments or projects, and research work are mainly the focus. Courses provide students with an introduction to disciplinary knowledge; projects and assignments allow them to explore or apply this knowledge; and research within these courses and with faculty mentors initiates participants' awareness of how new knowledge is made. These activities build research identity, considering how courses challenge doctoral students to research and practice the process of writing papers, essays, or other projects. Since the majority of the participants appear to be in their first semesters, the importance of these activities supports conventional wisdom and practice in doctoral programming.

Negative comments, however, reveal potential pain points that programmatic administrators may not recognize or know, particularly regarding overall program requirements, projects and assignments, advisory functions, and research opportunities. For example, overall program requirements for doctoral students can create obstacles for students who are studying on a fellowship or enrolled in a distance program; many times these challenges stymie students' progress, affect their motivation, and, thus, hinder their research identity. Another pain point participants identified was the relationship between advising and research in the initial stages of doctoral study: doctoral students need to connect with faculty members and their research, make decisions about advisors, and start thinking about their own research and future scholarship as

quickly as possible. The process where a student and a professor establish a mutual agreement to work together is not easy or fast. When delays occur or advisors are not available or accessible, making a connection between advising and research is difficult and can affect research identity by lowering the motivation of the student to be involved in this work together. Finally, projects and assignments can diminish research identity by requiring time that could otherwise be oriented toward research.

Preliminary conclusions

Researcher identity development in engineering doctoral students can be affected by multiple sources. In the present study, preliminary results have shown that in early semesters of programs, three main activities may be involved most directly with research identity formation: courses taken, projects and assignments completed, and research activities. Since these three relate to students in early stages of their programs, several options are possible for improving researcher identity development when students are in their first year: (1) course content should promote connections between students and advisors, and (2) projects and assignments should encourage students to conduct preliminary research. Faculty should design assignments (e.g., homework, projects, and research) that motivate and encourage students to engage in research activities. For example, activities that promote research activity include having doctoral students review research papers prior to writing their own, assigning systemic literature review papers, requiring students to turn successful research papers into a conference proposals, and asking students to look for funding programs that would support their early research proposals. Additionally, meetings with faculty professors, research fairs, and engagement activities can be helpful.

Overall program requirements that may appear as pain points can lessen research identity in students; as presented in the results, this was the activity code with the most negative responses. When program requirements extend beyond coursework and engagement with faculty and faculty research, research identity development can be hindered by preoccupying the student with routine matters. Other activities that impacted researcher identity development negatively were related to advisory work and to research activities. Research identity can be diminished if the connection between students and their faculty advisor is absent or not strengthened constantly through collaborative work. Doctoral programs can support research identity by providing guidance to students as they seek and acquire a faculty advisor. Conferences, personal meetings, and other connective activities can guide students and support them in determining what they want to research. The final goal should be to enhance their research identity, rather than diminish it. Finally, although many participants positively mapped projects and assignments, some negatives in this category were highlighted as well. Doctoral students usually are involved in individual work, supervised and guided by their advisor; however, projects and assignments from courses may challenge participants, especially those in online programs, to work as a team. When collaborative teamwork is required, the final product may not satisfy all team members. Dissatisfaction with online teaming is another pain point and potential challenge to research identity development. To mollify this negative impact, faculty should provide instruction in remote teaming and support teaming efforts; in addition, discussing the frequency of remote collaborations in research teams can provide a context for requiring students to engage in team projects in doctoral courses.

The findings and discussion provided in this paper reinforce conventional wisdom about doctoral researcher identity development in early semesters of a program and support conclusions from other research projects; for example, Choe and Borrego in 2019 concluded that identification with engineering for engineering graduate students is positively and significantly predicted by engineering interest, competence, recognition [1]. While the results reported here are based on preliminary analysis, a more detailed analysis of findings will show the impact of these eight categories over time and trace the continuing development of participants engaged in the study. Journey maps have proven useful in providing insights into key activities students engage in across a program, giving a 360° snapshot of doctoral students' experiences and contrasting those activities that hinder identity growth with those that promote it.

Additional data collection will also allow researchers to increase sample size, although Neilson and Landauer suggest that there is no definitive sample size for user experience data collection [20]. Their research has found that as few as five participants can identify up to 85% of issues, but they recommend starting with a small sample, analyzing data as it is collected, and adding more participants and data until saturation is reached. In the near future, plans for this work-in-progress study include the addition of another seven to ten participants. Additionally, results from other data collection methods, such as surveys [21], focus groups, and interviews, will be synthesized and reported. As with most UX research, the sample size limits the data generalizability; therefore, the researchers plan to ultimately extend their research to other engineering doctoral programs to determine if user responses are replicable across programs.

Acknowledgment and disclaimer

This material is based upon work supported by the National Science Foundation under Award No. 2205033. Any opinions, findings and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

[1] N. Choe and M. Borrego. "Prediction of engineering identity in engineering graduate students," *IEEE Transactions on Education*, vol. 62, no. 3, pp. 181-187, 2019. Available: https://ieeexplore.ieee.org/abstract/document/8667045.

[2] M. Bahnson, H. Perkins, M. Tsugawa, D. Satterfield, M. Parker, C. Cass, and A. Kirn. "Inequity in graduate engineering identity: Disciplinary differences and opportunity structures," *Journal of Engineering Education*, vol. 110, no. 4, pp. 949-976, 2021. Available: https://onlinelibrary.wiley.com/doi/abs/10.1002/jee.20427.

[3] J. Morelock. "A systematic literature review of engineering identity: definitions, factors, and interventions affecting development, and means of measurement," *European Journal of Engineering Education*, vol. 42, no. 6, pp. 1240-1262, 2017. Available: https://www.tandfonline.com/doi/full/10.1080/03043797.2017.1287664.

[4] A. Elizondo-Noriega, N. Tiruvengadam, K. Cargile-Cook, J. Cross, and M. Beruvides. "Understanding Engineering Identity Formation Mechanisms in Graduate and Undergraduate Education: A State-of-the-Art Matrix Analysis," in *Proceedings of the 2020 IIE Annual Conference,* 2020. Available: https://www.proquest.com/docview/2522431819.

[5] M. Caskey, D. Stevens, and M. Yeo. "Examining doctoral student development of a researcher identity: Using the draw a researcher test," *Impacting Education: Journal on Transforming Professional Practice*, vol. 5, no. 1, 2020. Available: http://impactinged.pitt.edu/ojs/ImpactingEd/article/view/92.

[6] L. Hall and L. Burns. "Identity development and mentoring in doctoral education," *Harvard Educational Review*, vol. 79, no. 1, pp. 49-70, 2009. Available: https://meridian.allenpress.com/her/article-abstract/79/1/49/31955/Identity-Development-and-Mentoring-in-Doctoral.

[7] C. Cass, A. Kirn, M. A. Tsugawa-Nieves, H. L. Perkins, M. Bahnson, R. Mills, and A. B. Parker. "Board 18: Engineering Doctoral Students' Motivations and Identities: Understandings and Implications," presented at the *2018 ASEE Annual Conference & Exposition*. Available: https://peer.asee.org/29975.

[8] M. Bahnson, H. Perkins, D. Satterfield, M. Parker, M. Tsugawa, A. Kirn, and C. Cass. "Variance in Engineering Identity in Master's Degree-Seeking Engineering Students," in *Proceedings of the 2019 IEEE Frontiers in Education Conference (FIE)*, October 2019, pp.1-7. Available: https://ieeexplore.ieee.org/abstract/document/9028414.

[9] A. McAlister., S. Lilly., and J. Chiu. "A Framework for Examining Engineering Doctoral Student Identity," in *Proceedings of the 2021 ASEE Virtual Annual Conference,* July 2021. Available: https://peer.asee.org/36580.

[10] A. Godwin., G. Potvin., Z. Hazari., and R. Lock. "Understanding Engineering Identity Through Structural Equation Modeling," in *Proceedings of the 2013 IEEE Frontiers in Education Conference (FIE)*, October 2013, pp. 50-56. Available: https://ieeexplore.ieee.org/abstract/document/6684787.

[11] N. W. Brickhouse, P. Lowery, and K. Schultz, "What kind of a girl does science? The construction of school science identities," *Journal of Research in Science Teaching*, vol. 37, no. 5, pp. 441–458, May 2000.

[12] *Ergonomics of human-system interaction,* ISO 9241-11:2018, International Organization for Standardization, 2018. Available: https://www.iso.org/standard/63500.html.
[13] B. Nunnally and D. Farkas. *UX Research: Practical Rechniques for Designing Better Products*. Boston, MA: O'Reilly Media, Inc., 2016.
[14] K. Crane. "Out of industry, into the classroom: UX as proactive academic practice," in K. Crane and K. Cargile Cook, Eds. *User Experience as Innovative Academic Practice*. Louisville, CO: University Press of Colorado, 2022.
[15] L. Potts and M. Salvo., Eds. *Rhetoric and Experience Architecture*. Anderson, SC: Parlor Press LLC, 2017.
[16] C. Lallemand, G. Gronier, and V. Koening. "User experience: A concept without consensus? Exploring practitioners' perspective through an international survey," *Computers in Humans Behavior*, vol 43, pp. 35-48.
[17] G. Getto and F. Beecher. "Toward a model of UX education: Training UX designers within the academy," *IEEE Transactions on Professional Communication*, vol 59, no. 2, pp. 153-164.
[18] K. Crane and K. Cargile Cook, Eds. *User Experience as Innovative Academic Practice*. Louisville, CO: University Press of Colorado, 2022. https://doi.org/10.37514/TPC-B.2022.1367.
[19] B. Still and K. Crane. *Fundamentals of user-centered design: A practical approach*. CRC Press, 2017.
[20] J. Nielsen and T.K Landauer. "A mathematical model of the finding of usability problems," in *Proceedings of the ACM INTERCHI'93 Conference*, April 1993. Available: https://dl.acm.org/doi/10.1145/169059.169166.
[21] D. Polanco-Lahoz, F. Carion-Anampa, J. Cross, K. Cargile Cook, and M. Beruvides. "Self-perceptions Regarding Researcher Identity Development in Engineering Doctoral Students: Preliminary Results," in *Proceedings of the 2023 IIE Annual Conference,* 2023.