

MAPPING CHANGE IN PROFESSIONAL IDENTITY GROWTH IN DOCTORAL ENGINEERING STUDENTS

Dr. Kelli Cargile-Cook
Texas Tech University
kelli.cargile-cook@ttu.edu

Dr. Jennifer Cross
Texas Tech University
jennifer.cross@ttu.edu

Dr. Mario Beruvides
Texas Tech University
mario.beruvides@ttu.edu

Diego Polanco-Lahoz
Texas Tech University
diego.polanco-lahoz@ttu.edu

Fabiola Carrion-Anampa
Texas Tech University
fcarrin@ttu.edu

Abstract - While identity development in engineering students has attracted scholarly attention for over two decades, very little is known about the process of professional identity development in engineering doctoral students. This brief paper describes a research study that employs user-experience (UX) methods to identify critical change indicators in professional identity development. It focuses on journey mapping to track change processes in identity development and reports how the researchers' use of journey mapping as a research method changed, oscillating between the collection of visual qualitative data to coded quantitative data and back again. It also discusses how this oscillation has required the research team to adopt various technologies to assist with the analysis and visualization of findings.

Index Terms – Journey maps, user experience, graduate education, researcher identity development.

INTRODUCTION

While identity development in engineering students has attracted scholarly attention for over two decades [1], very little is known about the *process* of professional identity development in engineering doctoral students [1]–[3]. To address this gap, the NSF-funded research project—**Mapping Identity Development in Doctoral Engineering Students**—employs user-experience (UX) methods, including user profiles and journey mapping, to identify critical change indicators in professional identity development.

This brief paper focuses on journey mapping to track change processes in identity development. It reports how our use of journey mapping as a research method has changed, oscillating between being collected as textual qualitative data, transformed to visual qualitative data, and then coded as quantitative data, and back again. It also discusses how this oscillation has required the research

team to adopt various technologies to assist with the analysis and visualization of findings.

JOURNEY MAPPING AS UX METHOD

Among the UX methods employed in this research, journey mapping was chosen initially to capture doctoral engineering students' perceptions of their personal identity development process and the interaction between this process and doctoral program design, using participants from a large state university in the United States. 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” from the first interaction to the last [4]. For this research study, we chose to designate the maps we co-created with doctoral students in engineering as journey maps; however, as Robert Curedale notes in *Experience Maps*, “A journey map focuses on identifying touch points. An experience map focuses on the emotions your customer experiences. In practice many people use these terms interchangeably. The particular lanes can be mixed and matched to your goals” [5]. Although our overall research study is guided by four research questions, our use of journey maps was directed primarily at one: *What is the process of developing engineering identity (primarily, researcher identity) in doctoral students?* The map template we designed was intended to collect touch points, pain points, and other experiences longitudinally as doctoral students progressed through their programs.

To collect data for the journey maps, we designed our study to co-create journey maps with participating doctoral students: “In a co-creative journey mapping workshop, [designers or, in our case, researchers] invite participants who have solid knowledge about the experience [being mapped]....”[6]. A participatory design practice, co-creating or co-designing is “about co-production rather than one designer making decisions in isolation and asking for user feedback at specific points in the process” [7]. In

this study, the researchers wanted to engage students through rounds of semesterly feedback; in theory, these data collection rounds would provide information and emotional responses about ongoing experiences within the participants' program. To prepare students to create their own journey maps, researchers provided a brief introduction to journey mapping as a research method, explained how personas are often used to guide journey mapping, and engaged students in creating a journey map based on the persona. Figure 1 shows a portion of the persona used for training:



FIGURE 1. SAMPLE PERSONA USED FOR JOURNEY MAPPING TRAINING

For the training exercise and later with their own journey maps, participants used a series of PowerPoint slides to describe the experiences that they perceived as either promoting or hindering their development as a researcher. Participants used a different slide for each semester. Figure 2 provides an example of the semesterly journey map template participants used.

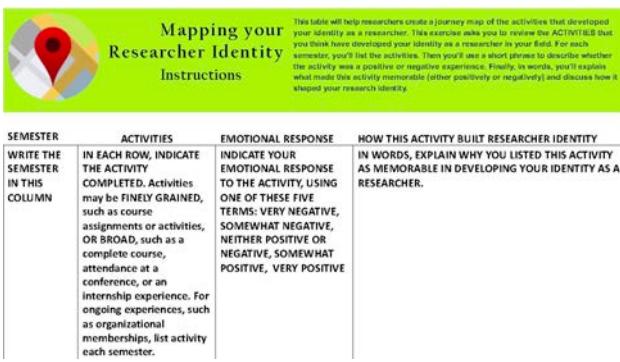


FIGURE 2. MAP TEMPLATE USED FOR TRAINING AND COLLECTING PARTICIPANT DATA AFTER TRAINING

Journey maps generated in our study describe retrospectively how participants initiated their journeys at the beginning of doctoral work and conclude with their leaving the program or graduating. Over the course of the

study, participants update their maps biannually. By tracing participants' perceptions of identity growth over time, journey mapping asks them to chart their identity development, tracking the engineering identity development process as well as participants' interactions with programmatic components—e.g., advisors, faculty, curriculum, extracurricular activities—which support or deter them from forming identities as researchers.

DATA OSCILLATION AND TRANSFORMATION IN JOURNEY MAPPING ANALYSIS

As illustrated in Figures 1 and 2, participants were trained using a persona that provided data primarily as text. They then identified key touchpoints, pain points, and other key experiences that they assumed would promote or hinder the persona's perceptions of herself as a researcher. These experiences were then mapped textually by semester onto the map template. After the training exercise was completed, participants then generated their own maps. The maps varied in length depending on the participants' longevity in their doctoral programs. These maps were then emailed to the researcher who is employed in a different university department. This researcher then de-identified the maps, which were eventually analyzed after the semester of data collection was completed. In addition to de-identifying the maps, all semesterly maps were aggregated to further protect individual student experiences.

I. First move: From textual to visual maps

The first transformation, which resulted in a preliminary codebook, began in June 2021 with a pilot study (#IRB2019-58) that set the stage for the funded proposal. With the aggregated semesterly maps from the pilot study in hand, the researchers worked through each semester to create a visual map of comments. The purpose of this mapping exercise was to develop a code set of experiences identified by participants and to begin to identify and count touchpoints (both positive and negative), other mapped experiences, and emotional responses to all these experiences. Figure 3 provides an example of the initial mapping exercise.

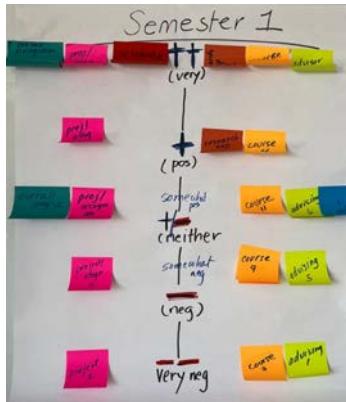


FIGURE 3. SEMESTER 1 MAP SHOWING CODED EXPERIENCES AND EMOTIONAL RESPONSES

The first move was a rapid, primarily qualitative, data analysis that synthesized reported experiences into codes and visually color-coded these experiences across semesters. For this move, researchers relied on standard journey mapping technologies: laptop computers, large sticky notes, small sticky notes, and permanent markers. Color-coding, in this case with sticky notes, “allowed us to see individual facets of information across the diagram” [8]. The result of the first move provided researchers with a preliminary codebook and several insights into participants’ experiences. For example, in early semesters, such as Semester 1 depicted in Figure 3, participants primarily focused on coursework, advising, and overall program requirements that promoted or hindered their researcher development. The number of very negative comments in Semester 1 also suggested that initially, one or more participants had struggled immediately upon matriculation.

II. Second move: From visual map to spreadsheet

With this initial coding in place and a funded project in hand, researchers collected a second data set in June 2022 ((#IRB2021-856)). With this set, the researchers transferred all semester comments to a spreadsheet so a more finely grained analysis and coding process could begin. Using the preliminary codebook, two researchers independently coded each comment by semester and met weekly to reach a consensus about their coding. When consensus could not be reached, a third coder independently reviewed the comment and assisted with consensus. This move was completed entirely in Microsoft Teams using individual and shared spreadsheets. A total of 205 comments were coded across ten semesters. Each semester spreadsheet had six columns: semester, participant number, activity description, activity code (one of nine categories), response code (one of six codes ranging from very negative to very positive), and the coded comment itself. Table 1 below provides an example of two

coded comments. (Participant numbers were removed and replaced with two asterisks.)

TABLE 1. EXAMPLE OF CODED COMMENTS.

| Sem | Activity Descriptor | Activity Code | Response Code | Comment |
|-------|--|---------------|---------------|--|
| Sem 1 | Advising | A | SP | Even though I didn't meet enough times with my advisor, the times I met her were very fruitful. Affected identity. |
| Sem 1 | Determine advisor and dissertation topic | A | NG | Couldn't get an advisor that semester and had to send several email to professors |

This analysis required researchers to move from qualitative analysis to quantitative analysis. In this round, eight categories were coded, counted, and compared. Courses, projects and assignments, and individual research were the most frequently identified categories of experiences while scholarship and mentoring were less frequent. Emotional responses to these experiences were overwhelmingly positive with 147 comments or 72 mapped as somewhat positive, positive, or very positive; only 51 or 25% were mapped as negative. Table 2 illustrates how tables were used to count the coded experiences, identify their frequency across different semesters, and determine if experiences were primarily positive or negative.

TABLE 2. QUALITATIVE COUNT OF CODED EXPERIENCE CATEGORIES AND EMOTIONAL RESPONSES.

| Coded experiences | V N | N G | S N | N | S P | P | V P | Total s |
|---|-----------|-----------|-----------|----------|-----------|----------|-----------|------------|
| Courses (in general) | 1 | 3 | 1 | 2 | 13 | 1 6 | 11 | 47 |
| Projects & Assignments | 3 | 1 | 6 | 1 | 10 | 1 | 23 | 45 |
| Research (individual) | 2 | 2 | | | 5 | 7 | 6 20 | 42 |
| Overall program | 3 | 5 | 3 | 1 | 3 | 4 | 8 | 27 |
| Advising | 2 | 5 | 3 | 1 | 5 | 2 | 3 | 21 |
| External factors, such as CoVid | 3 | 2 | 1 | | 1 | 2 | 2 | 11 |
| Scholarship (presentations, publications) | | | | | 1 | 1 | 1 4 | 7 |
| Mentoring | | | | | 2 | 2 | 1 | 5 |
| Grand Total | 14 | 18 | 19 | 7 | 41 | 4 | 72 | 205 |

III. Third move: From spreadsheet to textual and visual maps again

As Nunnaly and Farkas (2017) explain, “Quantitative customer journeys provide only the steps a customer takes. A qualitative journey focuses primarily on emotions. Combining data from both sources allows you to create data-driven customer journeys that account for real task time and latency with awareness of human needs. These can be used as baselines for ... establishing longer-term roadmaps” [9, p. 63]. With this advice in mind, researchers are moving to more sophisticated mapping methods. Although not yet completed, at least two additional technologies will be used in the next phase of research. To visualize quantitative data, researchers plan to use Tableau, which will allow researchers to map aggregate and individual data both chronologically and categorically. For mapping qualitative data across time, Miro will be used to diagram timelines, specific touchpoints and pain points, and emotional responses on individual and aggregate maps. Drawing from the engineering toolkit, they will also experiment with Behavior over Time graphs (BoT), a graph designed to show change over time, which can assist with illustrating identity development processes chronologically. Because this move is currently underway, examples are not yet available.

CONCLUSIONS

This year’s IEEE ProComm conference is centered on the idea that “nobody steps in the same stream twice.” Over the first year of our longitudinal study of research identity development, we have learned that even analyzing the same data set stream has required us to step into the

data—the participants’ individual and aggregate journey maps—in multiple ways to understand what the maps are telling us. With each step, new insights are revealed, and our ability to see changes is challenged. Furthermore, with each step, we engaged new technologies to support our analysis. To collect the data, we trained participants using a persona that required them to identify touch points and pain points that promoted or hindered the persona’s researcher identity development. They then transferred those experiences to a map template. From this training, participants then generated their own maps in PowerPoint based on their own experiences. With these maps completed and aggregated in a Word table, researchers used a sticky note approach to create visual maps of aggregated experience by semester and generate a preliminary set of categories and a codebook. Categories were then tested and verified when the visual map codes were applied in an Excel spreadsheet and visualized in tables. In future research, the coded data will be transformed again into more sophisticated quantitative and qualitative maps using Tableau and Miro. Throughout this process, moving into the data stream required different visual and technological means to map the participants’ experiences. These moves have allowed researchers to begin to understand the process of researcher identity formation in doctoral engineering students.

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ABOUT THE AUTHORS



Kelli Cargile Cook is a Professor and Founding Chair of the Professional Communication Department at Texas Tech University. Her scholarship focuses on online education, program development and assessment, and user-experience design. Most recently, she co-edited *User*

Experience as Innovative Academic Practice (2022) with Kate Crane. She also co-edited two collections on online education: *Online Education 2.0: Evolving, Adapting, and Reinventing Online Technical Communication* (2013) and *Online Education: Global Questions, Local Answers* (2005).

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.



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.

Mario Beruvides received a PhD in Industrial & Systems Engineering from Virginia Tech and an M.S. in Industrial Engineering and B.S. in Mechanical Engineering from the University of Miami. Dr. Beruvides is the Associate Vice Provost for International Affairs and AT&T Professor of Industrial Engineering in the IMSE Department at Texas Tech University. His



professional interests are in engineering economics, education and systems engineering. He holds a professional engineering license in the state of Texas.



Diego 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.



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.