AN APPROACH TO LONGITUDINAL IDENTITY FORMATION TRACKING: USER EXPERIENCE (UX) JOURNEY MAPPING AND SYSTEMS THEORY BEHAVIOR OVER TIME METHODOLOGIES FOR ENHANCED IDENTITY MODELING

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Abstract

Understanding the identity formation process of engineering professionals in work environments and educational settings, and developing supportive mentoring structures, is an area of growing interest for technical management. Much has been written on conceptual frameworks and influencing factors which interplay in identity formation; however, empirical documentation of the critical influencing factors in engineering identity development in graduate education and workplace settings has been limited in open literature. This area of research and practice is further complicated in that influencing factors are recorded longitudinally over periods of time which extend over months or years, and longitudinal research is scarce in any engineering identity research domain. Some work has been done using UX (user experience) approaches such as journey mapping and persona development. Further, some work on UX methods combined with Systems Theory causal loop diagramming (CLDs) has been ventured. CLDs are critical in mapping cause-and-effect relationships of complex systems. A prerequisite to building CLDs is developing BOTs (behavior over time) graphs. Industrial or data driven environments lend themselves well for compiling data for BOTs. In such longitudinal spaces as journey mapping and persona development, BOT formation is more challenging. Developmental work of merging UX methods and Systems Theory BOTs using enhanced data visualization, infographics, and media rich content to better represent longitudinal complexities in identity formation is presented in this paper. Benefits of this work impact several areas of research and practice related to the development of future practitioners in the engineering management profession.

Keywords

Engineering Identity, Engineering Identity Formation, Engineering Education and Influence on Engineering Researcher Identity Formation

Introduction and Review of the State of the Art

This paper explores a new methodological approach for studying complex behaviors and identity formation, particularly among doctoral students in engineering. Over the past two decades, interest in engineering identity research has grown steadily [1]. However, most existing studies focus on undergraduate students, leaving a gap in our understanding of identity development at the doctoral level [see 2, 3, & 4]. While many graduate students already possess a professional engineering identity—shaped by prior education and work experience—their identity as researchers is still forming [5, 6]. This aspect of identity is less understood and often overlooked. Faculty members frequently observe that even highly capable doctoral students must still develop the mindset and skills of a researcher [7, 8]. This process may be unpredictable, varies widely among individuals, and is not easily taught. Given this complexity, there is a clear need for more research into how doctoral students develop their researcher identities. This paper proposes combining two tools—UX journey mapping and Systems Theory BOT (Behavior Over Time) graphs—to better capture and analyze this developmental process. A summary of ongoing research work on PhD researcher identity formation is presented and reviewed to provide a foundation for the proposed mapping approach combining UX and Systems Theory that has been developed and is continuing to be developed to attempt to better map the complexity of longitudinal identity formation.

Professional identity refers to how individuals see themselves in relation to their profession—how they internalize the roles, responsibilities, and knowledge associated with their field [9]. For engineers, this might mean thinking, acting, and communicating like an engineer. This identity is shaped by specialized skills, shared language, and recognition

from peers. While professional identity has been widely studied, especially in undergraduate engineering education, there is a noticeable gap when it comes to understanding how doctoral students develop their identities as researchers [11, 12]. Unlike professional engineering identity, which many doctoral students have already formed through prior education and work experience, researcher identity is still emerging. In some cases, a strong professional engineering identity might even hinder the development of a research-focused mindset.

An Interdisciplinary Approach

To explore this complex process, our research takes an interdisciplinary approach. The work presented here builds on the previous work [see 5, 6, 13] that explored the interdisciplinary approach to user experience mapping combined with Systems Theory mapping to create a more holistic visualization of the identity formation of developing researchers (PhD students). The process presented in this work is believed to be generalizable to other professional development situations that are systemically complex and require a more rigorous methodological approach. We draw on insights from identity theory, engineering education, and systems thinking. Specifically, two tools from different domains are combined: journey mapping from UX research, which helps us capture the lived experiences of doctoral students as they navigate their academic journeys, and BOT graphs from Systems Theory, which allow us to track patterns and changes in complex behaviors over time. The temporal interconnectedness with varying levels of complex interactions are the subject matter addressed in this type of identity formation mapping approach.

UX methods emerged during the rise of personal computing, where leading computer technology companies designed technology for everyday users [14, 15]. UX methods aimed at understanding how individuals interact with complex technical systems—their expectations, their emotional reaction to the technology, and the sources and situational encounters creating socio-technical challenges. Journey mapping is a particularly useful UX tool which assists in visualizing an individual's experience over a set period of time. These maps help analysts understand the key milestones and complex interactions that shape the individual's journey.

Journey maps are built from the individual's perspective and often include data from interviews, surveys, and focus groups [14, 15, 16, 17]. The maps capture not just what happens, but how individuals feel and think about their experiences. In the current research context, the qualitative data gathered through journey maps provides rich insights into the personal and social dimensions of identity development. In conducting the research into identity formation in budding researchers the research team adapted user experience (UX) journey mapping techniques to document the experiences, emotions, and milestones that doctoral students encounter throughout their academic journey. This approach assisted in visualizing the complex path of identity formation by capturing emotional fluctuations, the documenting of critical touchpoints and milestones, and mapping the temporal nature of identity development.

Employing systems theory [18] approaches allowed for a complementary lens for understanding the complex, dynamic processes of identity formation. Originating in the early 20th century, Systems Theory focuses on how components within a system interact over time. This theory assumes that these components are interconnected and that their interactions can produce delayed or hidden effects. A key tool in this field is the BOT graph, which tracks changes in a system's behavior—such as growth, decline, or cycles of critical variables—over time [19]. This study employed BOT graphs to visualize patterns in doctoral students' experiences and behaviors. These graphs help us identify when and where significant changes occur, and whether those changes might be linked to specific events or interactions. What makes BOT graphs especially powerful is their ability to highlight not just trends, but also potential causal relationships. For example, a sudden increase in research confidence might follow a successful project or a mentoring experience. By overlaying journey mapping data onto BOT graphs, we can begin to see how individual experiences contribute to broader patterns of identity development.

Methodological Development

A structured methodology for capturing and visualizing the longitudinal development of professional researchers' identity by integrating UX journey mapping with systems theory was developed and employed as part of a larger ongoing research project. This research project incorporated a variety of known research methods such as surveys, focus groups, and longitudinal tracking. The use of structured surveys to collect data about students' backgrounds, experiences, and self-perceptions was an initial step in the research process. These surveys were administered at multiple points throughout the doctoral program.

The surveys were followed by conducting focus group sessions to explore shared experiences and collective understanding of what it means to be a researcher in engineering. These discussions helped in identifying common themes and variations in identity development. Participants then completed journey maps to document the experiences they believed most impacted their identity formation over time and their emotional responses to these experiences. The participants were tracked over time to capture the evolution of their researcher identity with the focus group replaced by individual interviews in later rounds. This longitudinal tracking approach allowed for the documenting of observed changes, adaptations, and critical turning points in the individual's development process.
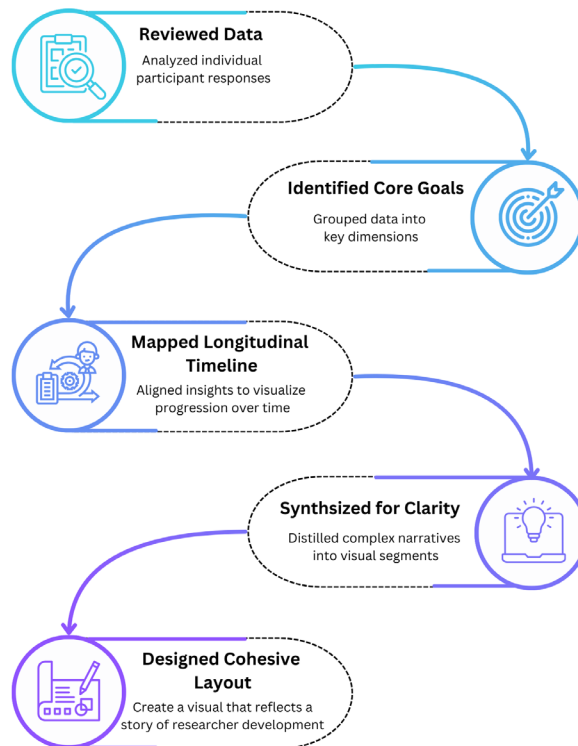
Participants were recruited from two doctoral programs in an industrial engineering department at a large state university in the southwestern U.S. with high research activity. Recruitment employed a combination of email, seminar and course-based recruiting. A total of 25 individuals (12 online and 13 onsite) participated in the research over a 3 year period, although not all participated in all rounds or all data collection methods. Surveys, interviews and journey maps comprised both closed-ended (Likert scale and categorical) and open-ended questions; whereas focus groups only comprised open-ended questions. Open-ended questions were coded utilizing multiple coders to identify key themes. Results were triangulated across the different methods to identify areas where findings converged and diverged across the different instruments. Additional detail on the research methods and participants, and a summary of some key research findings to date can be found in [20], which also references other publications from the work.

Analysis Framework

The analysis provided in this paper combines phenomenological approaches with systems analysis to understand both the individual experience and the structural factors that shape researcher identity development. It uses iterative coding, thematic analysis, and visual mapping to synthesize the research findings in new ways to better capture the complexity of the UX journey mapping process while incorporating, combining, and merging systems theory mapping formats. The process to incorporate this interdisciplinary approach is presented in Exhibit 1

Exhibit 1: The Mapping Process of Researcher Identity Longitudinal Experience

Crafting the Narrative: Building the Researcher Development Map

The analysis based on the journey maps, survey results, structured interviews, as well as focus group results, resulted in developing UX persona descriptions [6], which in turn provided the foundational material to develop modified journey maps. As indicated, these modified journey maps built upon the journey maps the participants had created by incorporating their data from other methods. See Exhibits 2a and b as well as Exhibit 3a and b that captures development samples of the modified journey mapping along four critical research variables (Exhibit 2a and 3a) and academic experiences (Exhibit 2b and 3b) for two research participants. In Exhibit 2 the longitudinal structure is per semester, and in Exhibit 3 the longitudinal structure is in a per year timeframe. Since this work is still developmental in nature, this dual representation was used to see which visualization timeframe would prove beneficial. Both timeframes have their merits and further research is being pursued to determine which approach might be more beneficial to educators in consideration of the specific developmental stage the young researcher is experiencing.

Exhibit 2a: Sample Experiential Identity Formation Journey Map for Participant 5.
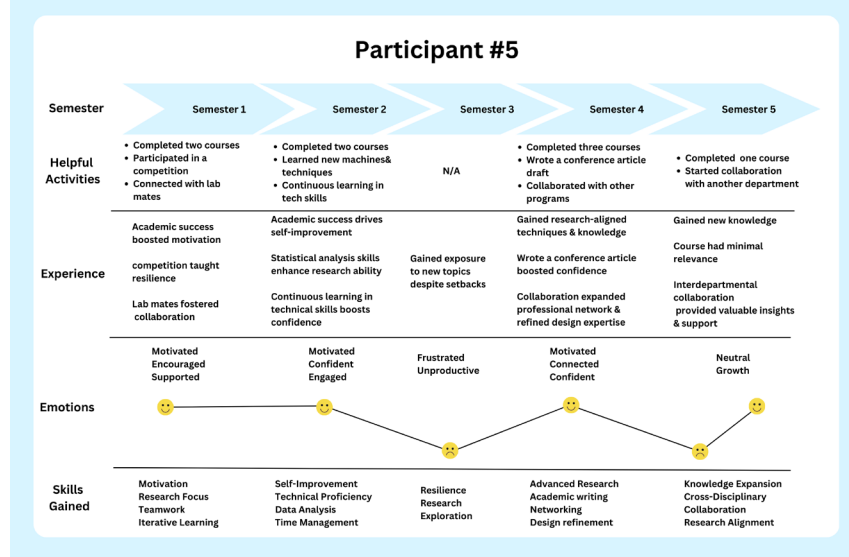

Exhibit 2b: Sample Experiential Identity Formation Academic Journey Map for Participant 5
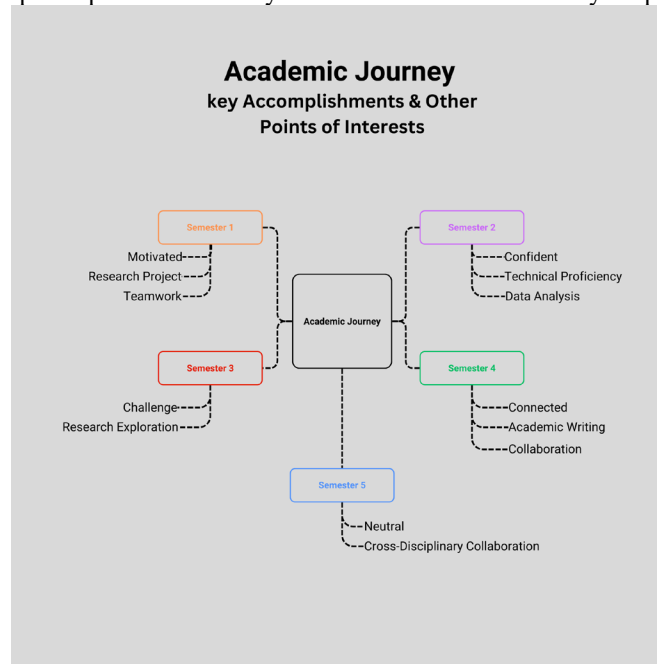
Exhibit 3a: Sample Experiential Identity Formation Journey Map for Participant 16.
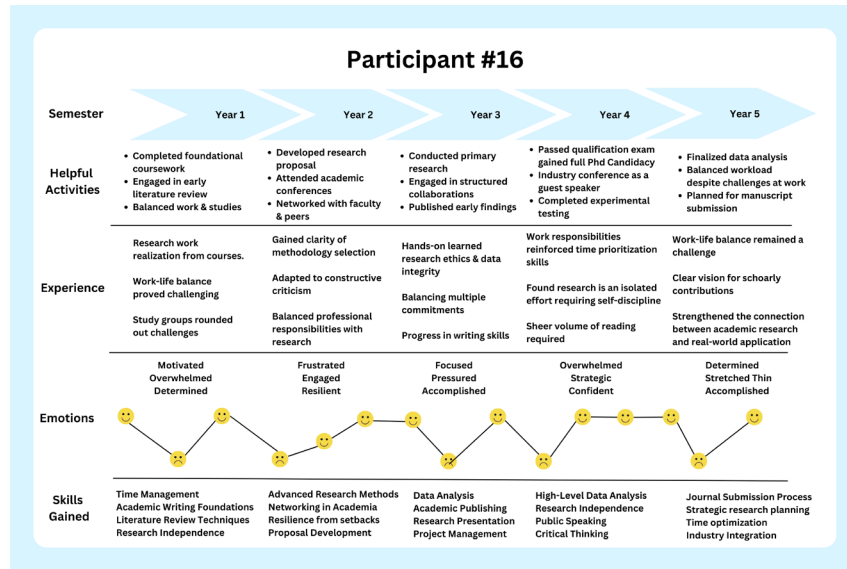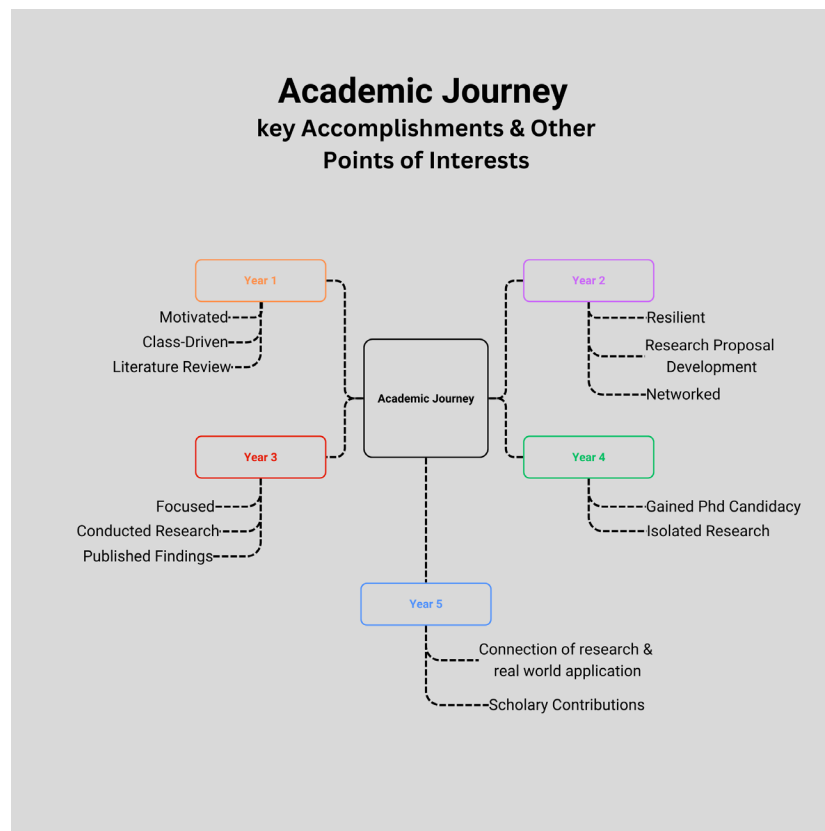

Exhibit 3b: Sample Experiential Identity Formation Academic Journey Map for Participant 16

Summary and Preliminary Conclusion

The ongoing research into researcher identity formation indicates the PhD experience is largely positive for most participants in the study according to the journey mapping and other results [20]. Though results to date are still preliminary, the developing combined journey mapping and BOT mapping is proving to be useful and illustrative, but several aspects of the new mapping techniques are still under evaluation. Some of the lessons learned in this ongoing research are such things as follow-up in longitudinal research is time-intensive and can be logistically complicated. The mapping techniques being developed are believed to have the potential to assist the logistic complexity of managing identity formation. The persona methodology is a powerful approach for analyzing and communicating rich project data. Matching the persona formation with the proposed mapping techniques is seen as a way to both enrich the persona descriptors and development as well as to assist in better developing the longitudinal journey mapping approaches.

The challenges and opportunities that are facing this line of research and the development of the proposed mapping techniques are many and varied. The development of the visualization approach to better represent the findings to both educators and those in the process of growing their professional identity is critical. There is little doubt that one of the challenges in the development of professional identity, in this case researcher identity, is assisting both educators and those individuals in the process of identity growth in perceiving where the "persona" is growing to. The improvement of mapping approaches addresses this issue, which, if not addressed, can lead to frustration and potential exit of individuals who399 have a hard time visualizing what it is to be a professional in their chosen profession. The work presented in this paper is believed to assist in opening the conversation of how improved and more detailed mapping approaches might assist in these issues. To that end, the research team has developing a website for interested students and researchers in this area to stimulate an open forum for conversation and knowledge transfer, which will be made available after final project review by the grant funding agency.

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