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Considerations for the Use of Personas and Journey Maps in Engineering Course Design

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Abstract

Personas and journey maps are ubiquitous in many design disciplines. These tools allow designers to better understand key users and engage with a user's experience over time with a product or system. While personas and journey maps are widely used in design disciplines, little scholarship exists on how they, collectively, might be successfully adapted to different contexts, e.g., engineering instruction and course development. Yet, these tools have the potential to help educators better understand students' experiences during a learning activity, class session, semester, or even an entire curriculum, and identify key issues to address as they develop or revise new learning experiences. This paper presents three case studies of the persona and journey map creation among engineering educators, explores their effects on educator empathy, and investigates factors that may influence their successful implementation in engineering course design settings. Each case features some variation on the format of personas and journey maps. We utilize several data sources to achieve a comprehensive snapshot of each case, including audio recordings of team course design meetings, persona and journey map artifacts, course data, and researcher observations. We present each case individually and identify themes that run across the implementations. These themes include the importance of instructor involvement in the creation process, the effect of diverse voices in the creation process, and the role of play, as well as relevant trade-offs in each of these themes.

Keywords: persona, journey map, empathy, course design, design thinking

Introduction

Personas and journey maps are ubiquitous in many design disciplines. These syntheses of users and visualizations of a user's experience over time help designers better understand users, highlight important pain points to address, communicate as a design team, and make critical design decisions [1–4]. While personas and journey maps are widely used in design disciplines, little scholarship exists on how they might be successfully adapted to different contexts, e.g., engineering instruction and course development. Personas have the potential to help educators connect to their students and understand key aspects of their identities and motivations while journey maps have the potential to help educators better understand students' experiences during a learning activity, class session, semester, or even an entire curriculum. Collectively, they might help educators empathize with students and identify key issues to address as they develop or revise learning experiences. This paper will describe a persona and journey mapping cycle, present three case studies of their use among engineering educators, and explore three research questions:

1) How might the persona-journey map cycle be used by engineering educators when designing or redesigning core engineering courses?

2) How does engaging in the persona-journey map cycle inform empathy, among engineering educators, for students in the context of designing or redesigning core engineering courses?

3) What factors affect the utilization and outcomes of persona and journey mapping activities among engineering educators when designing or redesigning core engineering courses?

Literature Review

Conceptualizing Empathy

In the simplest terms, empathy represents the experience of understanding, experiencing, and/or feeling as a result of another's internal state. However, within this definition, empathy has taken many forms over the years [5]. The experience can be affective, as matching or feeling as a result of another's feelings, experiences, or emotional state [5]. This experience can also be cognitive, as in understanding another's thoughts and perspectives [6]. In addition to the cognitive-affective dichotomy, empathy has also been described as other-oriented, imagining how another feels or thinks, and self-oriented, imagining how one would think and feel in another's situation [7]. While both the cognitive-affective and self-other dichotomies might suggest four disparate constructs, experiencing one of these constructs may lead to experiencing one or more of the others. For example, one might see a student frustrated over a challenging problem and recall a similar experience they had as a student (e.g., cognitive, self-oriented empathy). Then they might observe features of the student's context and experience that differ from their own and shift their focus to the student's unique thoughts and feelings (e.g., cognitive, other-oriented) empathy. Hoffman [8] called this back-and-forth dialogue pluralism.

In addition to what empathy *is*, others have considered what empathy *does*. Batson [5], for example, describes empathy as answering two important questions about our interactions with

others: (1) how we know what others think and/or feel and (2) why we respond to others' suffering. Echoing these questions, Finn [9] identified three distinct "faces" of empathy, albeit within the context of therapeutic assessment. The first face of empathy, aligned with Batson's first question, was a means of gathering information about others. The second face of empathy presented empathy as a two-way process, expanded the idea of us understanding others to add others also understanding us. Finally, the third face of empathy aligned with Batson's second question, describing empathy as a therapeutic tool.

Each of these faces can play a substantive role in an educator's practice. The information gathering face allows educators to understand, for example, how their students are responding to specific content, the emotions that are supporting or limiting their classroom engagement, what might motivate students to actively participate in learning activities, and much more. The two-way process face can support student understanding of instructor experiences and intentions, which can improve interpersonal relationships in a classroom and even support community-building. Finally, the therapeutic face may directly affect student emotion and sense of belonging in the learning environment. In other contexts, e.g., engineering, researchers have considered empathy beyond the realm of interpersonal processes and noted important contributions of broader service to society [10] and personal feelings of connectedness [11].

Empathizing in education

Traditionally, researchers have explored the effects of instructors' empathy for their students within the classroom, likening these interactions to the therapeutic process [12]. Empathy between teachers and students has demonstrated substantive benefits towards students' learning experiences in a variety of contexts. McAllister and Irvine [13], for example, found that teachers attributed positive interactions with students; supportive learning environments; and effective, student-centered pedagogical practices to their greater focus on empathizing with students, especially those from different cultures. In the nursing field, students expressed how empathy demonstrated by their instructors supported constructive learning experiences [14]. Similarly, empathy demonstrated by instructors has promoted the importance of empathy in their own work, something that engineering students described as lacking in their own education experiences [15].

The role of empathy in the design aspect of education has been less robustly explored. As educators develop their courses, empathy can play a substantive role in many aspects: determining content that will be appropriate and engaging for students, developing pedagogy that will resonate with students and respond to their various needs and approaches, and identifying assessment strategies that are just and effective. Yet, traditional roles of empathy in this process have been either underdeveloped or under-studied. For example, while many studies of expert instructional design processes have incorporated some element of learner analysis [16–18], this step is often limited to understanding learner preparedness for the learning experience and may not necessarily incorporate the affective elements of empathy. Scholars have found that engineering educators often used empathy during a team course design process, however, this empathy was often either self-oriented (e.g., projection of one's own experiences onto those of their students) or generalized empathic concern that did not consider the nuances of specific students or groups of students [19]. This work shows that empathy can play a role in course/curriculum design, but it may need more robust support, which may come from the world of design.

Empathizing in design

Empathy has played an important role in many design traditions. Designers value empathy for users because it allows them to incorporate emotional and experiential aspects of the user experience and tap into previously unarticulated user needs [20]. While processes vary, one general approach to empathizing in design was described by Kouprie and Sleeswijk Visser [21], who identified four distinct stages: (1) designers ‘‘discover’’ a particular user group, (2) designers ‘‘immerse’’ themselves in the users’ context, (3) designers ‘‘connect’’ with the users’ experiences, and (4) designers ‘‘detach’’ from the users’ world to leverage their new insights. While this process may appear linear and transactional, some design traditions, such as co-design, have emphasized engaging users as partners throughout the design process [22] and have found that designers continue to develop and leverage new empathic insights throughout the development of individual design solutions [23]. This iterative and user-immersive view might be particularly applicable to engineering educators who regularly interact with their users (i.e., students) in and out of the classroom and develop courses over several terms.

While empathy plays an important role in many design processes, its role in different traditions differs and many contexts have demonstrated distinct threats to empathy. These can be useful to explore when considering ways to empathize with students during the course design process. The first of these threats is personal. Kouprie and Sleeswijk Visser [21] note that designers must have the ability and willingness to empathize with users. Here, they focus on individual’s innate tendencies to authentically consider others’ thoughts and feelings (ability) and situational factors (e.g., stress) that limit motivation to empathize (willingness). Additionally, professional and role identity or expectations of value in their work may limit engineers and engineering educators in empathizing with their student users [15,19].

In addition to personal aspects, organizational structures may threaten opportunities to empathize with users. Postma and colleagues [24] identify eight distinct challenges that manifested in three categories: dissonance with rational approaches that were entrenched in the organization, compartmentalization of user research, and engaging designers and project team members throughout the process. Designers may also find contextual constraints that limit their access to users. A robust solution to supporting empathy in any design enterprise (including course design) may require structures at various levels, e.g., tools, methods, methodology, mindset, and culture [22]. In this work, we explore tools, with the expectation that these tools may inform changes across these levels.

Tools for designerly empathy

Designers have employed many means to build empathy for their users. These can be organized into those meant to immerse the designer in the user experience and those meant to support insights culled from those immersions. In this work, we focus on the latter for two reasons. First, educators may already tend to immerse themselves in the user experience in various ways (e.g., classroom observations, role-taking based on prior experiences, collecting user artifacts, interactions with students, etc.). Second, educator experiences and contexts differ substantively, which renders different immersion techniques applicable and/or accessible while insight techniques, like personas and journey maps, may be more broadly applicable. For those interested, various

resources present the variety of empathy-generating immersion techniques. For example, Thomas and McDonagh [25] provide a concise exploration of such tools, Liedtka and colleagues [26] describe specific tool templates in their field guide, and Gallagher and Thordarson [27] describe some of these tools in the context of describing design thinking mindsets among school leaders. Here, we focus on two primary insight-focused tools: personas and journey maps.

Personas

Personas are archetypical representations of target users of a design project [1,3,4]. These representations can convey a variety of information, often including names, pictures, demographics, backstory, behaviors, interests, values, motivations, functions or roles, and other information. Personas are hypothetical but are treated as authentic users throughout the design process. Within an individual design project, multiple personas are typically created [1].

Personas can take several distinct forms. Nielsen [3], for example, identified four common types: goal-directed, role-based, engaging, and fictional. Goal-directed personas focus on the goals a user has within the design context or in using the design product (see [1]). Role-based personas may incorporate goals but also focus on an individual's roles and how those roles interact within larger contexts (e.g., the workplace) (see [4]). Engaging personas present more well-rounded representations of users as people, featuring emotions, psychology, and backstory [3]. Finally, fiction-based personas are based on designers' intuition and can be used as a starting point for design/evaluation or to explore extreme cases [3].

Personas can fulfill a variety of roles in a design project [1,28]. Chief among these roles is maintaining a user-focus, developing empathy for user experience, and challenging assumptions about users. However, personas also provide tangible artifacts that can aid communication and engagement in the design team, keep essential needs in mind, support ideation (divergent thinking), and provide a quick test of new ideas and prototypes [1,28]. Further, the act of creating personas can reveal and confront biases you have about your users [28] which embeds empathy into the development process.

Journey maps

One common criticism about personas is that they are "two-dimensional" [2,3]. They present a relatable and authentic characterization of a user, but do not immerse that characterization in relevant scenarios or offer active behavior insights. This two-dimensional snapshot limits designers' abilities to understand experiences and identify needs. Adding a third, temporal dimension can help "round out" a persona. Some do this by creating scenarios for personas [3], however a journey map is a more sophisticated solution.

Journey maps are used in design and business disciplines to understand a user's experience with products, systems, and services over time [2]. While formats vary, journey maps are typically depicted as flowcharts or two-dimensional graphs. The x-axis displays key touchpoints with a product or company or milestones on a timeline. The y-axis, or y-axes, represent key metrics to evaluate the user's experience at each touchpoint. Typically, the y-axis displays some variation of emotional highs and lows. However, designers can be creative with their framing of metrics, which

can affect the ultimate success of the journey map in communicating the user experience [2]. Like personas, journey maps can be data-driven or imagined.

Using Personas and Journey Maps in Course Design

We explored the use and utility of personas and journey maps in the course design process through three case studies. Each of these cases centered around the redesign of an electrical or computer engineering course at a large university in the midwestern United States. The courses were being redesigned as part of a departmental initiative [29,30] to improve student-centered instruction and professional formation in second- and third-year courses, each by separate interdisciplinary teams of 5–10 educators, researchers, and students (although four members participated in each of the teams). The common student-centered, team-based setting provided a viable opportunity to explore the persona and journey mapping techniques, while the differences between the cases provided an opportunity to investigate different instantiations and compare across the differences. In the following sections, we describe each of the cases, focusing on (1) the case setting, (2) how personas and journey maps were implemented, and (3) outcomes of each implementation.

Electronic Circuits and Systems was a sophomore-level course taught by one faculty member in the electrical and computer engineering department. There were typically about 125 students enrolled each semester, from both electrical and computer engineering. Embedded Systems was a sophomore-level course, taught by two faculty members in the electrical and computer engineering department. There were between 125 and 250 students enrolled each semester, most of whom were second-year computer and software engineering students or upper-level students in electrical engineering. Computer Architecture was a third-year course, taught by two faculty members in the electrical and computer engineering department. There were typically between 60 and 150 students enrolled each semester, most of whom were upper-level undergraduate students majoring in computer engineering. Table 1 provides an overview of persona and journey map development aspects in each setting.

Table 1. Overview of Persona and Journey Map Implementations

Aspect	**Electronic Circuits and Systems**	**Embedded Systems**	**Computer Architecture**
Persona type	Engaged	Goal-directed	Goal-directed
Persona creator	External design consultant	Course design team (cross-disciplinary)	Course design team (mostly ECE)
Persona background	Design observations and ethnography	First- and second-hand observations from course personnel, written reflections and feedback, surveys, assignments	First- and second-hand observations from course instructors, written reflections and feedback, assignments, design observations
Other analysis techniques	None	Empathy map	Empathy map

Persona characteristics	Diverse demographics Focused on how engaged during lecture Provided rationale for engagement based on background	Demonstrated diverse motivations and ways engaged in course Not mutually exclusive	Demonstrated some diverse motivations Positive or negative valences Not mutually exclusive
How personas were used in course design	Not used	Interwoven into fabric of design team General discussions Ideation Review potential implementations Diversified student considerations	Discussed in design team Some ideation Aligning instructor observations with personas to better understand challenges Used to explain observed student behavior
Journey map creator	External design consultant	Course design team	Course design team
Journey map focus	Classroom engagement	Connectedness to material	Resonance with course overall
Journey map time scale	Class period	Semester	Semester
How journey maps were created	Compiled classroom observations	Design team members role-playing one persona	Design team synthesizing student reflections
Journey map characteristics	Demonstrated key moments when engagement changed for each persona	Demonstrated opportunities to improve connectedness for each persona Showed potential for a roller-coaster ride through a course rather than a smooth ride Underscored the challenges of supporting all students to the same extent all the time	Demonstrated changes in resonance with the course among personas. Similar trajectories of some personas highlighted points at which they diverged, helping to identify critical incidents in the course for different groups of students.

How journey maps were used in course design	Identified features of environment that supported or did not support engagement Brought new meaning to what engagement is	Role-playing generated new empathy Identified pain points for personas Positivity about expanding use to curriculum	Generated discussions on "resonance" Highlighted important pain points for some students Increased affective empathy

Case 1: Second Year Electronic Circuits and Systems Course

Electronic Circuits and Systems was a second-year course required for electrical and computer engineering students. The course was taught by several faculty members in the electrical and computer engineering department, but the current case focused on one section of the course taught by a single instructor, an associate professor in the ECE department. There were typically about 125 students enrolled each semester, most of whom were second-year students majoring in electrical engineering and third-year students majoring in computer engineering. The course redesign team consisted of the course instructor, three other ECE faculty, an associate professor in industrial design, and an engineering education postdoctoral research associate. Based on early conversations about instructor priorities and directives from the overarching departmental initiative, one focus of the redesign was to improve student engagement in the course.

Based on the student engagement focus, two members of the team (the industrial design associate professor and engineering education postdoc) oversaw a team of graduate and undergraduate industrial design students who observed both lecture and laboratory sessions and informally interviewed students over a four-week period. The observation focus was student behaviors within the course settings and observers' experience of the course setting from the student perspective, while interviews provided clarifications of these observations and additional experiences and perspectives related to the course.

From these observations and interviews, a graduate industrial design student completed five personas and an associated journey map, with oversight from the industrial design associate professor and engineering education postdoc but independent from the remainder of the team. Personas took the "engaging" perspective, which incorporates background and psychological characteristics with one's relationship to the focus area [3], in this case, engagement with the course material. This type of persona is intended to present a well-rounded picture of the individual, balancing real data and imagined users to help build empathy for the users represented by the persona. In this case, each persona represented a different type of engagement within the course, from the highly attuned "Knowledge Seeker" to the seemingly disinterested "Classroom Ghost." Personas were given backstories and attitudes compiled from the student interviews. The journey maps were also developed by the same industrial design graduate student. Each depicted the persona's level of attentiveness during a single class lecture session based on instructor actions and other classroom events. The design consultant team presented the personas and journey maps to the full course redesign team for discussion and as a reference for follow-up design activities (e.g., needs statements, ideation, reframing the concept of "engagement").

The results of this first iteration are presented in the form of an empathy map in Table 2. An empathy map is a way to organize observations of users to craft insights about their issues and needs [26,27]. While empathy maps were utilized in the following two iterations to compile insights about students, here, the empathy map focused on observations of the course design team's experience related to the personas and journey map. We see that the personas and journey maps resonated to some degree with the educators. They noted that the personas matched, and even gave voice to, some of their prior observations and understandings of students in the class. They also noted interest in the journey map as a way to understand students' attention levels in the class.

Table 2. Electronic Circuits and Systems Empathy Map

Do/Say (Observable Behavior)	**See/Hear (Experience)**
Push back on the demographic features of the personas Question the strength of the data upon which the personas were built "I can see some of my students in these personas." "Change in student behavior based on course events is interesting, but so what?"	Attention in one lecture period based on my movements and course events Personas with demographic information and type of classroom engagement Personas by placement in class Student audio-visual experience in the class Students do this when you do this These are the five types of students
Think	**Feel**
"They really didn't understand what I was saying with 'engagement'." "This is a waste of time. I already have a process."	Uncertain about design thinking Frustrated at misunderstanding my perspective and wasting my time Unconvinced of utility of the personas
Needs and Insights	
Instructors need to be more involved in the process to: 1) Trust the data 2) Build buy-in 3) Feel more comfortable with the process 4) Ensure focus of the activities resonates with their goals for the course	
Outcomes and Opportunities	
Shed new light on observed student behaviors Clarify goals for students in the course Rethinking classroom environment and specific actions	

The instantiation was ultimately unsuccessful due to negative reactions and challenges among the educators. First, while the educators noted some useful outcomes and further interest in personas and journey maps, they overall questioned the utility of the personas and journey map, as currently constructed, in their current course redesign efforts. The course instructor noted that while the information was interesting, it did not really address his noted issue of engagement, but rather what he defined as student attention. Second, several of the educators challenged the format of the personas and the data upon which they were based. Most specifically, one educator noted the potential stereotype threat of the demographic information provided with the personas.

Ultimately, the personas and journey maps did not greatly or ostensibly influence the course design process or educator empathy for students. As noted in Table 2, the modest outcomes included marginal new awareness of student behaviors in the classroom, perhaps some rethinking of the classroom environment, and, most importantly, clarification among the team what the course instructor really meant by "engagement." The personas and journey maps were not referenced in future meetings and their lasting influence on the Electronic Circuits and Systems design process was limited. These tools did, however, draw interest from some team members, so long as they could be better adapted to their course design needs. Thus, the personas mostly served as an individual tool for reflection, an artifact that supported team communication, and an entry point to using personas, journey maps, and similar tools in the future.

This first iteration did clarify some issues that could be addressed through later iterations. First, several of the educators did not trust the data or the process used to develop the personas. This may have been connected to their own discomfort with design thinking and previous ways of understanding students, approaching course design, and ontological views. Second, while the personas and journey maps conveyed some interesting information, the educators were unsure how they might utilize it, beyond just their individual concerns about its origins. This may have had to do with the format of the presentation or, once again, their own discomfort with design thinking and related tools. Finally, the instructor demonstrated frustration over the misinterpretation of his goal of student engagement and how that was reflected in the personas and journey map. As an educator with a personally well-defined process, he did not see the value in these tools that did not support his vision.

These issues led the next team to identify a single, complex need: instructors needed a way to be more involved in the process. Through involvement of persona and journey map creation, educators could ensure that the focus resonated with their needs and priorities, giving them more reason to trust and use the results. This would also allow them to build comfort with and better understand aspects of the design thinking process and develop a deeper connection to the personas, and thereby their students. However, one challenge was how educators might be more thoroughly involved and how they might remain engaged throughout the process, given their current comfort level and trust in design thinking. We attempted to address these concerns in the second iteration.

Case 2: Second Year Embedded Systems Course

Embedded Systems was a second-year course required for electrical and computer engineering students. The course was taught by two faculty members in the electrical and computer engineering department who alternated between semesters. There were typically 150–250 students enrolled each semester, most of whom were second-year students majoring in computer and software engineering and third- or fourth-year students majoring in electrical engineering. The course redesign team consisted of the course instructors (a university professor and an associate professor in the ECE department), one other member of the ECE faculty, engineering education and higher education postdoctoral research associates, and a current undergraduate teaching assistant who had previously taken the course. Four of these team members had also participated on the Electronic Circuits and Systems team.

Based on the previous persona and journey mapping experience, the team took a different tactic in creating the personas and journey maps. First, each member of the team was involved in all aspects of persona and journey map creation, from data collection and user research to artifact development. Second, the personas were created as goal-directed personas, compared to the engaging personas of the previous iteration. These personas were simpler than the previous personas, focusing on three statements: what the student wants to do in the course, how the student wants to feel during the course, and who the student wants to be by taking the course. The focus on motivations rather than history and demographics resonated with the instructors' priorities and provided a simpler persona format that reduced the barrier to understanding. The involvement of the full team also had the benefit of incorporating more diverse data, user research and perspectives into the development.

The team began by compiling a variety of user research. This included student artifacts from the course (written reflections, end-of-year surveys, and assignments), firsthand and secondhand observations from the instructors and teaching assistants, secondhand observations from other team members (e.g., discussions with students about the course through informal interactions and research interviews), and prior analyses of selections of these course data. The team reviewed the data individually and later met to complete an empathy map to summarize what they saw. This empathy map differed from those displayed in Tables 2–4 in that they focused on observations of students, not the course design teams. Each team member contributed their observations until the team reached saturation. Then, the team collectively identified themes across the empathy map, which formed the basis of individual personas. The team described these initial personas and one member was tasked with refining and presenting the personas.

Once the personas were finalized, most of the team met to create a journey map (one member was unavailable at the time of the meeting). During this process, each team member took one persona and attempted to embody that persona (e.g., role-playing). The course instructor drew a weekly course timeline, with brief description of activities and milestones, and each member considered what their persona's experience would be like that week. The members then marked the level of feeling connected to the course material during that week and wrote a word or short phrase to encapsulate the experience. Each member shared their perceptions of their persona's experiences and discussed the collective experience. The team then moved to the next week until the journey map was complete.

The results of this second iteration are presented in the form of an empathy map in Table 3. Overall, this iteration was viewed as successful by the team. While a few of the team members noted challenges during the role-playing activities (e.g., trusting selves to accurately identify student perspectives), the activity was viewed as more engaging and outcomes more relevant to their course design and implementation purposes. The team felt engaged with the process through participating in the role-playing to create the journey map and energized by the collective discussion during and after the journey map activity. The team was also noted and demonstrated deeper understanding of a variety of student perspectives and awareness of the affective aspects of students' experiences (i.e., that all personas wanted to belong). The team also regularly referenced the personas and journey mapping results during subsequent course design meetings.

Table 3. Embedded Systems Empathy Map

Do/Say (Observable Behavior)	See/Hear (Experience)
Immersion in role-playing/role-taking Vivid discussion during empathy map, persona, and journey map creation Using personas to influence course design decisions	Now see personas in student interactions See course from student perspective (with some projection) Students as real and not idealized All personas wanted to belong
Think	Feel
More comfortable with design thinking and tools, but facilitator still necessary Have more insight into student behaviors More accepting of who students are "My job is harder now"	Encouraged by new perspectives Excited by team discussion Tired from the journey map effort Frustrated when students don't respond like personas
Needs and Insights	
Involving instructors had desired effect. Role-playing and team engagement aspects were essential to broadening perspectives. Instructors still need a way to become comfortable with the tools without a facilitator. Instructors need strategies to keep personas aligned with dynamic students.	
Outcomes and Opportunities	
Adoption of personas in course design team and instructor daily experience Deeper understanding of student experience through empathy and broader team perspectives Considering possibilities of extending tools for other uses (across courses and curricula, course activities)	

The success of this case example was largely attributed to three things: (1) a more diverse design team that included both instructors of the course, and other team members equally invested in student success; (2) more diverse data sources, such as proxy stories, written user feedback, and role-play of student personas to develop journey maps; and (3) more direct engagement in the persona development and journey mapping processes.

Case 3: Third Year Computer Architecture Course

Computer Architecture was a third-year course required for computer engineering students and an elective for electrical and software engineering students. The course was taught by two faculty members in the electrical and computer engineering department who alternated between semesters. There were typically between 60 and 150 students enrolled each semester (Fall semesters typically had more students). The course redesign team consisted of the course instructors and four additional members of the ECE faculty. Four of these team members had also participated on the Electronic Circuits and Systems and Embedded Systems teams.

Based on the previous persona and journey mapping experiences, the team took a similar tactic in creating the personas and journey maps as the Embedded Systems team with some modifications based on the course context and instructor interests. The team began by compiling a variety of user research. This included student artifacts from the course (written reflections, end-of-year surveys, and assignments), firsthand and secondhand observations from the instructors and teaching assistants, ethnographic observations by designers, secondhand observations from other team

members (e.g., discussions with students about the course through informal interactions and research interviews), and prior analyses of selections of these course data. The team reviewed the data individually and later met to complete an empathy map to summarize what they saw. Each team member contributed their observations until the team reached saturation. Then the team collectively identified themes across the empathy map, which formed the basis of individual personas. The team described these initial personas and formed sub-teams to refine and describe the personas. This time, personas tended to focus on key issues instructors had observed among students in the class.

Once the personas were finalized, additional student data was collected in the form of written student reflections. These were complete about once every two weeks after key lab exercises. The team convened about three-fourths of the way into the semester to review the student data and create an in-progress journey map based on the student experience thus far in the course. During this process, pairs of team members took two personas and reviewed the reflections of three students per persona. The students were selected by the instructor based on alignment with the personas. The course instructor drew a bi-weekly course timeline, with brief description of activities and milestones, and each pair considered their personas' experiences that week given synthesis of their assigned students' reflections. The members then marked the level of resonance with the course, which the team collectively defined as the degree to which "students perceive of the course experience as meaningful, valuable, and/or aligned with their interests and goals," at each milestone and wrote a word or short phrase to indicate the quality of the experience. Each member shared their perceptions of their personas' experiences and discussed the collective experience. The team then moved to the next milestone until the journey map was complete.

The results of this third iteration are presented in the form of an empathy map in Table 4. Overall, this instantiation was viewed as successful but presented substantive concerns and points of interest not identified during previous iterations. First, the team noted more nuanced issues with their enactment of the personas and journey maps. Prior to creating the journey maps, the team noted limitations in the personas due to their basis in instructor-observed issues (i.e., issues did not deeply consider issues from other perspectives). During journey map creation, the team also noted "artificiality" in aligning the personas with authentic data from specific students. Instead, most students aligned to some degree with multiple personas. This resonates with the conception of personas as composites of many users but creates challenges for creating journey maps based on composite user data. Further, during the journey mapping activity, the team spent a large amount of time discussing the y-axis label and struggling to negotiate and accept a definition of resonance.

While these issues could be seen as a negative, or at least distracting from the main purpose (to help understand students and make design decisions), they more aptly stem from prior engagement among the team members, and thus more nuanced considerations. Thus, the team showed greater awareness of and interest in design thinking and its tools. As a further example of this, two team members later began a project to build an automated journey mapping system based on a variety of course data. Second, whether due to use of authentic student data (rather than role-playing as personas) or the paired consideration of similar personas, several members of the team demonstrated deeper affective empathy for students, especially those who were struggling. This was a positive development but did leave some members feeling helpless when issues could be identified but no obvious solutions were apparent.

Table 4. Computer Architecture Empathy Map

Do/Say (Observable Behavior)	See/Hear (Experience)
Less immersion in role-playing/role-taking More discussion around persona and journey map process than previously Using personas to influence course design decisions	See personas in student interactions Connectivity between personas Authentic student responses What's happening to the "lost" students
Think	Feel
Uncertainty around the y-axis label and original concept of "resonance" Have more insight into previously hidden student behaviors "Personas seem more artificial now" Process took a long time	Increased affective empathy, especially for struggling students Increased worry about struggling students Excited about potential new course design directions Challenged by new considerations of resonance and personas
Needs and Insights	
Less role-playing made experience less engaging but allowed new insights. Instructors still need a way to become comfortable with the tools without a facilitator. Instructors need strategies to keep personas aligned with real students. Instructors need clearer ways to act on identified student issues.	
Outcomes and Opportunities	
Greater awareness of the use of tools in the design process, leading to greater awareness of nuanced issues with tool use (e.g., framing of "resonance," inauthenticity of personas compared to whole students) Deeper understanding of student experience through empathy and broader team perspectives, more affective considerations based on authentic responses from struggling students Considering possibilities of extending tools for other uses (in particular, automatic creation of journey maps based on course data) Instructor adaptation of tools to use in course delivery (e.g., setting expectations by showing a typical course journey map during an early lecture) Instructor using empathy and learning from persona and journey map creation to inform engagement with students and course design decisions	

This iteration also proved personally and professionally consequential for one of the course instructors, who had not been involved in either of the prior two iterations. First, the instructor became interested in journey maps as a tool for course design and course delivery in various forms. The instructor began to use journey maps to communicate course expectations (e.g., expected student journeys through the course). Further, he has begun a new project to develop a software tool that creates flexible and automated journey maps of students' course experiences to support instructor understanding, course decision-making, and, potentially, student reflective outcomes. Second, he noted that creating personas and the journey map "heightened and honed" his empathy with students. He frequently utilizes his newfound empathy to support course design decisions (inside and outside the course design team), inform his presentation of course material and expectations, and guide his interactions with students and lab groups. We discuss additional considerations related to empathy for each of the three cases in the next section.

Effects on Educator Empathy

Empathy between educators and students was evident in each of the three cases, but it differed in substantive ways. Each case offered unique manifestations of empathy connected with the unique ways personas and journey maps were created. Table 5 provides a snapshot of empathy that was evident in the review of each case. This includes the distinct *types of empathy* that were evident, within the cognitive-affective and self-other spectra, the *stages of empathy in design* as outlined by Kouprie and Sleeswijk Visser [21], and types of *empathic outcomes* observed. We unpack each case below, describing key empathic instances.

Table 5. Evidence of Empathy within Each Case

Aspect	**Electronic Circuits and Systems**	**Embedded Systems**	**Computer Architecture**
Empathy Types	Empathic concern, perspective-taking	Empathic concern, empathic distress, perspective-taking, projection	Empathic concern, empathic distress, perspective-taking
Empathy Stages	Discovery	Discovery, immersion, connection, detachment	Discovery, immersion, connection, detachment
Empathic Outcomes	Interpersonal	Interpersonal, behavioral, personal	Interpersonal, behavioral

Empathy in Electronic Circuits and Systems

Two key instances in the Electronic Circuits and Systems case demonstrated connections to empathy among the educators. First, when personas were presented to the team, several members pushed back against the inclusion of demographic information. They worried that such specific information could essentialize students who shared those characteristics and marginalize students who did not. This demonstrated a degree of other-oriented, affective empathy, or empathic concern, for students and how they might be treated within the design process based on the persona work. The second instance occurred during the review of the journey map. The team noted the connection between student behaviors across several of the personas and the effect that instructor activity had on those behaviors. While the processing did not appear particularly deep, the team demonstrated at least an attempt to understand how the instructor's activities affected students and why they took the actions that they did, thus demonstrating other-oriented, affective and cognitive empathy. Neither of these instances went much further than acknowledging students as targets of empathy and creating some surface-level interpersonal outcomes (e.g., generalized care and awareness of perspectives).

Empathy in Embedded Systems

Empathy in the Embedded Systems case was much richer and more enduring. The primary instance of this empathy was in the role-playing aspect of creating the journey maps. Here, team members cycled through each of the empathy stages. First, they achieved willingness to empathize with a

subset of students through inhabiting one or more personas. They then immersed themselves in the students' worlds by considering their experiences, perspectives, and feelings at key course milestones. They then experienced a connection to the students they were representing. This connection spanned the self-other and cognitive-affective spectra. Finally, having empathized with the students they leveraged those insights and experiences throughout other design phases such as framing the problem, ideating design concepts, and testing prototypes. The outcomes were interpersonal, but also affected both behavioral (e.g., treatment of students in class and positionality during design meetings) and personal outcomes (e.g., deeper awareness of one's ability to empathize with students and limitations therein). Thus, empathic outcomes related to this implementation were deep, robust, and enduring.

Empathy in Computer Architecture

Empathy in the Computer Architecture case was similar to the Embedded systems case in that it spanned most of the empathy types, stages, and outcomes, largely in the same manner. However, the immersion stage of empathizing differed in that the team analyzed and synthesized student reflections rather than role-playing. This resulted in a shallower connection to the students but a more accurate representation of their perspectives. This enhanced affective empathy types, particularly empathic distress at understanding students' struggles and not having ready solutions to resolve them. Like the instructors in Embedded Systems, at least one of the Computer Architecture instructors evidenced strong, robust empathy for students in follow-up design activities and reported changes to his individual instructional practice (e.g., way of engaging with students) based on his newfound empathy.

Implementation Factors

As a final step, we investigated factors that affected the utilization and outcomes related to personas and journey maps. By comparing across the distinct cases, we hope to identify considerations educators and researchers might use or further explore to enhance the use of personas and journey maps in a variety of educational and course design settings.

Data Analysis Method

We utilized thematic analysis to identify themes that were relevant across the cases. These themes were intended to represent key considerations in the use of personas and journey maps, especially in light of affecting empathy for students. We utilized a common thematic analysis process [31] but made modifications to best utilize case-to-case similarities and differences.

The six-step process was as follows:

1. **Familiarize Self with Data** – This step involved compiling and reading/viewing all data pertinent to each case. Data included observation notes and audio recordings of meetings, persona and journey map artifacts, and communications from team members.
2. **Generate Codes** – This step involved reviewing the data and coding passages related to development, utilization, or consideration of personas and journey maps.

3. **Identify Themes** – This step involved identifying patterns in the codes. Here, presence of constituent codes across the distinct cases could inform themes. Both similarities and differences across cases were considered.
4. **Describe Themes** – Once themes began to stabilize, they were elaborated with the support of constituent codes and excerpts.
5. **Check Themes** – This step involved reviewing the themes and their descriptions across three levels. First, themes were checked for internal alignment, i.e., descriptions matched the data excerpts that helped define the themes. Second, themes, collectively, were checked against the entire dataset to ensure they were representative and comprehensive. Finally, themes were checked against external scholarship to note consistencies, discrepancies, and novel insights.
6. **Write Report** – This step involved writing the narrative description of the theme that is consistent with the data and analysis and resonates with the larger literature base.

This process resulted in four key themes. We describe each below and explore how they could affect implementation decisions related to personas and journey maps in the course design process.

Theme 1: Instructor Involvement

One key factor that differentiated the Electronic Circuits and Systems case from the latter two cases was the involvement of the course instructor in the planning and development of the personas and journey maps. In the Electronic Circuits and Systems case, the instructor remained hands-off during the design process and the task was completed by an external designer. In the other two cases, the course instructors actively engaged in creating the personas and journey maps. The latter cases demonstrated positive results in terms of team engagement with the personas and journey maps, the effect these artifacts had on instructor empathy and course design processes, and overall acceptance and interest in personas and journey maps as course design tools. For example, one instructor began a project to develop an automated journey map creation application that leveraged data from a course management system. Conversely, while the team acknowledged some marginal insights in the Electronic Circuits and Systems case, they identified substantive issues with both the personas and journey map and did not leverage these insights or the artifacts that inspired them further in the course design process.

Discussions with and among the educators suggested that their direct involvement in the planning and development of the artifacts influenced the artifacts' utility and their personal buy-in in two ways. First, by participating in the persona and journey mapping activities, their sensibilities, knowledge, and priorities were imbued within the artifacts. Conversely, the Electronic Circuits and Systems instructor criticized and negated the journey map because the y-axis construct of engagement did not reflect his interpretation. Second, facilitated participation helped the instructors and other team members better understand the process of creating the artifacts, the philosophy behind them, and, through repeated engagement, nuances in their form and function. This understanding led to appreciation and more informed participation.

Theme 2: Diverse Voices

Each of the cases differed in both the make-up of the team creating the personas and journey maps and the sample of users (i.e., students) whose perspectives informed the personas and journey maps. In Electronic Circuits and Systems, the artifacts were created by a single designer based on the observations of a limited number of students in a single class section. In Computer Architecture, the artifacts were created by a team of mostly electrical and computer engineering faculty based on a variety of research on a majority of students across several course sections. In Embedded Systems, there was similar variety in student research but the team was more diverse and engagement with the student research was more varied. Ultimately, the Embedded Systems case was the most successful in (1) comprehensively empathizing with students, (2) accounting for a greater variety of student perspectives in the course, and (3) engaging the team in the process.

The teams noted one key distinction between the personas they created. The Embedded Systems personas focused on a variety of student motivations that affected a variety of course aspects, demonstrating several ways the course did or could uplift them and help them connect and engage. The Computer Architecture personas presented varied motivations, but these were more rooted in deficit-oriented perspectives. The course instructors played a more dominant role in the Computer Architecture personas, and thus they more greatly reflected issues the instructors had noted during their several course iterations but had been unable to address. These focused the design activities on fixing problems. Conversely, the more eclectic and egalitarian focus in Embedded Systems allowed each of the team members' interpretations of the variety of student research to inform the personas. This focused design activities not on fixing problems but on creating a learning environment that responded to the needs of many students and attempted to enhance their feeling of connection to the material and to engineering.

Theme 3: Play

Although personas and journey maps can be informed by user research, they are also widely noted as creative pursuits. In line with this framing, many of the team members championed the opportunity to "play" in the creation and utilization of the artifacts. This took several different forms. In both the Embedded Systems and Computer Architecture cases, the team enjoyed open-ended, fluid sessions exploring the student research and gathering over whiteboards and sticky notes to craft personas. Further, the act of role-playing as a team to create the Embedded Systems journey map was noted as particularly fun and engaging. Team members demonstrated more opportunities for novel insights and new directions in the settings in which they were given space to play. This is easily contrasted with the Electronic Circuits and Systems case, where the personas and journey map were presented via slideshow in a conference room.

One notable effect of play was on the framing of the y-axis constructs across the cases. As previously noted, the Electronic Circuits and Systems y-axis construct was simply defined as "engagement." Neither the journey map developer, nor the instructor/team had a chance to play with this construct. They ended up defining the construct differently, which limited their own engagement with the journey map in the course design process. Conversely, the other cases had a chance to try out different conceptualizations of the y-axes, both in ideating labels and negotiating definitions. While the entire team was not in perfect agreement on the y-axis construct in the

Computer Architecture case, it held important meanings for each member, facilitated the creation and interpretation of the journey map, and led to engaging discussions about the nature of "resonance" and the direction of the course they were designing.

Theme 4: Trade-Offs

This theme notes that while each of the previous three themes may be relevant in the creation and utilization of personas and journey maps in course design, they each also come with a critical trade-off. In theme 1, instructor involvement supports buy-in, effective utilization, and even professional development. However, instructors noted the increased demands on their time and effort that such involvement creates. In the Computer Architecture and Embedded Systems cases, instructors appreciated the opportunity to participate in the process but noted that other instructors might find it daunting to devote the time they did.

In theme 2, diverse voices both in the design team and the student research informed more robust and generative personas and journey maps. However, these diverse voices also increased the time it took to complete the activities and the mental challenge of synthesizing such rich student data. Team members agreed that the level of diversity in the Embedded Systems case was most desirable but also indicated that design teams ought to consider the utility of adding more team members and a greater variety of student research data rather than simply adding team members or student data blindly.

In theme 3, play was seen as a necessary aspect of achieving novel insights and generative outcomes. However, it was also viewed, from a more traditional productivity lens, as potentially wasteful if taken to extremes. Put simply, the teams were worried about spending too much time on exploration without achieving tangible results. This concept is perhaps amplified by potential Theme 1 trade-offs. However, the teams evidenced a viewpoint that finding a comfortable medium level of play was ideal.

Conclusion

This paper presented three case studies of the use of personas and journey maps in the course design process. By investigating these cases, which each differed in team constitution, process, and persona and journey map format, we suggested factors that may have informed different outcomes related to the effective use of personas and journey maps, the educator experience of using these artifacts, and the empathy for students such experiences might generate. In general, greater instructor involvement, more diverse perspectives, and opportunities to play supported more effective and positive outcomes in the cases, but each of these themes was paired with a potentially mitigating trade-off. We do not present these themes as firm conclusions in these areas, simply observations that may inform usage and research in other contexts. We hope that this work inspires others to try out personas and journey maps in their course design contexts and further contribute to understanding of where, how, when, why, and with whom they might be effective.

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