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JOURNEY MAPPING THE VIRTUAL DESIGN THINKING EXPERIENCE: ENGAGING STUDENTS ACROSS DISCIPLINES IN HUMAN-CENTERED DESIGN

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ABSTRACT

Practitioners' and students' experiences while engaging in design thinking and human-centered design activities is well understood to shape outcomes of those activities. However, an understanding of the trajectory of experiences that characterizes the design thinking process, and relates experiences to outcomes, is still emerging. To contribute to this knowledge area, we examine six student teams engaged in a project-based learning course, and seek to understand each participant and team's experiences with the design thinking process across each design phase, through discrete assessments, and holistically, through reflections on the entire process: what we term journey mapping the students' experiences. This approach reveals two preliminary findings about the trajectory of novices participating in design thinking work. First, we note that the beginning, research-oriented phases of the design thinking process appear to offer a less positive experience than later phases. Second, we note that students of engineering and non-engineering backgrounds have differing retrospective reflections on their design thinking experiences. These findings suggest that deeper engagement with particular design thinking phases, and an awareness of disciplinary experience, can positively shape the experiences of design thinking practitioners. Also, these results suggest that the significant factors impressing upon a participant's design thinking experience may change throughout the process.

Keywords: Design Thinking, Human-Centered Design, Journey Mapping

1. INTRODUCTION

The emergence of design thinking frameworks shares a history with the construct of *wicked problems* [1], increasingly common and complex challenges facing societies. Design thinking has, in the past two decades, evolved as an approach to take actionable steps in addressing these problems. Over time, many frameworks and pedagogical approaches have emerged from the design thinking community (e.g., Google Design Sprint, Stanford/IDEO's design thinking process, the Innovation Process, and the Double Diamond) [2–5]. While the diversity of design thinking methods to choose from has become abundant, metrics to define success of these methods are yet to be definitively established. Simultaneously, the experiences of design thinking practitioners - what we term in this work as *participants* to capture their dual role of participants in an innovation process, and their participation in a research study - have been shown to shape design outcomes, as exemplified by recent studies exploring situated emotion and psychological safety [6,7].

In this work, we seek to characterize design thinking frameworks in relation to the participants' experiences as they navigate the design process in the context of their own work. We conduct a longitudinal assessment of student teams practicing the design thinking process over the course of an intensive, six-week project-based learning course. We examine how participant experience correlates to various critical nodes in the design thinking process, which we study using assessments of particular design phases and also reflections and assessments that consider the design process holistically. Together, these examinations form *journey maps* of the student participants' experiences as they navigate the design thinking process. In our previous work [8], we used journey maps as an instrument to study the experiences of participants in the design process. Here, we extend on previous findings to more deeply explore student experiences, and subsequently construct journey maps to describe participant experience holistically.

The following research questions were used to frame the goals of this study:

R1: How do students' self-reported ratings for individual experience change as they navigate through phases in the Design Thinking journey?

R2: How does a student's academic discipline and Design Thinking team shape the trajectory of their self-reported ratings during the Design Thinking journey?

R3: How do students' self-reported ratings observed in their First Design Thinking journey (during the journey itself) compare to ratings reported in their Final Design Thinking journey (after the journey is complete)?

2. RELATED WORK

2.1 Measuring and Evaluating Design Thinking

As design thinking has emerged across academic and professional disciplines [9, 10], the need to assess design thinking metrics has surfaced as a need for the field [11]. Many conversations about measuring design thinking emphasize 'mindsets and capabilities,' 'outcomes,' and 'participant experience.' [12].

The study of design thinking mindsets and capabilities are arguably among the first to directly address setting foundations for measuring design thinking. Suggested design thinking mindsets and capabilities that have emerged from the field include: tolerance for uncertainty, a risk taking mentality, empathy, human centeredness, a holistic perspective, experimentalism, optimism, and a dynamic mindset, just to name a few [13-17]. Chesson, Dosi et al., and Hassi & Laakso recently documented an extensive collection of these in their work [13,14, 17]. While these traits offer a reference point for measuring design thinking skills, Royalty et al. caution against the binary perspective of design thinking as a skill (or set of skills) that a person possesses or lacks [18].

There is less agreement across design thinking discourse about factors that contribute to design thinking outcomes. Nonetheless, pressure to prove that a design thinking practice, or similar innovation-based practice, is successful usually results in drawing some correlation to improving financial outcomes for a company or organization [19]. As Mayer argues in a large-scale interview study, even experienced design thinking practitioners often relied on financial outcomes as measures of success. Additional expectations that are often reinforced by organizational standards include measuring project-based efforts at intervals [20].

Validation through external experts, empirical evidence via success stories, and contextualized project-based metrics serve as an approach to pacify those seeking immediate signs of design thinking success in organizational structures [21]. However, attaining measurable proof of design thinking success is generally a difficult task [22]. On that note, Björklund et al. presents the Design Ladder [23], Design Value Scorecard [24], and Design Maturity Matrix [25] as examples of frameworks that measure design thinking progress and outcomes within organizational structures [21]. While these offer a starting point for how design thinking outcomes (and checkpoints along the way) are beginning to be assessed, there is still much to be learned about how to measure design thinking outcomes and which frameworks to choose based on the organization's goal.

Additional examples of performance measurements for design thinking, primarily adapted from organization management research, includes Balanced Scorecard [26] and Du Pont's Pyramid of Financial Ratios [27,28]. From conducting a literature review on performance measurement of design thinking, Haskamp proposes three streams of performance measurement: (1) innovation, (2) impact, and (3) the organization. Still, there is skepticism and disagreement about the usefulness of performance measuring instruments for design thinking stemming from concerns about how these metrics may lead to less creativity and misleading incentives for participants [28]. Ultimately, the degree of difficulty involved in identifying and engaging with sufficient metrics and measurement instruments for design thinking outcomes makes this a complex problem. Mayer et al. argue that better trusted solutions are found by identifying eight challenges related to the measurement of design thinking activities [29].

In this work, we extend on existing approaches to understanding the success of design thinking by centering participants' experiences in the process as a key metric of project and personal outcomes from design thinking. The work represents a preliminary step towards incorporating experience assessment into a deeper understanding of the effectiveness of the design thinking process.

2.2 The Role of Participant Experience in Design Thinking

Efforts to measure the participant experience of design thinking have benefitted from project-based learning and interdisciplinary team research. Participant motivation, conflict, and participative safety are three useful metrics that have proven useful as applications from project-based and team research on design thinking research. Kröper et al. used the experience sampling method (ESM) to measure chronic affect and chronic regulatory focus in design thinking participants as a way of assessing participant motivation. ESM is designed to capture a participant's immediate conscious experiences by prompting them for responses (via questionnaire) several times a day [30,31]. Jehn frames a definition for three kinds of conflict related to project-based learning: task conflict, relationship conflict, and process conflict. Moreover, Jehn and Ewald et al. provide sufficient rationale to consider participative safety as a key design thinking factor to measure since relationship conflict and process conflict have been significantly linked to negative impacts on team performance, team satisfaction, and team cooperation [32,33]. On a related note, task conflicts are indecisive – meaning there is not significant data to declare a positive or negative impact on team performance, team satisfaction, or team cooperation; specifically, that is without adding context such as when the conflict occurred during the team life cycle (earlier or later) [33,34].

Edmondson explains team psychological safety (closely synonymous with participative safety) as a "shared belief that the team is safe for interpersonal risk taking [35]." While, participative safety has only been minimally correlated with innovative outcomes – in which some attribute to the "comfort zone effect" – others note that it is important to distinguish between participative safety and similar socioemotional team factors, such as team cohesiveness, that may be also be disguising the value of participative safety in design thinking [33,35,36].

In short, through design thinking, project-based learning, and team collaboration research, there is enough understanding about socioemotional factors to state that failing to cultivate an inclusive environment for each design thinking participant to feel valued and treated as an equal, compromises the impact of the design thinking process [37,38].

In this work, we extend on existing explorations of characterizing design thinking success by seeking to more deeply understand novice design thinking practitioners' experience *over time*. While previous research examined the importance of various measures of participant experience, such as psychological safety, in particular phases of design or specific design activities, we seek to examine participant experience across the entirety of the design thinking process. In doing so, we are able to extend previous findings by looking at prevalent experiences that may characterize particular design process phases.

2.3 Journey Mapping Experience with Socioemotional Factors

Journey mapping is a human-centered design research method that is commonly used in exploratory research and testing stages of design thinking as well as in organizations to assess a customer's or user's interaction with their products and services [39]. Recent studies have demonstrated the value of using journey mapping to collect data about experiences where socioemotional factors are important contextual factors [40,41]. Similarly, there have been adaptations of journey mapping being used for academic research purposes in addition to more conventional organizational and commercial research focuses [40,42]. In fact, Dove et al. describe their approach to the journey mapping method as something that "spans across time, devices, and workflows; and characterizes a complete set of customer interactions with a company [40]." Also, Sinitskaya et al. introduced the combined, "linked" journey mapping technique in an effort to capture multiple perspectives of the same experience [42].

This study draws on these examples of journey mapping as a data collection tool to support capturing participant experiences in design thinking. We extend on prior work methodologically, as this work uses journey maps to understand the experience participants in the design thinking process, rather than the experience of customers.

3. MATERIALS AND METHODS

3.1 Course Description

The setting of this study takes place during a course at a public research university in the United States. This course was listed as a 2 unit course, spanning a 6 week duration over the summer. All course activities were conducted online via synchronous video conference platforms and included the Mural platform for virtual collaboration. Of 23 enrolled students, 13 chose to participate in this study. There were 10 female and 3 male participants. Also, 7 participants were from non-engineering disciplines while 6 participants were from engineering disciplines. Non-engineering major fields represented included Cognitive Science, Chemistry, Data Science, Statistics, Environmental Science, Psychology, American Studies and Art Practice.

This course was a project-based learning course that guided students through the five phases of the Human-Centered Design (HCD) process (Research, Analyze, Ideate, Build, and Communicate). After an introductory module in which student teams were formed around a specific topic, each module of the class focused on one of the phases of HCD. Each module combined lecture and readings to introduce key concepts of the phase and in-class activities and out-of-class individual and team assignments to support experiential learning and develop design thinking mindsets in students. Key deliverables for the course included several activities such as conducting user interviews, framing a problem to solve using "How Might We" statements, brainstorming ideas as a team, creating a final prototype, and communicating the value of a solution through a slide presentation and short video.

3.2 Data Collection

This investigation leverages the use of journey mapping to collect self-reported data about design thinking experiences. The rating system used for this study is aligned with what has been used in engineering design self-efficacy (EDSE) related work. Also, this study includes documenting multiple journey maps for the same experience. This was partly inspired by journey map studies where participants got a chance to reflect and, potentially, change responses that they submitted towards the documentation of their journey maps [42].

Two methods were used for collecting the data. They are referred to as the "first" and "final" journey maps. The first journey map involves collecting students' self-reported ratings about their design thinking journey via Google Form at specified intervals during the design thinking process. The final journey map involves collecting students' self-reported ratings of their design thinking journey all at once after the process has concluded. The schematic in Figure 1 illustrates the frequency in which the journey map data were collected in relation to the duration of the course.

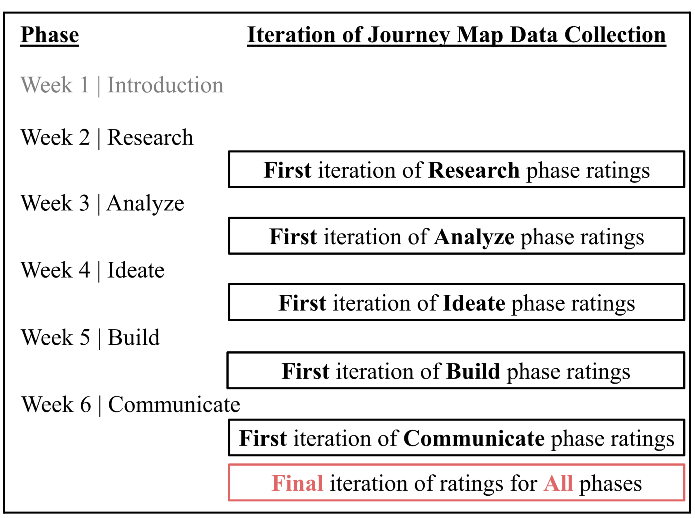

FIGURE 1: FREQUENCY OF JOURNEY MAP DATA COLLECTION (FIRST AND FINAL ITERATIONS)

Documentation of the first journey map involved using data collected from students' "Phase Reflection" assignment. This assignment was delivered via Google Form and was embedded in an online course environment that was to be completed within the first 10 minutes of class following each phase of the Design Thinking process. There was one exception: during the final week of the course, the last "Phase Reflection" assignment was due at 12pm the day after final presentations. .

Specific instructions were provided to students in the google form as prompts to document both a self-reported rating and qualitative comment about their individual experience, individual performance, team experience, and team performance. So, a total of four self-reported ratings and four qualitative comments were collected from each student during each phase. This manuscript focuses on the individual experience ratings reported by students.

The prompt for students to report individual experience feedback states the following: "On a scale of 1-10, how would you rate YOUR EXPERIENCE with the activities and assignments required during this phase of the Human Centered-Design process (10 being MOST satisfying and 1 being LEAST satisfying)"

Documentation of the final journey map involved collecting interactive plots (created in Google slides) that students submitted through their online course environment as a part of their "Individual Reflection" assignment. This assignment was due on the final day of the course (which was also two days after all of the first journey map data were collected). The instructions are provided below:

"The purpose of this exercise is to create two Journey Maps that illustrate your journey through the human-centered design process. The Journey Maps should reflect PERSONAL evaluation of (1) individual success, (2) individual satisfaction, (3) team success, and (4) team satisfaction at the five stages during the human-centered design process.

For each step in your journey map, please associate a rating on a scale from 1-10 that corresponds to how you felt during that stage. For this exercise, a rating of 10 represents the MOST successful and MOST satisfactory experiences, while a rating of 1 represents the LEAST successful and LEAST satisfactory experiences."

Instructions communicated during class for all journey map assignments (related to both first and final iterations) included a reminder that they would be graded for completion and that the content of the submission would not impact their course grade.

3.3 Data Analysis

Data for four journeys were collected at each phase of the five design thinking process. This was done during design thinking experience (first journey map) and after the entire experience was over (final journey map). With 13 participants in this study, there were a total of 520 self-reported ratings and 520 qualitative comments to be collected (2 journey collection efforts x 4 types of ratings to document x 5 design thinking phases x 13 participants). In actuality, there were 456 self-reported ratings and qualitative comments collected – in which, missing data points were due to students not completing particular assignments.

Steps to analyze the self-reported ratings included beginning with using type III, two-way ANOVA tests to determine which factors (academic discipline, iteration, design thinking phase, and team) were significantly impacting the self-reported rating submitted by students participating in this study. After identifying which factors were significant, one-way ANOVA tests were performed as post hoc tests to determine which specific factor levels were significantly impacting self-reported ratings. Finally, Shapiro-Wilk's test (test for normality of the data) and Levene's tests (tests for homogeneity of variance) were performed to validate assumptions of the ANOVA model.

Complimentary to statistical methods being used to identify significant factors and factor levels, affinity mapping was used as a technique to extract high level themes that were discussed in the qualitative comments. Themes were sorted based on the design thinking phase.

3.4 Assumptions

The course in which this study was conducted uses the term "Human-Centered Design process" while this study uses the term Design Thinking. These terms are assumed to be synonymous. Regarding academic discipline, students that were listed as studying Computer Science were counted as engineering students although some of them are on a degree path where they will receive degrees from the college of letters and sciences instead of the college of engineering (this distinction has mostly to do with their elective courses).

4. RESULTS AND DISCUSSION

The following results and discussion topics will be presented: (Sections 4.1) statistically significant factor and factor levels that influence the self-reported journey map ratings; (Section 4.2) qualitative data expressing key themes from each design thinking journey across all phases of the design thinking process; and (Sections 4.3 & Section 4.4) finally discussions of limitations and future work, respectively.

4.1 Significant Factors and Factor Levels Acting on Self-Reported Ratings

Since the journey map data was unbalanced and included several independent variables, several type III ANOVA tests were performed to understand the significance of each variable in relation to each other and the dependent variable – the self-reported ratings of the students. Table 1 represents all of the factors and factor levels influencing the dependent variable – numbers next to each factor level represent the number of participants represented in each factor level.

Factor	Factor Levels
Discipline	Non-engineering (7), engineering (6)
Phase	Research, Analyze, Ideate, Build, Communicate
Iteration	First, Final
Team	Team-A (2), Team-B (2), Team-C (3), Team-D (2), Team-E (2), Team-F (2)

Table 1: FACTORS AND FACTOR LEVELS ASSOCIATED WITH SELF-REPORTED RATINGS IN EACH JOURNEY MAP

After conducting type III ANOVA calculations and several one-way ANOVA Tukey post hoc tests, additional tests were performed to validate assumptions of the one-way ANOVA tests. That is, performing the Shapiro-Wilks test to confirm a normal distribution of the data and performing Levene's test to confirm that the population variances are equal. Table 2 provides a list of the factor and factor level combinations that passed these tests – indicating that this factor and factor level combination exhibits significantly different expressions from the self-reported ratings.

The following plots (Figures 2-6) provide a closer look at how the significant factors and factors levels from Table 2 impact the trajectories of self-reported ratings for students' design thinking journeys.

Rating Type	Factor	Factor Level
Individual Experience	Discipline	analyze
	Iteration	non-engineering
	Phase	engineering
	Phase	team-C
	Phase	team-E

Table 2: FACTORS AND FACTOR LEVELS SIGNIFICANTLY IMPACTING INDIVIDUAL EXPERIENCE SELF-REPORTED RATINGS

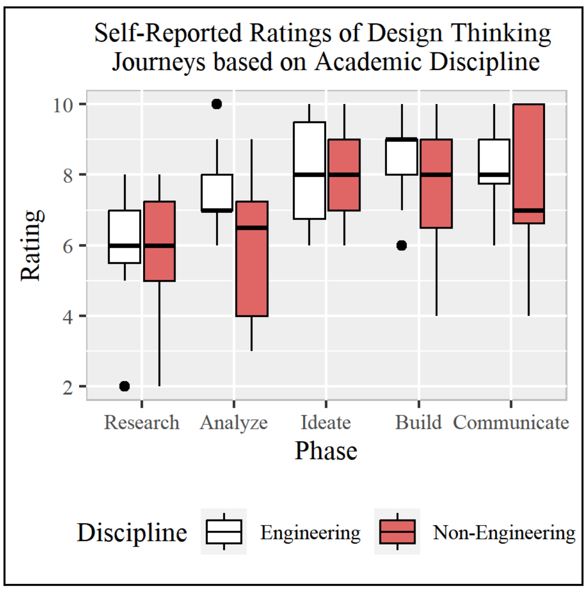

FIGURE 2: IMPACT OF ACADEMIC DISCIPLINE ON THE ANALYZE PHASE OF THE INDIVIDUAL EXPERIENCE SELF-REPORTED RATINGS

Figure 2 applies most to RQ1 and RQ2 by demonstrating a significantly different experience for engineering and non-engineering students during the Analyze phase. Figure 3 addresses RQ3 by showing that non-engineering students expressed a significant difference in their self-reported ratings during their first journey map vs their final journey map. Figure 4 addresses RQ1 by demonstrating significantly different experiences for engineering students at the beginning phases of the design thinking journey compared to those at the end. Finally, results from Figures 5 & 6 are most related to RQ1 and RQ2. In these figures, the beginning of the design thinking journey seemed to be a significantly worse experience than the later half of the journey – particularly for students from Team-C and Team-E.

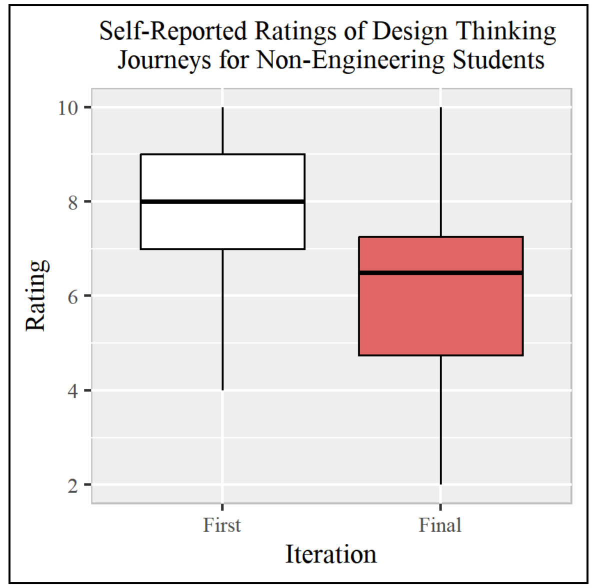

FIGURE 3: IMPACT OF JOURNEY MAP ITERATION ON INDIVIDUAL EXPERIENCE SELF-REPORTED RATINGS FOR NON-ENGINEERING STUDENTS

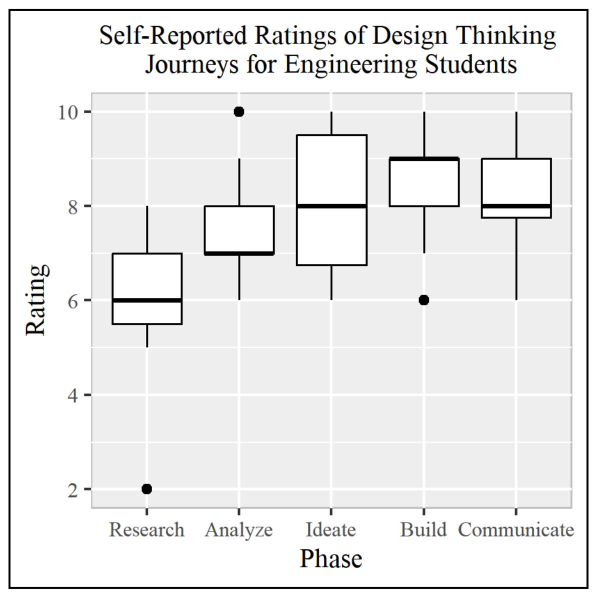

FIGURE 4: IMPACT OF DESIGN THINKING PHASE ON INDIVIDUAL EXPERIENCE SELF-REPORTED RATINGS FOR ENGINEERING STUDENTS

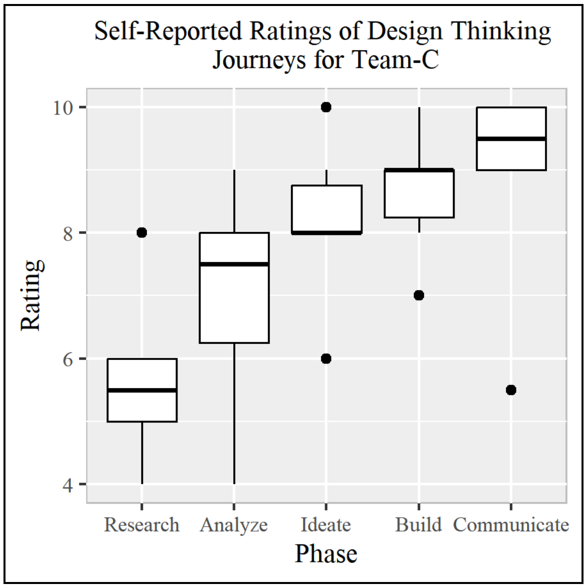

FIGURE 5: IMPACT OF DESIGN THINKING PHASE ON INDIVIDUAL EXPERIENCE SELF-REPORTED RATINGS FOR STUDENTS ON TEAM-C

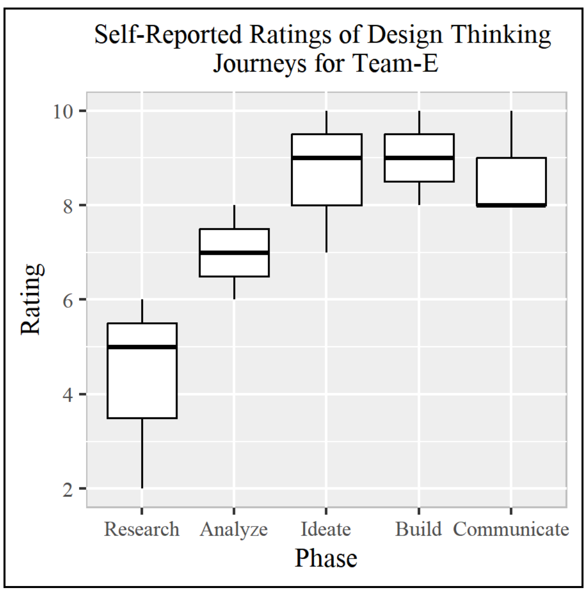

FIGURE 6: IMPACT OF DESIGN THINKING PHASE ON INDIVIDUAL EXPERIENCE SELF-REPORTED RATINGS FOR STUDENTS ON TEAM-E

4.2 Qualitative Themes from Self-Reported Ratings

4.2.1 Non-engineering vs Engineering student individual experience ratings during the "Analyze" Design Thinking phase

Quotes provided in Table 3 were selected to further understand significant differences in individual experience by non-engineering and engineering students, during the Analyze phase.

Discipline	Quote
Engineering	"I have really enjoyed completing the project so far! The interviews I conducted [were] actually very interesting to sit on and provided me with a great amount of background information to actually get my part of the project started."
Non-engineering	"It was difficult for me to find the right rhythm for this class. I found it to be difficult to keep up with."
Non-engineering	"I believe as far as the material of the course goes, it's exceptional. However, there is just too much work to keep up with . . . I try to provide the assignments with quality, but I feel as though it is sometimes hard to do so given my bandwidth and the tight deadlines."

TABLE 3: ENGINEERING VS NON-ENGINEERING FEEDBACK ABOUT THE ANALYZE PHASE

Quotes from the non-engineering students during the analyze phase are centered around workload expectations of the design thinking process. Differences observed between engineering and non-engineering students may indicate varying values and expectations of project-based learning across academic disciplines.

We hypothesize that students are struggling in the early phases because of the inherent ambiguity of the research and analyze phases of the design thinking process [43], which especially embody the 'fuzzy front-end' of innovation work, characterized by high levels of uncertainty. To explain the salience of this sentiment among non-engineering students, we hypothesize that, compared to engineering students, non-engineering students are less familiar with project-based learning and navigating ambiguity in teams toward building consensus. The latter is a characteristic of many team-based project experiences in engineering education [44].

4.2.2 Individual experience during the "Research" phase vs "Ideate," "Build," and "Communicate" Design Thinking phases

Quotes provided in Table 4 were selected to further understand the significant difference in individual experience by all students during the Research phase vs the Ideate, Build, and Communicate phases.

While section 4.2.1 expresses a significant difference in how engineering students and non-engineering students experience the early stages of design thinking, this section highlights how students appear to have significantly better experiences in later stages in the design thinking process compared to earlier stages. Based on the quotes above, a plausible reason for this difference could involve students having an affinity for solution framing vs problem framing. Moreover, it may be worthwhile to consider that each phase of the design thinking process may require different amounts of time in order for participants to feel satisfied and successful about their experience and performance.

Phase	Quote
Research	"While I was able to produce decent work, I found the process of transcribing interviews to be incredibly tedious and tiresome which accounted for a large portion of my disdain and initial lack of motivation to move forwards"
Ideate	"This was definitely one of my top-favorite phases to have engaged in thus far. I really enjoyed implementing a weighted matrix and 2x2 matrix, and stimulating my thoughts and ideas in generating five solutions to our problem. This phase definitely pushed me to think the most and forced me to get more creative."
Build	"I personally found the build phase to be really fun. Creating prototypes helps with envisioning the final product because you now have something tangible to work with and manipulate. The process of actually making the prototypes is also nice because you are putting [or] taking different aspects from the ideation phase and trying to figure out how to put them together in a cohesive way like a puzzle."
Communicate	"The reason that I chose this rating [10] is because it was exciting to finally see 6 weeks worth of hard work come to life."

TABLE 4: RESEARCH PHASE VS IDEATE, BUILD, AND COMMUNICATE PHASE FEEDBACK ABOUT THE DESIGN THINKING INDIVIDUAL EXPERIENCE

4.2.3 First vs Final journey map ratings from non-engineering students

Quotes provided in Table 5 were selected to further understand significant differences in individual experience by non-engineering students during the First and Final journey map iterations.

A plausible cause for significant differences between first and final journey map ratings for non-engineering students may include some combination of less familiarity with project-based courses and recency bias – rating an experience from one design thinking phase based on the previous.

Iteration	Quote
First	"I think our team continues to grow throughout the different phases and I think the IDEATE phase was a shining example of how we have grown as a team…."
First	"The reason that I chose this rating is because I found this to be the most exciting part of the course. While there were quite a few assignments to complete, they were extremely helpful in guiding my team and I in the right direction. I also found the assignments to be fun."
Final	"This was really hard because we weren't given much instruction on what to do considering the limitless boundaries."
Final	"I really enjoyed this phase because I was able to indulge in a variety of potential solutions without necessarily having to worry about feasibility yet."
Final	"This phase I rated 7 This build phase was daunting at first but once the design was settled it became fun to create a prototype."

TABLE 5: FEEDBACK FROM FIRST VS FINAL ITERATION OF JOURNEY MAP DOCUMENTATION FOR NON-ENGINEERING STUDENTS

Also, the context of being able to reflect on the entire design thinking experience may prompt non-engineering students to re-evaluate the takeaways from the design thinking experience with more scrutiny. For example, non-engineering students may not be as satisfied as engineering students with creating a low to medium fidelity prototype as their final artifact during a design thinking experience.

4.3 Limitations

In relation to the unbalanced data, many statistical tests were used to declare significance of several factors and factor levels acting on the students' self-reported ratings. Using so many statistical comparisons with this unbalanced data set and a small sample size of participants makes this work vulnerable to the multiple comparisons problem. Future work would benefit from clarifying these vulnerabilities by using methods that address this conflict – such as the Bonferroni correction.

The distinction between academic disciplines was drawn at engineering vs. non-engineering. Taking into account the specific disciplines of the participants would likely lead to other ways to consider how different academic paths might impact a participant's journey through the design thinking process. As described previously, this would require a larger sample size to better represent sub-disciplines of engineering and non-engineering fields.

4.4 Future Work

With a comfortable understanding of valued design thinking mindsets & capabilities, outcomes, and participant experience, a significant contribution to the field of design education and design research would involve assessing how factors related to mindsets & capabilities, outcomes, and participant experience interact with each other. Identifying factors that have the most significant impact on what it takes to design think effectively enables academic, professional, and organizational efforts toward scouting and developing design thinking mindsets, cultivating ideal environments for design thinking experiences, and producing optimal results from design thinking work.

One of the expected results of this study included finding some kind of symmetry between the first and final design thinking journeys. Or perhaps more interesting, to find a significant difference in the one of the factor level's impact on the iterations of self-reported ratings of the first vs final design thinking journeys. In other words, this means discovering if the perspectives of design thinking participants change after they have had a moment to reflect on the experience in its entirety. In retrospective, it may have been helpful to actually inquire about the hypothesized perspective shift through a procedural step in this study. Instead, adding this layer of inviting the participant to acknowledge a perspective shift (or consistency) may provide more insight. After all, some change may be due to poor memory or recency bias.

Takeaways from the qualitative feedback suggest that some design thinking phases invite more polarizing experiences than others. Based on the qualitative feedback it seems to be the research phase and the communication phase (or the beginning and the end of the design thinking journey). It may be helpful to invest in understanding strategies to both diagnose and help teams that are having an extreme experience on the negative end in these phases.

5. CONCLUSION

The guiding research questions for this study are all rooted in better understanding participants' perspectives of the design thinking process. The following results were the most notable findings from this work.

First, self-reported ratings of individual experience during the Analyze phase were significantly different for engineering and non-engineering students. Also, this study found that first and final self-reported ratings of the design thinking experience are significantly different for non-engineering students. This may be due to varying expectations of the value of the design thinking experience by non-engineering students. Finally, the pace of typical design thinking experiences can be a lot to digest and as a result, the individual experiences of design thinking participants at the beginning phases (research) are significantly worse than individual experiences at the later phases (ideate, build, and communicate).

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