Developing Framing Judgment Ability: Student Perceptions from a Graduate UX Design Program

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ABSTRACT

Making framing judgments is at the heart of design. When faced with complex, open-ended situations, designers need to exercise good judgment to identify the core of the problem at hand and set the boundaries of the conceptual space through which the design process will unfold. While framing ability is broadly recognized as important, the factors that contribute to its development in educational settings are not well understood, particularly in the context of HCI education. In this study, we collected data from master's students in a UX design program at several points in time across their program journey. We interviewed 11 of these students in their final semester, having them reflect on how their ability to make framing judgments has evolved over time. We highlight pedagogical factors relevant for the development of their framing ability as indicated by the students. Our findings also highlight the impact of framing ability on other design activities and personal design philosophy.

CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI)**; • **Applied computing → Education**; • **Social and professional topics → Computing education**.

KEYWORDS

HCI education, framing, design pedagogy, design judgment

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1 INTRODUCTION

Judgment making is central to design, and good design relies on the ability of designers to make good and wise judgments. Judgment is what allows designers to appreciate what is important in a particular situation, and what is inconsequential or of less importance based on their sensitization to the problem space [26]; it supports designers in selecting the right tools and methods [16, 25]; and even to determine the core problem or opportunity at hand in ambiguous, complex, and open-ended situations [8]. In general, judgment is what allows designers navigate the complexity of real-world situations with skill, involving both their sensemaking and conceptual understanding of the unique attributes of the present design situation prior to any decisions being made. Due to the centrality of judgment, its development should be one of the core goals of design education. However, there is not much literature investigating pedagogical strategies for developing judgment ability, particularly in HCI and UX education.

Design judgment has been theorized generally (e.g., [18, 26]), and has been investigated in the context of specific disciplines (e.g., instructional design [2, 20], interaction design [24], and data visualization design [27]), with only a few instances investigating judgment from an educational angle. In the most comprehensive theoretical framework, Nelson and Stolterman [26] outline 12 different types of judgments that are made throughout design processes. They note that one type in particular—framing judgments—serves as one of the most consequential, as framing judgments set the foundation from which the design process proceeds. Prior empirical work has similarly shown the centrality of framing judgments, with early work by Gray et al. [12] showing that framing judgments occurred very frequently, and served as organizers for relevant design complexity at both a micro- and macro-scale. In this study, we investigated student perceptions of their framing competence and its growth over time, seeking to answer the following research questions:

- How does the ability to make framing judgments change over time as students progress through an intensive master's-level UX design program? What are the educational factors contributing to such change?
- How do students conceptualize the relationship of their framing ability to other aspects of their design work? How does

this ability influence their sense of design competence and their personal design identity and philosophy?

2 PROBLEM FRAMING AND FRAMING JUDGMENT

Framing is a fundamental cognitive act underlying all thought [22]; hence, its relevance cuts across all human activity. Scholars have studied framing across several disciplines and contexts, including design, psychology, management, public policy, and others. Problem framing—a particular kind of framing—refers to the structures, metaphors, variables, and assumptions that contribute to how a problem is conceptualized—including what the 'core' of the problem is, what should be foregrounded and what should be kept in the periphery. Classic examples highlighting the importance and difficulty of framing include issues relating to climate and environmental concerns, public infrastructure, and social housing [8, 21]. Such issues are essentially 'wicked'—open-ended, complex, and dynamic. These issues are especially challenging because they involve far more than technical concerns, and the attempt to address them through the instrumental application of technical knowledge inevitably falls short [32]. Instead, they are value-laden, not amenable to optimization, and involve several political, social, and ethical ramifications [11].

Working in the field of design inherently requires designers to deal with open, networked, dynamic, and complex problems [8, 26]. Such problems are rooted in a landscape full of potential constraints and paradoxes, where the solution for one problem is likely to lead to additional problems (i.e., Rittel and Webber's "no stopping" rule [30]). Expert designers rely on design knowledge and design judgment to handle such paradoxes, and in particular make use of framing judgments [4, 23, 33]. This form of judgment becomes key in these situations by providing a new way of looking at the problem situation itself in ways that privilege or foreground certain constraints or aspects of the overall design situation—involving the needs of other stakeholders, the conflicting values or appreciative systems of these stakeholders, and early formulations of potential design solutions [6, 7, 32].

Prior work has shown that expert design practitioners have sophisticated ways of creating problem frames. Based on decades of work studying expert designers, Dorst has proposed the following nine–step frame creation model: (1) 'archaeology', where the apparent nature of the problem and previous attempts to address it are investigated; (2) 'paradox', where the core challenges and contradictions are surfaced; (3) 'context', where practices of key stakeholders are explored; (4) 'field', where the exploration is broadened to include all potential players that may have a connection to the problem; (5) 'themes', where the deeper factors that underlie needs, motivations, and experiences of the potential players are analyzed; (6) 'frames', where frames are proposed based on connections identified among the previous steps; (7) 'futures', where frames and their solutions are envisioned in the future and their promise is explored; (8) 'transformation', where frames and solution directions are critically evaluated; and (9) 'integration', where the frames and their ramifications are brought into the context of the individuals and organizations involved. In this model, the first four steps lay the groundwork, the fifth involves an analysis from which new frames can be created, and the final four steps explore the implications of the frames. Dorst notes that the steps can occur in parallel, and the starting point is not always the first step. Models such as this can be used to interrogate the practices of students in HCI programs—e.g., identifying which steps students tend to skip or not engage with deeply enough. Ideally, if project prompts are open and complex enough, students will have the potential to engage with most or all of these steps in their work. Figure 1 depicts the considerations from Dorst's model that go into framing, including the groundwork components, the forward-looking components, and their connections leading to a problem frame.

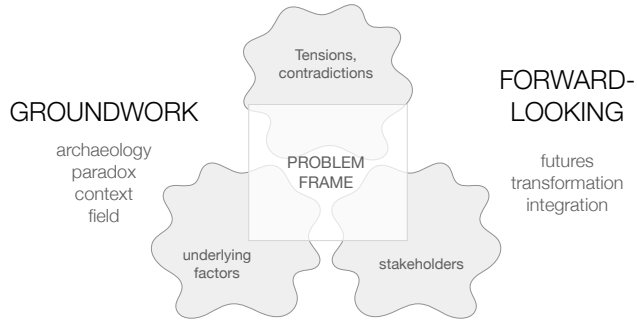

Figure 1: A frame is created from a process involving several components, including those needed to build the groundwork, and those needed to envision future possibilities. When brought together, a problem frame can be created where the core of the issue is identified. Inspired by Dorst's frame creation model [8].

Broadly construed, making framing judgments can involve more than determining the 'right' view on the problem or situation at hand. In its broader construal, framing refers to setting the boundaries of a project or process—determining what is included and what is not. In their theoretical treatment of design judgment, Nelson and Stolterman [26] identify framing judgments as the key to establishing a design direction—the "passkey to the overall formation of the design pallette". They note that framing judgments set the space of potential design outcomes, delineate the conceptual space in which the designer operates, and provide the initial determination of how the design process will unfold. Framing judgments may take place throughout a whole design process, but are essential and particularly concentrated in the early parts of the process. Figure 2 depicts framing judgments that need to be made—in relation to materials, methods, deliverables, features, and so on—to set the scope of the design process, determining what the edges are and what is beyond consideration.

In this work we view framing broadly, inclusive of notions of both 'problem framing' and 'framing judgments'. Our view is inclusive of framing activities focusing on identifying the core problem at hand—i.e., what is the actual problem, and why is it a problem?—and more practical judgments that need to be made about the scope of the work—e.g., who are the stakeholders being considered, what materials will be used, and what features might a solution include. Designers must make several framing judgments at multiple scales to determine the problem frame and relevant scope of consideration.

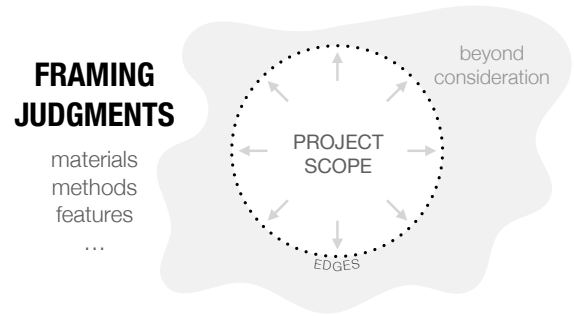

Figure 2: Framing judgments that need to be made—in relation to materials, methods, features, and so on—to set the scope of the design process, determining what the edges are and what is beyond consideration.

3 EDUCATIONAL CONTEXT

Here we describe several details about the educational context in which this study was conducted. At a large, research-intensive university, we have developed comprehensive, studio-based programs in UX Design at the undergraduate and graduate levels. The programs exist within a polytechnic environment where technical, human, artistic, and social concerns are brought together in a transdisciplinary fashion [35]. We have outlined several details of our program elsewhere, including how the program is built on an integrated studio structure [35], where students are continuously engaged in project-based learning experiences with multiple types of design competence addressed through a spiral pedagogical framework [14, 15]. Some of the pedagogical innovations we have pursued include a vertically-integrated curriculum [28], the intentional separation of grading and feedback [29], a focus on cultivating reflection as an attitude and way of being [14], and the promotion of intercultural learning experiences [13].

Our program development efforts were originally focused at the undergraduate level, which led to the development of a five–semester studio sequence. Our MS-level program was modeled on the undergraduate program, but was developed as a three–semester studio sequence due to a smaller footprint for the plan of study. Students progress through the following sequence of core UX classes: the first studio course—"Grad Studio 1"—which focuses on the fundamentals of human-centered design, user research, prototyping, and evaluation; a seminar course focused on the fundamentals of UX and HCI theory and history; the second studio course—"Grad Studio 2"—which builds on the first and adds a focus on cross-channel design and emerging technologies; a qualitative research methods course; and the third studio course—"Capstone"—which is focused on the students' capstone project. Students are generally admitted as a cohort, and proceed through the sequence of courses together. The cohort size has been growing since the start of the program, currently sitting at around 20 students.

The faculty in charge of the program treat it as a "living laboratory", allowing for the collection of data in relation to specific pedagogical choices while in an authentic learning context. Students are aware that the faculty study the program and refine it in response to data collected and analyzed across the course sequences. All data collection is approved by a university research board, and students are consented each semester for their data to be linked across their courses.

Course Projects. During the program experience, students complete 6 to 8 group design projects in the core UX studios, at least one qualitative research project, and an individual capstone project. Students also complete projects in their elective courses, some of which may involve design or HCI-adjacent types of projects (e.g., in the context of game design, virtual or augmented reality, data visualization and visual analytics, and educational technology). In Grad Studio 1, students complete the following four group projects: (1) redesigning a fitness tracking experience, with an underlying focus on mental models and behavior change; (2) redesigning a freelance platform, with an underlying focus on multiple stakeholders and rating systems; (3) envisioning new technology-mediated grocery shopping experiences, with an underlying focus on multiple touchpoints and embodied interaction; and (4) designing an enculturation experience for new students to a UX program, with an underlying focus on service, place and spacex, and scale. The briefs for these projects are intentionally open-ended, introducing students to the complexity of the problem space without prescribing specific problem frames or solution directions. In the Capstone course, students work individually, proposing a project and executing it with instructor oversight, including regular critiques and check-ins from the instructor and peers.

4 METHOD

In this study, we focused on one cohort at the graduate level, following their progression through the program and examining data collected at multiple points in time. The cohort was in the final semester of the program, beginning their capstone project, at the time of writing. The first author was the instructor for this cohort's first studio—in the fall of their first year—and their capstone studio in the spring of the final year. Figure 3 depicts the sequence of core courses a student goes through, and the points at which data were collected for this study.

Our primary contribution comes from interviews conducted with the students. We used the following data collected from classes to structure the prompts for our interviews: entry and exit surveys, class projects, and weekly reflections. On the first day of each course, students are given an entry survey, asking them to self-report their perceived competence on several core skills. Questions included "defining UX design", "collecting data from users to guide design decisions", and "finding the 'right' problem to solve", among others. Students provided their answers on a likert-type scale from 1 to 7. On the last day of class, students receive an exit survey composed of virtually the same questions as the entry survey.

To prepare for our interviews, we examined students' responses from the entry and exit survey of their first studio, and the entry survey of their final, capstone studio. We used their scores to prompt them to reflect on their experiences, and their ability to self-assess their framing ability, while in the program. The precise score given on the surveys was not very important; rather, we were more interested in the development of ability over time, and the ability to self-assess.

We recruited students who were enrolled in the master's-level UX specialization and were in Grad Studio 1 with the lead author as instructor, and enrolled in the Capstone course at the time of the study. Students were contacted via email about participating in our study. Of 14 eligible students, 11 volunteered to be interviewed. Interviews took place via Zoom and were recorded and subsequently transcribed. The second and third authors, who are both graduate students (not part of the cohort being studied) conducted the interviews. Not having an instructor involved in the interviews may have led to more authentic discussions.

At the beginning of each interview, participants were shown their responses to the following surveys: entry and exit surveys from Grad Studio 1 and entry surveys from Capstone. We focused on the question about finding the 'right' problem to solve. We asked participants to reflect on their previous scores, and tell us whether they now think the earlier scores were accurate or not. This would usually lead to discussion about their own ability to self-asses their work and how that has developed over time. We then asked participants to think back to the projects they did in Grad Studio 1, probing them to think about their framing approaches (e.g., 'how did you decide on the core user group?', 'how did you decide what the core of the problem was?', 'how did you decide the scope of work to take on?'). Following this, we asked about their current projects in their Capstone. At the time of the interviews, all participants were in the preliminary stages of their capstone project and making critical framing judgments to set their projects in motion. Finally, we asked how their framing abilities have impacted other aspects of their design work, including their sense of competence, identity, and philosophy. Interviews ranged in duration from 25 to 45 minutes, and averaged approximately 30 minutes.

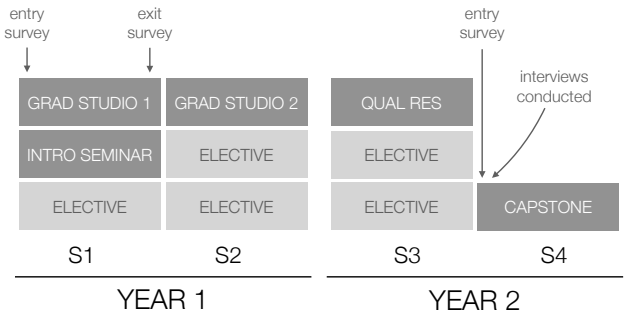

Figure 3: Course sequence for our program, depicting core UX courses (Grad Studio 1, Grad Studio 2, Qualitative Research Methods, and Capstone) and electives. Program length is two years, spanning four semesters (S1-S4). Data were collected at different points throughout the journey of a single MS cohort, including entry and exit surveys.

4.1 Analysis

We analyzed the interview transcripts using a hybrid coding strategy—involving both deductive and inductive approaches—deriving the initial codes from our research questions then inductively developing themes. Three researchers independently coded the data. After the initial round of coding, as a research team we engaged in multiple rounds of discussion to ensure the codes accurately captured the data. We resolved any disagreement in the interpretation through negotiation to arrive at full consensus.

5 FINDINGS

We report our findings in relation to the research questions we set out to answer. Specifically, we present (1) participants' accounts of their framing ability changing over time; (2) the educational factors participants recognized as contributing to their development; and (3) participants' perceptions regarding how their framing ability relates to other aspects of UX design.

5.1 Change in framing ability over time

Here we identify key themes in relation to how students perceived their framing ability changing over time. During the course of the UX Design program, students noted a transformation in their ability to frame problems and make important judgments to set the boundaries of their design work. They considered themselves to be more open, confident, practical, and reflective.

5.1.1 Becoming comfortable with uncertainty. P4 described being scared with the uncertainty involved in problem framing early on in the program, and feeling the need quickly jump into solution mode: *"I think it's good to be hung up on the problem. Sometimes, when you are new to these things, being hung up on a problem scares you—you're like, I want to find a solution. That's what makes you self-conscious and scares you. But I feel like now, when I am hung up on a problem, I am in a good space—I don't feel scared. I feel like, okay, I'm doing some progress. I am, you know, I'm in a phase, I will get out of it, but this phase is good for me."* P10 described something similar, noting that the original prompt provided by the instructor is simply a starting point for engaging in framing judgments: *"I think the biggest one is that I try to embrace the ambiguity or uncertainties during the process. And I will not stick to the original project prompt [provided by the instructor]. So I tend to consider the original project scope or the brief as a hypothesis, and then try to use different kinds of methods to validate the hypothesis or refrain from the prompt, and try to find the root problem and to solve it."*

5.1.2 Embracing openness and avoiding early attachment. Many participants felt they had become more open to tackling unstructured problems and avoiding fixation, with several indicating they are now more open to multiple and diverse perspectives. In one instance, P6 reflected on the downside of limiting the scope too quickly, noting that earlier in the program she would : *"narrow down too quickly and then realize, oh, this is not working"*, adding that *"now it's more so I know a space, I keep it open enough that I, you know, I have different options within that space to pursue."* Multiple participants noted that they no longer fixate on their initial ideas while attempting to frame a problem. For example, P4 says, *"initially I was becoming a little attached to my ideas and my work, and that's why I had trouble letting go of them and listening to other people."* P3 shares a similar account, saying *"we were thinking maybe whatever happens at the end, we need to give some sort of screens or UIs that need to fix something. [I] feel like that approach wasn't that good. Maybe if I did the project again now, I would not keep that lens*

[...] the point is keeping more of an open mind and not just thinking about, oh, it's just gonna be like a few screens and a few buttons and stuff like that."

5.1.3 Appreciating diverse aspects of the design situation. Students described being able to appreciate aspects of the design situation that they previously would not have recognized as relating to their framing judgments. This included spending more time with the project brief, getting to know the target audience, and focusing on and building upon primary and secondary research. P1, in reflecting on factors they considered as being relevant for framing judgments, noted how they now consider research on the problem domain as being essential for framing: *" I think research is also part of the framing, and then identifying the good question and the context in some ways. More and more I realize I have to be a better researcher to be a good designer."* When reflecting on a particular project undertaken in Grad Studio 1, and how they would have done it differently now, P4 described *"For start I think we would spend more time understanding the brief. Secondly, we would spend more time planning what kind of data we want, like what kind of sample we want to go forward, what kind of people we want to interview."*. This answer indicates P4's expanded awareness of important factors to consider when making framing judgments and setting the boundaries of the project space.

5.2 Educational factors influencing framing ability

Students highlighted several pedagogical factors that they recognized as contributing to the development of their framing abilities. These factors ranged from having open project prompts that introduced ambiguity into the early parts of the process, to the creation of an environment that encouraged peer learning.

5.2.1 Open-ended prompts for projects. The kind of project prompts that are given to the students played a crucial role in enabling them to learn and appreciate the value of framing. For example, P3 noted that open-ended prompts allow for many possible problem framings: *"because it [the prompt] was so vague, and there were so many things you could do, but couldn't do them all in the time you had—that was a good exercise [for framing]"*. Reflecting on the openness of one particular prompt about redesigning the grocery shopping experience, P6 stated *"I think of different, just like problem spaces—for example, grocery shopping. Am I interested in like, you know, health related [issues], am I interested in just efficiency, you know, improving the efficiency of shopping? Am I interested in the delivery system? So these are the different spaces that I kind of start with."* Then, making a circle with her hands, P6 went on to say *"And then also, so like the here, here's the problem prompt"* and then gesturing to areas outside the circle, *"But then I think there's like different facets to it. There's different areas of focus you can choose."*

5.2.2 Multiple shorter projects. Throughout the program, students complete 3-4 major projects per course, and often work on related projects simultaneously across multiple courses, depending on the electives taken. P5 described how doing multiple projects helped them in learning and practicing their framing abilities and added: *"so for you as a designer to identify that opportunity, that design space, we need to practice it a lot, tackle that skill a lot, exercise it. And I felt like I developed some amount of expertise as compared to when I started off."*. P8 recalled the impact of projects they did on their framing and highlighted: *"I feel like at the start of the semester I did have a few like HCI projects, so I did sort of know and understand how to scope problems [...] So all of that, like experiencing multitude of prompts that varied from like narrowish problems."* P11 too felt that the experience of doing multiple projects shaped their judgment, reflecting: *"being just thrown at different problems, and then having to figure your way out out of like, okay, well, this is how we're going to tackle this certain type of problem. I think the experience and just doing it a lot and getting feedback, like helps that area [framing] a lot."*

5.2.3 Working in groups in a studio setting. Several students highlighted the impact that group projects had on the development of framing judgments. P9 pointed out that working in a group environment opened them up for the possibility of looking through multiple perspectives, stating *"I've learned that there's multiple angles that you would need to look through—or multiple lenses that you need to look through—when you're trying to define a problem. And I think that has really helped me within my capstone as well, like how to define a problem and the, all the readings that we do, they really talk about like different aspects."* P8 shared how various group members have introduced them to a unique way of looking at problem situation and says, *"So a lot of other people bring in other expertise as I mentioned. So some of them, some people are from like design backgrounds. Some people like myself are from technical backgrounds, like computer science. So it's like people bring in different lenses to a problem. So at times I'm like, okay, I think this is like something that we can apply. Other people are like, ok, no, this is something else that we can also explore. And then you talk to other people from other groups. So that's also like pretty interesting, right? You had different perspectives on that."* Several students also reflected on how observing and engaging with other teams that were working on the same project was influential in developing their framing abilities. For example, P8 recounted: *"A lot of other groups are solving the same problem, right? So you then you realize, okay, this is also as different scope that people are looking at. And then you realize, oh there are like tens of different ways of like narrowing down a problem. So looking at other people and then diverse groups"*.

5.2.4 Instructor and peer critique. One factor mentioned by most participants in shaping framing ability was feedback and critique given by instructors and peers. For example, P4 mentioned how the instructor's feedback was critical in shaping the direction of a project, stating: *"I think I knew that I was like pushing through ideas that were not making sense just because I wanted to do them. [...] you know, definitely [instructor's] feedback was good. Like he constantly was asking me, okay, 'how would this work? How do you imagine this will be?' And these kind of questions were just helpful in thinking what kind of outcome I want. And that's how I realized that I want more like a strategic research for design outcome rather than like a physical product. I think that was the big turning point."*. On a similar note, P2 discussed the impact of the instructor's feedback in shaping the problem scope, saying *"I was doing, how can we improve their experience and decisions. And then I kind of talked to [instructor] about it [...] then [instructor] was like, 'oh, this is a good question, but it's too broad—I can do 20 different projects about what*

kind of experience or what kind of decisions.' So I kind of changed it to basically one specific thing I was looking at.".

Apart from individual feedback from the instructor, students pointed out benefits of joining other teams' feedback/critique sessions. P8 shared that *"[the instructor] also encouraged us to join other groups' critique sessions. So that way that was also pretty interesting. That was very subtle, but that was very impactful for me. Cause I used to just go in and sit on other groups getting their critique done. I was like, oh, okay, this is pretty interesting. This is how they're talking about their project. This is the critique they're receiving. So this, these are the things that generally like a lot of groups are falling short on. So this is something to keep in mind—xyz, something along those lines."* P9 thought that being able to listen to other teams' feedback also influenced the growth of problem framing ability, concluding: *"Also, another really good part of the studio environment was that other groups were allowed to sit in their critiques when [instructor] was critiquing us. So we not only had feedback or like our own point of views or the three of us who were in the group, but we would hear from other people as well. And then we had an opportunity to sit in their critiques and learn how are they trying to approach the problem."* P4 reflected on the value of instructor feedback, and also being able to see the work other teams were doing, saying *"I remember most vividly was the first project [...] I remember thinking that, oh, I did such a great job. I collected amazing data. I have so much data, you know, I found the right problem, I designed the right solution. My solution looks really good, like aesthetically. And I remember thinking myself like I did a great job. Like I would've scored myself like 10 out of 10."* Then, reflecting on the role of instructor feedback and peer critique, they continued: *"But then like after we received feedback, after I saw what others did, after I, you know, did some more projects—now when I think of what I did, I think it was like absolute garbage."*

5.2.5 Readings and reflection. One of the core aspects of our program is an emphasis on reading and reflecting on scholarly HCI texts. The majority of participants reported using reflection in their own design process and underscored how it has developed their framing abilities. P10 says, *"I took several classes last semester and I feel like something in my head about UX design have changed—due to the readings from these classes [...] I feel like I gradually realized that design process includes multiple re-framing and reflection practice. So the original project goal—um, project scope—is not fixed."* Further, P9 talked about the various perspectives that readings offer and how reflecting on them could enrich the repertoire of one's own design knowledge that is relevant for framing, saying that the *"reflection part specifically really helped understand the other nuances that exist within HCI or UX design. And I think keeping those different aspects in mind when you are approaching a project, you start thinking like various other problems that would affect [...] You know, I think it's just more exposure to different problems, more exposure to different case studies, how different people approached a specific problem, what variables did they consider? I think just, you know, more exposure to literature and being able to reflect on it [influence framing ability]."* Students sometimes were unhappy about the theoretical and scholarly nature of the readings, not understanding their relevance to 'practical' design work. P1, for instance, reflected *"So during my first year, I didn't know why we had all this like very boring philosophical readings and frameworks, and theories. And I was like so bored, and then I was kind of disappointed in [program name] like, ah, why don't we do more practical stuff? [...] But from the second year while I'm being a better researcher, I think research is also part of the framing."*

5.3 Other factors influencing framing judgments

Apart from the pedagogical factors, students pointed out a range of other factors they considered as important in influencing their framing judgments. For instance, P3 and P10 highlighted how confidence plays an important role in making framing judgments. P3 says, *"since that was our first kind of intro to projects in the grad program, we were kind of nervous and we didn't wanna go too far out to choose a very specific audience that we would've trouble finding. [...] So that was easy. We just went out, interviewed our roommates, our neighbors, [...] We didn't even narrow down."* Similarly, P10 felt that *"since I have several years of working experience, but all this project experience happened in [country], not in the states. So probably I had like 75 or 80 percent of confidence about my skills knowledge towards UX design."*

Many of the participants noted how the role of team members impacted their framing judgments, identifying the influence of attitude and outlook of team members. For example, P5 shared their experience of working with a dominant team mate, recalling: *"But for the fourth project I had one team member who was terrible, absolutely terrible. And so the rest of us, like the three of us just, it was like my way or no way [in reference to framing]. And so we didn't wanna deal with it and it was very tough to deal with. So eventually we were just like, okay, whatever, we are just gonna finish this semester."*. P10 shared how working in interdisciplinary teams can encourage reflection on framing judgments: *"I remember we were struggling with the data analysis and reframing the core problem, but I think I learned a lot from my teammates because I collaborated with two students from interaction design [a different program on campus that is more arts-focused] [...] it was interesting to see how different people consider or reframe the same problem."*

Several participants discussed how resources, including time, skill, and access to target audiences influenced their framing judgments. P3 says, *"that was kind of a change in scope midway, because earlier our draft was like, oh, we'll just code everything [...] and then we found out we can't [...]"* Further, they added, *"over here, mostly my frames have been around people that I can easily access [...] I can just narrow down on students like [...] But yeah, and that all stems from deadlines."*. P1 also felt that most of their project framing related to students because they were easily accessible and concluded: *"a lot of target audience like unfortunately narrow it down to like lots of twenties and like students based because it's really easy to interview them and then it's like very accessible like so that's because there's like an audience right next to you. So that's why how you narrow it down. So it's more like convenience"*

5.4 Influence of framing ability on design practice, identity, and philosophy

We aimed to investigate how students perceived their framing abilities as influencing other aspects of their practice and identity.

5.4.1 Influence on competence. Reflecting on their framing ability, several students noted feeling more confident in their work and in their ability to make judgments about the quality of their methods. For example, P3 noted: *"we found out, okay, this frame doesn't make sense. It needs to be more focused [...] So we kind of reframed everything and we weren't afraid to go out and do the observations again and the interviews again. So I think when we did that, we felt like, okay, we've developed some competence here"*. P1 discussed becoming more careful and reflective in their approach, taking more time to think before diving right in: *"I became less reckless in some ways. Before I was just like, oh, if I see it I just dive into it [...] [now] I start to take [a step] back and decide: what do I have to know? What kind of question do I want to answer through this? Like [considering the] whole experience or process."* Overall, several participants felt they had become better designers as a result of their improved framing abilities. P3 reflected on how his increased confidence in framing has led to more predictability in his design work, stating: *"I think my sense of predictability has also increased. So if I frame a problem, I can now predict to some extent whether I will be able to obtain good information about this within the time I have, or will it be difficult to do so? So in Studio 1—a bit of Studio 2 as well—we usually chose frames and target audiences and narrowed down scopes that would be easy to do [...] And we were like, we can't change; we will find something easy to do because we don't wanna change it after a while. But now it's easy to predict, okay, if I change it to this, can I still do it? So if I feel like I've developed enough expertise to know that, to be able to predict that."*

5.4.2 Influence on other aspects of design activity. Virtually all students we interviewed highlighted the impact of framing on other aspects of their design activities, including resource planning, primary research, presentation, critique, and documentation. For example, P10 now likes to keep a cushion of time for each project to account for framing, noting: *"I realized that you have [have] multiple framing or reframing things during the design process; when I try to plan out the tasks for a design project, I would [now] have more buffer time."* P2, who is currently focusing his capstone project on international travel, reflects on the importance of making framing judgments to have a clear definition of the scope before interviewing, saying: *"even within the method, you can tell what exactly to look for and not to look for—and that depends on your problem framing. Once you actually identify the problem, you can basically make—let's say if I'm making my interview protocol for the travelers without actually narrowing it down to like cultural stuff, it would just be so broad, saying, 'oh, what are some decisions you make you made in your international travel?' That's such a broad question now because people make like what, a million decisions a day? [...] So making more specific about like, oh, what kind of cultural food you tried, what have, why didn't you try this? Why that kind of specific questions leads more like exactly results you're looking for."* P2 then reflected on his development, noting *"I feel like, yeah, for the first project [in Grad Studio 1], I would've definitely just asked them very broad questions without narrowing the problem."* P9 noted how the practice of framing encouraged seeking out critique, saying *"I've learned to ask questions at every stage when I'm trying to frame a problem—I think, and, you know, ask for feedback and get critique."*

5.4.3 Influence on design identity and philosophy. P8 and P10 highlighted how their philosophy has taken on a more humble and open-minded nature as their framing ability has increased. P8 summarized: *"my design philosophy sort of changed to like [...] trying to see a problem from a wider lens—initially trying to know what I don't know [...] So that is a sort of level that I try to reach initially when I'm researching, I go like, okay, these are the things they exist, I don't know, but I don't really care about them because I'm sort of focusing on this [other thing]. So knowing what I don't know is something that I develop in my philosophy."* P1 and P6 discussed framing in a way that prioritizes creating an impact or advocating for a cause, which were noted as important aspects of their philosophy. For example, P1 discussed how focusing on the problem frame is important for creating impactful design outcomes, saying *"Yeah, like looking for the problem and then trying to make a better place through my design—it's my philosophy."* P3 discussed his design philosophy as being "practical", noting *" my design philosophy includes, at the end of the day, whatever you design, it should translate to or should have potential to translate into something that can work in the real world. So whatever I frame, I try to think about it with that lens."*. P3 described his philosophy shifting throughout the program as result of different types of projects and experiences. When referencing a design fiction text as part of Studio 2, P3 noted *"It was something very much into the future. And I had a tough time understanding that, to be honest, because again, it contradicted with my personal philosophy."*, following up with *"But then we did the design fiction exercise, and all my prompts, all the stuff that I mentioned in that exercise, it was futuristic, but it was also things that you could do. Maybe not now, but like two, three years from now. So again, my predictability factor comes in there—I can predict that. Okay, maybe not now, but maybe five years from now, this can be done. Like something similar can be done. So I feel like that affects my framing as well."* Here P3 described how the ability to make good judgments about the nature and scope of a project—particularly in relation to its practicality and predictability—was an important aspect of his philosophy.

6 DISCUSSION

Our findings indicate that improvement in framing ability occurred as a result of students progressing through a graduate-level UX design program. The findings also suggest characteristic markers of this change, including students becoming increasingly comfortable with uncertainty, embracing openness and avoiding early attachment, and appreciating diverse aspects of design situations. Students reflected on the educational factors they believed influenced their development, which included open-ended prompts for projects, having multiple shorter projects, working in groups in a studio setting, receiving instructor and peer critique, and engaging in scholarly readings and reflecting on them. They also noted factors that influenced their framing ability, including confidence levels, team members, and various resources including time, skill, and access to participants. Finally, students reflected on how their framing ability influenced their design competence, methods and activities, and their personal design identity and philosophy.

Here we reflect on several aspects of our pedagogy that are designed to address the points above, encouraging students' ability to make framing judgments. Many of these have been discussed

elsewhere [14, 16, 35] in a general sense, and here we link them specifically to the findings surfaced in the previous section.

Frequent practice with many projects and opportunities for productive failure. We found that the inclusion of multiple projects across relatively aggressive time scales forced students to engage in framing judgments as a means of coping with complex, wicked problems under time pressure. This necessity of problem framing was reinforced not only as a practical matter of identifying relevant constraints to narrow a broad problem in a short period of time, but also in using resource constraints in creative ways to link a team's sense of purpose with incentives that would be more likely to lead to tractable pathways towards design outcomes. These opportunities also presented opportunities for productive failure—where the failure to frame quickly enough or in meaningful enough ways in one project might lead a team to frame more purposively in the next project cycle of the same course. Thus, framing ability served as a gateway towards competence development that had downstream impacts on design argumentation, utilization of appropriate methods, and a match of outcomes to the lived reality of end users, among others. Prior research has shown positive learning effects from dealing with failure [5, 19]. Research has also shown positive performance effects due to working under time pressure in scientists and engineers [1], although more research is needed to study these factors in the context of HCI design pedagogy.

Open-ended, ambiguous project prompts. The use of open-ended, complex prompts was intentional in our curriculum, pushing students to consider design problems as inherently wicked and ill-structured. As an outgrowth of these classic characteristics of design problems foregrounded by Rittel and Webber [30] a half-century ago, these prompts embodied this complexity and forced students to engage with framing as a key element of making an ill-structured problem first understandable and then later on, tractable. We modeled these open-ended prompts to reflect the reality of design practice, providing an analogue for the vast complexity of socio-technical ecologies in which most designers seek to promote change. And in using directional ambiguity to point towards areas of socio-technical complexity in the prompts, we began to sensitize our students towards the trails of evidence they may need to traverse to better understand the complexities of the domain they were working within, and thereby providing even more opportunities to practice their skills in both framing judgment (identifying which constraints would form their ultimate problem and solution space) and appreciative judgement (identifying which values point towards more or less valuable potential outcomes within the problem and solution space).

Reflection. Reflection is a central pillar of our pedagogy. We promote reflection as a habit and a way-of-being, rather than as an isolated act, with the goal of students adoptive a reflective approach to all aspects of their design work and as a way to understand themselves as designers [26]. We promote this type of reflection in several ways, through weekly written reflections in a Slack workspace, written reflections on class assignments and readings, and reflections during class discussions and activities. As noted by several participants, these reflection activities enabled them to develop an awareness of the importance of framing broadly speaking, and of individual framing judgments that they were making in particular contexts. These realizations align with known benefits of engaging in reflective practice in design contexts [17, 34]. We build upon previous scholarship that addresses the role of reflection in students' development of their design identity [14], including social effects such as the building of trust among students within and across cohorts [15]. We also model these reflective activities ourselves as instructors, socializing these behaviors and seeking to lessen the power distance between instructor and student.

Feedback and critique. Students were able to leverage socialization opportunities around their design activities that aided them in forming initial judgments, becoming critical of their own and others' approaches towards their design process and potential solutions, and in modeling expert design behaviors. Our use of the studio environment as a space to both practice design and engage in cognitive apprenticeship—learning from the activities of more capable others—allowed students with many different types of prior professional training to both build new skills and abilities as designers and also communicate their existing knowledge and related perspectives to their fellow classmates. Critique, in both formal and informal forms, given by instructors and students, provided the primary communication conduit for these interactions. These informal opportunities for critique are known to be important for building both design competence and identity [10]. Peer critique among students facilitated open-ended exploration of new problem frames with active problematization by fellow classmates, while navigational feedback from instructors allowed students to consider new points of view that might result in small or substantial changes in problem framing to aid them in reaching a more tractable solution space. While feedback is known to be critical for learning, it is a general concept with a high degree of variability, requiring specific attention to the kinds of feedback being used and the underlying goals for using them [37]. Building on studio pedagogy literature [3, 9, 31], we have aimed to leverage forms of feedback spanning degrees of formality (e.g., informal desk critique or a formal presentation), modalities (discussion, Slack critique, written documentation comments), and combinations of participants (one-to-one instructor critique, one-to-many instructor critique, and student-to-student critique). We have also enacted strategies to deliberately separate feedback from grades (see [29]), which can improve student engagement and satisfaction with feedback [36].

6.1 Limitations

Due to the nature of the study design we followed, we cannot be certain about which pedagogical factors led to which changes, and to what degree they may have done so. Our constructivist orientation led us to focus on the lived experiences of participants, foregrounding their perspectives on developing framing ability, rather than attempting to control variables within the pedagogical landscape to identify precise causal relationships. The pedagogical factors that we describe in Section 6 reflect the voices of the participants, the accumulated knowledge of the researchers, and what is known about effective design pedagogy broadly construed. Thus, we believe with reasonable confidence that students' ability to make framing judgments did improve throughout the program, and that some or all of the discussed pedagogical factors influenced that development.

Students volunteered to participate, and although we had high coverage within the target population, it is possible that our findings are not reflective of all students in the program. Because our main source of data is from interviews, the findings are subject to the usual limitations of this kind of research (e.g., demand characteristics, memory limitations, rationalization tendencies). Additionally, because our primary interest was in the development of framing ability, we did not focus on students' more general perceptions, such as whether they had positive or negative experiences with courses or projects. We also did not attempt to uncover any aspects of the program experience that may have hindered or negatively impacted the development of framing ability, as this was outside the scope and would likely require a different study design.

The extent to which our pedagogical initiatives can be transferred to other contexts depends on many factors, including the amount of control over curriculum decisions, the size of classes, the context in which the classes are being taught, and so on. However, we believe we have described the factors in a general enough way that they could be implemented in virtually any UX or HCI design-focused class or program.

7 CONCLUSION

In this study, we collected data from master's students in a UX Design program at several points in time across their program journey. We interviewed 11 of these students in their final semester, having them reflect on how their ability to make framing judgments has evolved over time, what perceived pedagogical and other factors contributed to such development, and how their framing ability influenced their sense of competence and their personal design identity and philosophy. Our contributions include both surfacing characteristic markers of an increasing ability to make framing judgments, and identifying pedagogical strategies that encourage the development of framing ability. HCI educators can employ such strategies in their own classrooms, and can look for these markers to indicate increased capacity to make good framing judgments.

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