Organizing Metaphors for Design Methods in Intermediate HCI Education

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Design students must develop competence in a wide range of areas in order to be successful in their future practice. Increasingly, knowledge of design methods is used to frame both a designer's repertoire and their overall facility as a designer. However, there is little research on how students build cognitive schema in relation to design methods or how these schema relate to specific epistemological patterns of engagement. In this research paper, we report a multiple case study, capturing the experiences of four advanced undergraduate UX design students at a large research-intensive institution. Through an interview study and subsequent analysis, we describe the wide variety of organizing metaphors that these students used to frame their understanding and performance of design methods, including both principles they used to consider methods as knowledge, and the ways in which these organizing principles impacted their practice of design. We conclude with recommendations for further research on the uptake of methods-focused competence in HCI education and practice.

CCS Concepts: • **Social and professional topics → Computing education**; • **Human-centered computing → Interaction design theory, concepts and paradigms**.

Additional Key Words and Phrases: UX education, design methods, instrumental judgment, design theory

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1 INTRODUCTION

The development of design knowledge requires the ability of students to build new patterns of cognition, engage with and build design knowledge, and form abductive hypotheses that lead to the creation of the "not-yet-existing" [6, 20, 22]. However, this development process is not well understood, with various metaphors used by education and design researchers to describe the development of students' competence [7], such as: acting more like an "informed designer" [4], passing through a series of "thresholds" [18, 24], or even the complete "metamorphosis" of the beginning designer into an expert designer [25, 27]. While these totalizing descriptions of competence formation are useful to an extent, there remains relatively little inquiry into the development of component skills that are necessary for students' success in professional design practice. Complicating this development of competence, there are ill-defined boundaries among the different kinds of knowledge contained within design methods, including procedural knowledge that embedded in the method description (codification-oriented), ways in which designers might utilize this knowledge to shape their design work (performance-oriented), and how the packaging or framing of a method might encourage certain qualities of use (presentation-oriented) [11]. Thus, while it is widely acknowledged that design students should build competence in design methods to support their future practice [8, 17, 21], the form this competence takes in individual designers is understudied and not well understood. In this research paper, we specifically investigate the development of knowledge relating to design methods, including the mental schema or organizing metaphors that advanced HCI students with two or more years of design coursework use to organize, build, and rely upon design knowledge as it relates to design

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methods. Based on our findings, we are able to characterize the diversity of metaphors that may point toward more or less efficient or useful framings of methods knowledge.

Through a multiple case study, we seek to answer the following research questions:

(1) How do advanced design students define design methods?
(2) What metaphors do advanced design students use to describe and frame their use of design methods?
(3) How do these metaphors complement or exist in tension with each other as advanced design students describe their design practice?

2 RELATED WORK

2.1 Developing Design Competence

As described by Löwgren [20], for design students to build their competence, they must build their capacity for design judgement and design knowledge. The development of expertise includes increasingly tacit awareness of the complexity of design moves [19], alongside the development of a designer's character and ability to engage in wise action [22]. This development process is complex, and recent scholarship has called for reform in design education practices that focus on the development of knowledge and identity, including deeper engagement with contingent and subjective aspects of design work [3, 12, 23]. For instance, Norman [23] has proposed that designers should have a deeper knowledge of the social sciences, reflecting a call from Faiola [5] over a decade ago in relation to the need for an "enterprise model" of design-infused HCI education. These challenges require design educators to develop more nimble approaches when creating educational experiences to address specific thresholds [18] and barriers [7, 25] to competence development.

2.2 Design Methods

In this paper, we focus specifically on students' uptake of design knowledge as it relates to design methods, including their ability to engage with codified forms of methods and translate these codifications into performance and adaptation. We adopt a broad definition of methods, encompassing "any intellectual or practical support that a practitioner might use to support the design process in a positive way" [8], and seek to identify what definitions or framings of methods used by design students as they increased in competence. This question of methods use and development of a mindset towards methods is relatively understudied in the literature, with a classroom study from Harrison et al. [15] representing one of the only examples that describes an educator's use of intentional pedagogical strategies to encourage adaptation and situational use of design methods. In this study, they sought to shift students from a codification-focused mindset, "avoid[ing] dressing up design methods as more systematic and predictive than they in fact are" and encouraging the students to better understand how their *selection* of methods and the ways in which methods are applied can shape their process. We also build upon Gray et al.'s [9] notion of a "conceptual repertoire" that includes the archive and mental schema through which a designer intentionally builds and makes sense of methods as design knowledge in a personal way, encompassing both a mindset towards methods [8] and a collection of methods that can be drawn upon to inform potential design moves. Finally, in describing the development of designer sensitivity towards the selection and use of methods, we draw upon Nelson and Stolterman's [22] description of *instrumental judgment*. This form of judgment focuses on the considerations that shape a designer's selection and use of tools, including how students "choose appropriate approaches to design problems, decide from an array of established options, or create new approaches" [21]. The development of a designer's instrumental judgment enables them to shift from a solely codification-oriented view of design methods—where the goal is to reproduce the listed steps in the proper order—to a

performance-oriented view of methods—where the designer is in command of how, when, and in what way portions of methods knowledge is deployed in a unique design context.

3 OUR APPROACH

We use a multiple case study approach [28] to characterize the knowledge and experiences of advanced UX design students. We recruited participants from an undergraduate program in UX design at a large research-intensive institution in the USA. Anne and Laura were second year students in this program at the time of data collection, and Colin is an instructor in this program and taught all participants for two or more semesters. This undergraduate program in UX Design is studio-based, intentionally drawing on many different disciplinary traditions that inform HCI and UX work without any direct programmatic connections to computer science, information science, or art and design [13, 26]. This program was designed to bring together multiple relevant disciplinary perspectives through an integrated studio approach [12] that prepares students for jobs in UX design, UX research, and product management, among others. The program faculty that teach studios in our core studio sequence bring expertise in HCI, computer science, data visualization, industrial design, graphic design, instructional design, and cognitive psychology. The studios in this program use a project-based pedagogy that foregrounds practice and learning by doing in teams. Students learn and refine their understanding of design methods across all studios through a spiral learning approach.

To recruit participants, we posted a public message on a program-wide Slack workspace and all students who responded were interviewed. We conducted 45–60 minute semi-structured interviews with a total of twelve participants, including both first year and third to fourth year students. In each interview, we used a critical interview approach [2] with three topic domains relevant to this paper: 1) identification of students' felt need for tools and methods; 2) approaches students used to discover new methods; and 3) how students reported using methods to support their design work. In each topic domain, a lead-off question was used to begin the conversation, with follow-up questions used to more deeply explore students' experiences, mindset, and emergent inconsistencies in their definitions and reported use of methods. Initially, our goal was to describe how students built competence in design methods and how this competence evolved across multiple portions of the studio curriculum. Through our interviews, we began to narrow our focus to account for students' understanding of design methods as this understanding began to concretize. We focus our analysis in this paper on the interviews conducted with third to fourth year students, since early design students had yet to engage with design methods for more than a semester in an educational or professional setting; thus, they represented a codification-oriented view of methods whereas their more advanced counterparts in their third year began to express competence relating to a performance orientation of methods. To answer our research questions, we identified four diverse cases—each constructed from one of our third or fourth year interview participants—which as a group represented the range of metaphors that we observed within the broader set of interviews. We use this set of multiple case studies in an exploratory sense to capture potential diversity among participant metaphors and inform further, more focused study, of this phenomenon in future work. The study was reviewed and approved by our Institutional Review Board (IRB); participation was voluntary, with a US $15 incentive.

As a research team, we reflexively engaged in preliminary verbal memos at the conclusion of each interview, augmented by Slack conversations that supported our interview process. Building on this immersion into the collected data, we used an open coding process [1] to identify how students spoke about methods, how these speech acts pointed towards their mindset regarding methods, and the actions they reported taking when engaging with methods in their design process. With regard to their actions, we identified when participants felt the need for methods, how they sought out methods, how they evaluated the success of methods, and their interactions with other team members. With

regard to their mindset, we assessed how they talked about their design process, how they described methods, and any explicit metaphors they articulated. We then created detailed mind maps to identify three main aspects of the students' perception of and engagement with methods—seeking and selection, evaluation and implementation, and teamwork and collaboration—as well as visually identifying contradictions in their definitional and performative accounts by mapping both in contrasting colors on a digital whiteboard. Next, we participated in an iterative process of construction and refinement of key metaphors explicitly stated and/or implicitly demonstrated by the participants in relation to their engagement with design methods. We then used these metaphors to frame each case study, illustrating how metaphors were used to structure advanced design students' mindsets towards methods.

As researchers and students within the UX program we were studying, we acknowledge the uniqueness of our position and lived experiences. The data collection process began when Anne and Laura were in their first semester of design education where they were interviewing students one or two years ahead of them in the program. Colin had taught all students that participated, but only participated peripherally in interviews with advanced students with which he had already gained rapport. By the time of the final write-up, Anne and Laura had gone through multiple semesters of additional design studios, ultimately ending up at the same point in their design education as the students in the cases we report on. Through this research process, both Anne and Laura have reflected on their substantial growth as designers and this evolution has impacted how they are able to recognize and understand these student accounts, while also playing a role in their own design competence development. Furthermore, the relationships of Anne and Laura with the participants was student to student, potentially lessening the power dynamic, aiding in the understanding of where these students were situated in their journey, and coloring how they collectively interpreted the data.

4 FINDINGS

4.1 Casey: Tensions between Methods as Guardrails and Performative Fluidity

Casey showed evidence of three metaphors concerning design methods which emerged across a continuum of their philosophical understanding of design methods, their desire to be more flexible, and their interactions with team members. They defined methods as flexible, fluid ways to achieve a desired outcome; however, this fluidity was limited to Casey's articulation of how their selection of a method related to a particular "desired outcome." The latter two metaphors entail a mental archive of methods which catalogs all of their past experiences with methods as well as their positioning of methods as stepping stones or guardrails. As Casey recollected their past work and design decision-making processes, the latter two metaphors tend to prioritize goal-attainability and practicality.

Methods as Stepping Stones or Guardrails describes Casey's use of a firm yet cyclical design process which included research, ideation, testing, and iteration, in that order. They reported taking personal responsibility to enact this process during team projects, staying a "few steps ahead" to make sure the team stayed "on track." Casey also cited multiple instances when they felt the need for a new method in the middle of a project to improve the validity of the designed outcomes, but chose not to pursue this method in order to prioritize meeting the deadline. They explained that this is "not the best practice, but that's what you want to do." Seeking out new resources during the process would take "too much time and too much setting up." This sense of rigidity also translated into Casey's identification of new methods, where they primarily framed searching for new methods on the internet as a way to further familiarize themself with known methods and do them "correctly," not a way to search for new ones:

> "[…] Googling helps when you know what method you want to work a bit, but you want to be more specific. When you want to learn how to actually appropriately do it. For example, desirability testing, we have fallen in that trap multiple times in the first few studios, like we'll call this a desirability test, but it is not a desirability test."

A Mental Archive of Methods was often referred to by Casey as a primary resource for finding a method that they felt "fit" the situation at hand. This metaphor aligned with the rigidity and structure of their use of methods indicated in their conception of "methods as guardrails," where they did have a repertoire of methods but that archive was limited in terms of expandability and adaptation within the larger design process.

Methods as Performative Fluidity, in contrast to the prior two metaphors which focused on a more rigid conception of process and methods use, represents Casey's belief that the use of a method should arise opportunistically as a need comes in place, contradicting their contention of a linear, pre-set process. Furthermore, they recalled that they "learned not to do a waterfall design—to embrace the chaos" which demonstrated an acknowledgement of ideological opposition to rigid waterfall-like structure; however, their desire to use this more rigid and predictable structure as a guardrail took precedence in their work. Casey also mentioned other engagement with methods that contrasted their contention of rigidity while showing evidence of fluidity; for instance, they described research being central to their design work early on in the interview, later stating "I usually don't do a whole lot of research in my design."

When viewed in context of team or collaborative design work, the methodological approach that Casey used as an individual designer appears quite rigid in its steps and justification, while also being permeable to their design team's opinions and choices. Casey also demonstrated an aversion to experimentation with methods—despite articulating a desire to seek out new ones—and a strong hesitation to implement newly discovered methods. For instance, when recalling a project focused on digital civics, they explained: "I wasn't a fan" of the team choosing to engage with a qualitative evaluative method because "it's not going to help me move forward in that particular design process." This sentiment suggests methodological rigidity since the team already had a selection of quantitative evaluative methods that they were using to inform their design work; however, Casey proved amenable to the team's decision after being outvoted.

4.2 Tia: Methods are Ethical and Everything Beyond

For Tia, their primary metaphor for design methods was a distinction between Methods and methods. They engaged with this distinction as a productive tension between formality and informality—both colloquial and prescribed—at essentially any point in their design process. Tia also framed methods as storytelling tools for advocacy and as "building blocks" to structure and motivate research activity, with both of these metaphors building upon the formal and informal dialectic from the first metaphor.

Methods and methods, illustrated by Tia, makes an explicit distinction where the uppercase methods are formal, well-established processes (e.g., heuristic analysis) and lowercase methods are informal, less definitive, and more personal ways to engage with the design process (e.g., going on an "ideation walk" or talking out loud to another person). Tia explained that both ends of this spectrum, as well as anything in between, are not only included in their regular engagement with methods but are also integral to their conception and performance of their design process. This integration of both codification and performance-oriented views of methods through this distinction aligns with a conceptual repertoire that has both objective and subjective dimensions.

Methods as Storytelling Tools for Advocacy encapsulates Tia's discussion of their role and philosophy as a designer. Tia sees themself as an advocate, preferring the term "human-centered" instead of "user-centered." They believe in equipping themself with "as many tools and methods as possible to convey their story and be able to read in between the lines and understand really what their story is." Tia went on to elaborate that their main commitment when selecting a method is to engage and empower the target population and answer the (often advocacy-focused) questions that they want to answer. In one example, Tia recalled an internship where they were asked to conduct a virtual interview study with a group of stakeholders. While writing their interview questions, they realized they had a "very stale protocol," and decided they needed to find more ways to engage the user in order to answer the questions they wanted to answer. After "looking at work that [their] mentor had done and looking at work that other people within the research team at [company name] had done," they developed a more interactive approach which they perceived as successful. This example demonstrates a reflection of their statements regarding their seeking out of methods from books and peers or coworkers, as well as a reflection of their goal of engaging the target group to answer the questions they needed to answer.

Tia's use of methods as tools for advocacy was also impacted by their positionality and philosophy as a designer. They explained that ethics are always at the forefront of their mind, causing them to be in "constant fear [of] misrepresenting someone." Tia expressed the importance of building time for and being specific with creating meaning for the target audience during the design process: "I don't want to take time away from them, but also I don't want to use people as guinea pigs [...] I want the work to be meaningful and impactful for not just myself, but [for] the group that I'm working with."

Research Methods as Building Blocks, represented by Tia's collaborative mindset and prioritization of participant engagement, is made evident in their framing of research methods which is built upon their work on research projects during their undergraduate academic career: "I think about research like building blocks, like Lego blocks [...] the research that I did, my mentor emailed me a few months after I left and was like, hey, people are still using your research. And that was really exciting for me because it showed that I had engaged with this foundational research in a way that made it open to letting people build upon it." This example illustrates Tia's desire not only to involve others' work (either directly or indirectly) into their process, but also a desire to have their own work involved in others' processes as productive and intentional building blocks.

4.3 Sebastian: Methods are Communicative Tools

Sebastian framed methods as a way to communicate design decisions as well as a means of organizing design workflows and delegating tasks among team members, with a focus on collaboration and coordination. When explicitly asked "How would you define a design method?," Sebastian stated that a method is "a way of structuring your thinking about a certain subject to better understand both any questions you have about the subject and how it applies to everything around it." While this approach to methods is present within Sebastian's descriptions of their design process, they also rely upon methods as an explicit mechanism to inform and structure communication with other stakeholders, and consider methods as a primary means of asking and answering questions that frame their design work.

Methods as Communication describes Sebastian's use of methods as dialogic tools used to communicate with team members and other stakeholders. This was evident in the mindset they had while selecting methods for project, where they asked questions regarding what communicative potential a method might have. They described a time during their internship where they had to engage non-UX practitioners in their design process and methodology. They

explained that this experience "changed how [they] approached project work" and reflected on this example from their internship:

> "[...] it just reemphasized to me more than anything the importance of constant and clear communication of the design rationale, not just at each checkpoint, but leading up to each project checkpoint and making sure that people know 'here is what I'm working on and why' each and every step of the way so that they are able to engage in that work with me if need be. Because sometimes that is important, especially when you're not the one that's going to actually code and build the software necessarily yourself."

Interestingly, while Sebastian mentioned that communication was not particularly impactful for their approach to methods, they frequently chose to describe their process through the the language of communication. When traversing their design process, they mentioned deliberating frequently about who should be involved, what should be communicated, and who would be best to communicate with, using methods as the infrastructure that described and informed these types of communication.

Methods as a Means of Traversing and Questioning is a central and recurring metaphor which described their engagement with methods, regarding their traversal of the problem space and engagement throughout the design process. This traversal was framed by their continual approach of asking and answering questions—a common indication of the purpose of methods that was part of their formal UX curriculum. Sebastian regularly mentioned that they were not as focused on the outcome, but rather wanted to find answers to their questions while also generating more questions:

> "I have not necessarily certain outcomes I want out of this, but there are certain questions I have. And I would like to at least make some progress on answering those or getting more information about those questions. So I'm going to try this method because I think it will be best at answering those questions."

This notion of asking and answering questions in an iterative and reflexive way was a determining factor in Sebastian's method choice as well as how they move through their entire design process. Sebastian continuously framed their design work and engagement with methods as seeking information to better understand their position within their design process and how to move forward. This framing of methods also had an impact on how they engaged with other team members, also relying upon the metaphor of methods as communication. They described methods as a way of structuring how they delegated and organized tasks and workflows within their team, using methods as a way to, "better understand both any questions you have about the subject and how it applies to everything around it."

4.4 Shannon: Methods are Structured But I Use Them for Play

Shannon framed methods as goal-oriented activities that helped them create a structural framework within their project work. When directly asked, Shannon defined a design method as "an activity in the design process that has a specific goal or outcome." However, in examples of their work, Shannon demonstrated significantly more complexity in choice, implementation, and evaluation of the success of methods, including relying upon more fluid and flexible metaphors of methods that encourage play and exploration of the problem space and a "trying on" of methods to see what fits best.

Methods as Play and Exploration demonstrates Shannon's approach to project work that includes an emphasis on methods as a way to have fun in a team environment and defamiliarize their current approach. In one prominent example of this metaphor in action within Shannon's project work, they described completing early prototyping after being encouraged by their professor. During this experience, they "did this weird role play thing where [they] printed out a little miniature house and then [they] acted out being inside the house, and then it felt silly and dumb." They describe the benefit of this method in "help[ing] play out a storyline and empathiz[ing] more effectively." During the

recounting of their early prototyping during this project, they described it as "playing" and "messing around." When engaging with methods through this metaphor, Shannon mentioned that their design team "just kind of grabbed at something like a random method," with no clear goal or outcome associated with this method choice—contrary to their formal definition of method use.

Shannon's use of methods to inform and encourage exploration and play also emerged through other instances of prototyping where the form of exploration did not always feel as positive. For instance, they described a project where they used experiential prototyping, "set[ting] up cardboard and stuff around the room" while acting out a scenario to imagine what the experience could be like. Shannon described this use of methods as "impromptu" and "really awkward," while also reflecting that "through experiencing it" the method helped their team to "move forward and decide." These examples demonstrated Shannon's willingness to try new methods as a way to play within their design process, encouraging spontaneity and a use of methods that might initially feel unconventional.

Methods as Something to "Try On" describes Shannon's flexible approach to choosing methods within their design process, where they seek to create space for unstructured trial and error. To begin this process of choosing a method, Shannon described how they determined whether or not they chose the "right method":

> "With those—like the mind mapping—I think it's just something to try on. This is where a lot of methods, but especially for sense-making stuff— I feel like it's something to try on and play with because the way that you visualize things varies from person to person."

Shannon did not put a strong emphasis on choosing the "right method;" rather, they approached methods in a manner which focused on sense-making, demonstrating their mindset of exploration and play. Their willingness to try methods in an exploratory and spontaneous way also extended to their work in team environments, acting as a way of dismantling conflict within their teams. When discussing a project within one of their studio classes they state, "So we ended up making—we didn't even think through ahead of time how we would prototype. It was just, let's just try it right now. Let's just try it because we keep arguing about it." Shannon's willingness to try methods without a clear goal or outcome put an emphasis on moving the design process forward while also allowing them to stabilize their teams and build alignment among team members.

Shannon's metaphor of "trying on" methods also carried over to their experience in a leadership role on an industry-sponsored project within another one of their studio courses, where they used their exploratory approach to methods to encourage their teammates to become more flexible as well. They described a time when they were proposing a method to their team, noting that it "seem[ed] like useful information" for that part of their project because the method allowed them to "see the relationships." Based on this perceived salience, Shannon's team decided to try the method, since "they were down to try anything new." This exploratory use of methods "was more just [that] everyone was willing to give it a shot more so than this was strategically decided," indicating their willingness to explore with no particular concrete goal or outcome in mind.

There are evident tensions among the metaphor Shannon used to describe engagement with design methods. Methods as Exploration and Play and Methods as Something to "Try On" within Shannon's design process demonstrate the flexible and open approach that they take when choosing methods, implementing them, and evaluating their success, providing a different account of methods as compared to their formal description of a method as something that has a "specific goal or outcome." When asked whether or not they would consider these fun and exploratory parts of their process as design methods, Shannon stated they "think [they] would consider it a method, even though [they] don't think of it as one."

5 DISCUSSION

5.1 Metaphors Frame Students' Praxis of Design Methods

As illustrated in the four cases, advanced UX design students used a wide range of metaphors to articulate their definitions of and engagement with design methods. Importantly, the students' formal definitions of design methods often revealed little of their actual engagement with methods in a performative sense. In contrast, the metaphors that emerged through their descriptions of their use of methods in design *did* frame their beliefs about methods in ways that appeared more personal and situated, pointing towards a more specific *praxis* and *conceptual repertoire* regarding their knowledge and use of methods. Even though not everything "felt" like a method to our participants—with methods sometimes used to point towards broader trends of judgment, process, or organizational realities of design work—in practicality, methods were a useful umbrella through which to interrogate and describe their attitudes and beliefs relating to design knowledge. Some metaphors connected to explicit portions of the program pedagogy, but many metaphors appeared to emerge based on students' subjective experiences of their studios rather than a broadly shared working definition of design methods. For instance, Shannon's account of using methods as something to "try on" resonated with instructional approaches that encouraged students to think about methods as "lenses" or "perspectives" to think with. Similarly, Sebastian's use of methods to traverse and question related to a common rhetorical framing of methods in their experience of studio learning, where students consistently were taught that design methods should be used to ask and answer questions. While these two examples were relatively consistent with expectations built into the formal pedagogy, other metaphors more closely mapped to individual student expressions of their developing design philosophy. Tia's framing of methods as a tool for advocacy expressed their commitment to inclusive and participatory practices, while Casey's tension between methods as guardrails or performative fluidity echoed some of their uncertainty in staking out their own role as a design leader. Across this diverse range of metaphors, we found both a pedagogical resonance and a sense of pluralism—where students have the space to build and sustain their own identity, design philosophy, and performative approach. This commitment to pluralism in our design studios (cf., [10]) likely allowed for this multiplicity of metaphors to emerge, whereas a more substantial focus on rote learning common in more technical portions of HCI education might result in fewer, more procedurally-focused metaphors.

We find both the range of metaphors and the ways they emerged in combination to be useful in triangulating an advanced design student's praxis towards design—including their beliefs about design, design knowledge, and their role as a designer. Previous articulations of methods use in the context of HCI education have revealed the subjective and personal judgments that drive method selection and performance (e.g., [15, 17]), including the formation of conceptual repertoire that supports a designer's work and can be actively and intentionally grown over time [9]. In our work, we can also identify how this emergent praxis as it relates to design methods may be productively used as a point of reflection for developing design students and practitioners. For instance, the cases of Casey, Tia, and Shannon reveal tensions between different metaphors they used to describe their engagement with design methods. For Casey, being forced to collaborate with others revealed tensions between how they conceptualized methods individually versus in a group, whereas Shannon and Tia actively balanced opposing metaphors of methods in a productive way (Shannon balancing structure and play-focused approaches; Tia balancing informal and formal dimensions of methods). Even if these tensions are not fully resolved, encouraging the designer to *reflect* on the lack of alignment between their formal definition of design methods and their pragmatic engagement with methods or between multiple metaphors they used to frame design methods may promote further growth and awareness of a methods-focused praxis. For instance, for Casey, methods as guardrails represented a ridigity of praxis; however, their engagement with a team forced them to

take on a more performatively fluid praxis towards methods, which if taken up as an area of design growth, could lead towards the continued development of instrumental judgment. Many of these tensions were fully experienced by the students, but not necessarily explicitly articulated as such. How can we further equip students with and encourage the use of reflective tools to aid in identifying and productively working through the tensions that emerge from their engagement with design methods? Furthermore, as educators and students, how can we be more conscientious of the complexity that exists even beyond explicitly stated descriptions of and reflections on method engagement?

5.2 Engaging a Plurality of Metaphors for Methods in HCI Education

As articulated by Harrison et al. [16] over a decade ago, the epistemological traditions of HCI are plural and in tension with one another. Building on our findings in this paper, we have found this pluralism to exist in relation to methods knowledge and praxis as well. While the "*It's Just a Method!*" approach [15], which focuses attention on the intentions that developing design students bring to the selection of methods while teaching students about a broad range of contrasting methods, has previously foregrounded the contingent and subjective judgments that must be leveraged by developing designers, our initial set of metaphors provides an additional means through which HCI educators might seek to build students' competence. Using the methods stances of Gray [11], we might ask how we can build both codification-oriented knowledge of methods (knowing "what to do") and performance oriented knowledge of methods (knowing "how and why to do it") in a systematic way, seeking to support a developing praxis that is undergirded by a student's instrumental design judgment. How could sources such as *Universal Methods of Design* [14] be rewritten or reframed to account for the performative dimension of methods engagement and praxis? What activities might best engage students in developing and becoming reflexively engaged with the metaphors they use to describe design methods? In our program, students' engagement with methods was supported through regular written and visual reflections, the creation and updating of a student's design philosophy, and a wide range of readings and critically-focused design projects that represent multiple epistemological positions within the broader HCI community. We would expect that building reflective capacity in other HCI education contexts, along with a focus on building awareness of students' personal design judgment and repertoire rather than rote memorization of common design processes or models, could result in opportunities for students to build, own, and concretize their own "mindset" towards methods.

6 OPPORTUNITIES FOR FUTURE WORK

Based on the diversity of metaphors that advanced design students used to describe design methods and method use in this study, we are able to identify multiple pathways for future research on the development of methods competence in HCI education and practice. First, our initial set of metaphors could be broadened by sampling students from other HCI education programs, with anticipated differences based on a variety of epistemological framings of HCI knowledge and practice (cf., [16]). This line of research could better explore the diversity of educational pathways into HCI education, with varying degrees of reliance upon design as a key or dominant epistemology. Second, researchers could more fully explore the liminal spaces between design pedagogy and practice, using metaphors of methods as a descriptive or analytic lens through which to describe the uptake of design competence. Building upon pathways towards competence suggested in the HCI education literature (e.g., [7, 18, 25]), individual designer's metaphors could be further analyzed in relation to broader themes of enculturation and formation of design repertoire, identifying spaces for greater diversity of design identities. Finally, our research findings may support further theoretical inquiry on the nature and use of design methods—including the uptake of methods as both a form of design knowledge and as a support for describing and refining designerly practices.

7 CONCLUSION

In this research paper, we conducted a multiple case study of advanced UX design students with the goal of describing the students' definitions of design methods and the organizing metaphors they used to pragmatically engage with design methods in their work. Across these cases, we have identified a wide range of metaphors that can operate in tension or complement one another, supporting reflection on methods performance and the potential development of greater facility with design methods.

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