

Navigating Complexity: Implementing a “Buckets and Lenses” Approach to Cultivate Adaptive Thinkers in HCI

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ABSTRACT

This article describes a **Teachable Moment** we refer to as the “Buckets and Lenses” approach, which aims to shift student thinking from rigid categorization (“bucket thinking”) to a more flexible, nuanced perspective (“lenses thinking”) that better aligns with the interdisciplinary field of Human-Computer Interaction (HCI). Given HCI’s amalgamation of diverse disciplinary concepts, students often struggle with the application of “fuzzy” concepts, leaning on their prior educational experiences that favor definitive labeling over exploration and context-dependent application. This approach challenges students to re-frame their engagement with HCI concepts, encouraging open-ended exploration and the embracing of ambiguity. By illustrating the method’s application through classroom examples, such as discussions on the “waves” and “paradigms” of HCI and the role of sketches and prototypes in the design process, this paper highlights a strategy for fostering an adaptive mindset. This Buckets and Lenses approach is a pedagogical strategy that we have found helpful for enhancing HCI students’ cognitive flexibility and promoting a deeper, more critical engagement with the field’s inherent complexities.

KEYWORDS

Cognitive Flexibility, Tolerance for Ambiguity, Interdisciplinary Pedagogy

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1 INTRODUCTION

Human-Computer Interaction (HCI) operates at the intersection of multiple disciplines, often drawing together concepts, approaches, and elements from computer science, psychology, various design disciplines, and more. This interdisciplinary nature, while one of HCI’s greatest strengths, also presents unique pedagogical challenges, particularly in presenting many of the “fuzzier” concepts,

including those that have different disciplinary origins yet, nevertheless, overlap in non-trivial ways. Examples of this fuzziness range from the somewhat simple—such as when discussing the similarities of experience maps, service blueprints, and other journey mapping techniques from marketing, service design, and similar disciplines—to the complex—such as attempting to answer a student who asks if they should use sociological frameworks or psychological theories to help them understand the interaction qualities of a multi-user proxemics-informed experience (the answer is likely “both!”). These fuzzy concepts, which are essential for a nuanced understanding of HCI, do not have fixed definitions with universal applicability; instead, their implications and boundaries of application shift based on the context in which they are being used. While these concepts are fuzzy by nature, their diverse origins—along with the varied academic backgrounds of HCI students—present additional challenges for their use in educational settings. Many students come into HCI from educational settings that favor unambiguous concepts with precise, universal meanings, and they are often most familiar with linear and rigid methodologies. Such students must engage with a significant paradigm shift to effectively learn the concepts that will make them successful in HCI. The *teachable moment* we present in this paper is one approach we use to address these educational challenges. By employing a conceptual scaffold we call “Buckets and Lenses,” this approach aims to help students navigate the fuzzy and often-overlapping concepts inherent to the interdisciplinary landscape of HCI, fostering a more flexible, critical, and expansive way of thinking. Drawing inspiration from cognitive flexibility theory [12], we advocate for a type of “principled pluralism” [11] in which multiple perspectives on a concept can be valid but must be accompanied by appropriate evidence and argumentation. Principled pluralism thus allows multiple perspectives on concepts to exist at once, yet still rejects shallow or sloppy thinking.

This Buckets and Lenses approach, as we will demonstrate below, is best used as an invitation for students to embrace a flexible and nuanced mindset toward the application of concepts they are learning. This mindset is particularly useful when addressing student inquiries and explanations that reveal a struggle with the ambiguity of applying HCI concepts, frameworks, or strategies. Often, when students are confronted with the complex task of employing these concepts to deepen their understanding of a situation or context, they resort to familiar strategies such as labeling, defining, or categorizing, ultimately looking to avoid ambiguity and find straightforward ways to apply the concepts. While such strategies can feel productive in-the-moment, they fall short of leveraging the concept as a springboard for richer exploration and dialogue. For instance, when students encounter the concept of embodied

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interaction and are then asked to design supports for an embodied experience, they often find themselves stuck with the task of identifying interactions as either “embodied” or not. We then use this Buckets and Lenses approach to prompt them, instead, to explore how applying the lens of “embodied interaction” can reveal deeper insights about the interactions that interest them, rather than simply categorizing an example as such.

With this teachable moment, we demonstrate how we aim to shift students away from this inclination to prioritize categorization over deep understanding and nuanced application. While we acknowledge that the idea of viewing concepts through different “lenses” is not novel, and that attempting to understand the tendency to categorize knowledge into “buckets” is a well-trodden path, framing these shifts in this particular way has significantly enhanced the learning experience in our classrooms. It has become a recurring theme, almost a mantra, that facilitates a deeper, more critical engagement with material. By sharing this approach, we hope to offer a tool that, while familiar in concept, provides a fresh perspective on fostering inquisitive and adaptive thinking in HCI education by creating a learning environment where ambiguity is not an obstacle but a pathway to deeper inquiry and understanding.

2 THE CHALLENGE IN HCI LEARNING

One challenge in teaching HCI lies in shifting the mentality of students who were trained in educational systems promoting the precise application of technical knowledge as the preeminent means of enacting change in the world. These students often originate from “hard science” disciplines, such as Computer Science and Engineering, but more broadly includes students coming from educational environments in which technical knowledge is prized (see Schön’s critique of technical rationality [9]). These disciplines have historically emphasized rationalist and technocratic perspectives on learning and problem solving [4], which generally value precision and prefer to avoid ambiguity. Challenges arise when students are asked to incorporate HCI concepts, which often cannot be neatly compartmentalized or defined due to their multi-disciplinary origins. As a result, the application of such concepts in complex, context-dependent design situations is challenging, as it requires appreciation and tolerance for ambiguity (see [3] for a description of how a similar situation plays out in UK art schools). Unlike the concrete and quantifiable content of their previous exam-oriented studies, HCI demands a fluidity of thought and an ability to navigate and embrace conceptual ambiguity [5] (see [10] for a similar claim about Industrial Design). This transition from a focus on memorization and demonstrating concrete skill to engaging with concepts as “tools to think with” represents a significant pedagogical hurdle, similar to the hurdle of encouraging students to adopt a flexible approach to understanding design methods ([6, 7]).

The baseline characteristics of this challenge are not limited to HCI, and they likely represent an academic shift that occurs in many graduate-level programs, where students must learn to move beyond the surface level of memorizing content to deeper engagement with material, applying critical thinking and problem-solving skills in varied and often unpredictable contexts. However, the way concepts and frameworks are drawn into HCI from multiple disciplines often leaves HCI graduate students with the task of

navigating questions about how to apply concepts that can often appear to overlap in obvious ways and diverge in subtle ways.

The tendency to lean heavily on “bucket thinking” among students stems from a deeply ingrained belief in the clarity and finality of categorization. This mindset convinces them that they will reach a point in their graduate HCI studies where they can effortlessly classify interactions, user experiences, or methods with objective certainty. Such classifications, they assume, will be universally recognized and validated by their peers within the field. This expectation sets a foundation for an educational journey focused on acquiring definitive labels rather than embracing the complexity and nuance of HCI concepts. However, the real-world application of HCI principles is rarely so black-and-white. The ability to navigate and make sense of ambiguity is crucial beyond the classroom, and in design contexts has been correlated with creativity [8, 13]. When students are stuck in “bucket thinking,” they miss the opportunity to leverage the full potential of HCI concepts in creative and unexpected ways. Embracing the ambiguity and fluidity of HCI concepts enables students to apply interdisciplinary thinking more effectively, adapting to the complexities of real-world challenges. Recognizing the limitations of “bucket thinking” is therefore essential for students, preparing them for the inevitable complexities and uncertainties they will encounter in their professional lives, where rigid categorizations fall short and a more adaptive, nuanced approach is required.

3 EXAMPLES FROM IMPLEMENTING “BUCKETS AND LENSES” AS A PEDAGOGICAL SCAFFOLD

We have adopted this discussion style in several types of courses, including seminars, courses that rely heavily on project-based learning, and a flipped-classroom approach to readings-heavy courses. We have used this approach with first-year undergraduates up to master’s and doctoral students, and believe it is useful and effective across all levels of higher education. For undergraduate design students, we use this approach to emphasize the benefits of flexibly applying concepts to their problem spaces. For master’s students, we also add on a consideration for how this type of thinking improves their ability to frame their problem spaces. And for PhD students, we often explicitly describe this as a metacognitive strategy that is useful in helping them articulate succinct yet powerful research questions. On a few occasions, we have introduced this type of thinking on the first day of class as part of an introduction to the class mantras¹. However, we often introduce this strategy when multiple concepts from class appear to conflict with each other in the moment that they need to be applied. For example, consider the following dialogue, which might occur when a student is puzzled about categorizing a paper as a particular “wave”

¹In a prototyping course taught by the first author to upper-level undergraduate students, he tends to introduce three mantras at the start of the semester. The first is a “Pedagogical Mantra” that says “feedback should be sought” and refers to the need for students to identify when they think they need feedback, rather than waiting for the professor to approach them. The second is a “Conceptual Mantra” that says “a prototype is something that helps us ask and/or answer questions” and is used to remind students that they should only be building prototypes for their projects after they have identified what they need that prototype for. The third mantra he refers to as a “Metacognitive Mantra” that says “concepts tend to be more powerful as lenses than as buckets,” which refers to what this current teachable moment paper is about.

or “paradigm” [2], following one of many potential categorization schemes they might learn in an HCI readings course:

Student: *I’m trying to figure out if this paper is considered ‘Wave 1’ or ‘Wave 2’ of HCI. Based on what we learned, I’m not sure where it fits.*

Teacher: *That’s a reasonable question, and it’s great that you’re thinking about the concepts deeply. But remember how we’ve talked about not strictly categorizing papers like this? ‘Wave 1’ and ‘Wave 2’ are more like lenses we use to view the evolution of HCI, not buckets to sort papers into.*

Student: *So, you’re saying the paper doesn’t have to fit neatly into one wave?*

Teacher: *Exactly. Each wave highlights different focuses within HCI history. So let’s shift our perspective a bit. How might viewing this paper through a ‘Wave 1’ lens help us understand its contributions or limitations?*

Student: *Well, if I look at it as a ‘Wave 1’ paper, I might focus more on its technical aspects and how it addresses human factors...*

Teacher: *Good start. And what about ‘Wave 2’? How does considering its social implications or user experience design principles change your understanding?*

Student: *That approach might reveal more about its impact on user engagement and the broader societal context it addresses.*

Teacher: *Right. By using the waves as lenses rather than categories, you can appreciate the paper’s multifaceted contributions and how it intersects with different HCI concerns. It’s not about labeling it as one or the other but understanding how it converses with various aspects of HCI’s history and future.*

This dialogue, while a bit cheesy, is not too far away from how we have used this technique in class, and it exemplifies how the Buckets and Lenses approach encourages deeper analysis and understanding, moving beyond simplistic categorization to embrace the ambiguity and generativity of HCI concepts.

In the rest of this section, we outline a few interactions in classes that we have taught where this approach helped students engage more generatively with class concepts. We regularly rely on this approach when discussing proxemics in HCI, which we often start with an overview of five dimensions of proxemic interaction design, including “distance, orientation, movement, identity, and location” [1]. Two initial mistakes the students often make, no matter how explicitly we warn them ahead of time, are (i) to assume that these five dimensions fully encapsulate everything that could be usefully designed from a proxemic point of view and (ii) to assume that whatever they design needs to incorporate all five dimensions. The first few students who approach us after we have tasked them with quickly brainstorming a few ideas that rely on proxemic concepts are often asking questions like, “is this idea relying on orientation or identity?” At this point, we remind them that the dimensions are not buckets, and that, if we use them as lenses, they can see how thinking about their idea in terms of “orientation” can help them understand a few strengths and weaknesses of the design,

and thinking about it in terms of “identity” can help them pinpoint others. Rather than categorizing interactions into predefined dimensions, the Buckets and Lenses analogy helps them to view these dimensions as a generative foundation for brainstorming. As a result, we have found that students who approach us with their concerns and receive this feedback seem to develop more creative and exploratory concepts, whereas students who attempt the exercise from more of a proxemic checklist perspective develop superficial concepts (more research would need to be done to confirm this, of course).

Similarly, when introducing tools such as journey maps and experience maps, which are designed to visualize user interactions with a system, we shift the emphasis away from classification to insight generation. Students often struggle with the terminology, because many of these types of maps come from different fields (e.g., service design, marketing, and business). As a result, they end up focusing too much on whether they need an experience map, a journey map, an emotion map, etc., and less on what actual questions they want to answer about the experience they are designing. In this instance, we often apply the Buckets and Lenses approach to encourage the students to prioritize what insights they are seeking, rather than what “bucket” their map would fit into. This also then helps the students understand that these kinds of maps are often valuable to create simply because they help the design team fill in gaps in their knowledge. Used this way, where students are encouraged to adapt or discard frameworks as their understanding evolves, the approach promotes conceptual flexibility and helps develop students’ appreciation for principled pluralism [11].

The two examples above show how we use this approach when students are designing interactions, but the approach is also useful in more conceptual discussions. In a graduate seminar about online communities and digital relationships, this teaching method helped to facilitate a deeper inquiry into the nature of online behaviors. When students in this class start their research projects by narrowly questioning whether a platform or kind of interaction they found online qualifies as a community, we urge them, instead, to consider how viewing it *as* a community helps them understand what they found better *and/or* helps them understand “online communities” better. This reframing invites a broader, more analytical exploration of digital relationships, enhancing students’ ability to engage with the material critically and improving the research questions they develop.

Frequently, students’ questions reflect a desire for clear-cut definitions and boundaries: Is this considered service design? Can this sketch be classified as a prototype, or is it just a sketch? Is this a usability test or an experience prototype? Such inquiries reveal an underlying struggle with ambiguity. The Buckets and Lenses response has helped us, as educators, navigate these moments, offering a constructive alternative to the often-unsatisfying “it depends” answer that students come to expect. Through these examples, it becomes evident that the Buckets and Lenses approach does not merely serve as a pedagogical tool but as a mindset that can cultivate tolerance for ambiguity and foster a deeper, more flexible engagement with HCI concepts.

4 ADAPTABILITY AND PRACTICAL IMPLEMENTATION

This approach is adaptable for most environments requiring students to think fluidly or generatively. In an English class, for example, discussing “Is Frankenstein horror or science fiction?” can be interesting if the facilitator of the discussion pushes the arguments toward applying the genres as lenses. But the conversation is certainly more interesting and less combative, from the start, if the instructor begins the conversation with “how does thinking about Frankenstein as a horror novel help us think about Frankenstein and about the horror genre? And how does thinking about it as a science fiction novel help us think about the novel and about the genre?” However, that wordy question is difficult for students to fully comprehend, so better scaffolds leading up to it can often be helpful—e.g., asking students “what are some qualities of this novel that feel science-fiction-y? What are some qualities that don’t feel science-fiction-y?” etc. Similar adaptations can be made for any situation where students are over-emphasizing the lines between categories and under-emphasizing the creativity associated with questioning, building upon, or blurring such lines.

We are still experimenting with ways to introduce this mindset to a class. As noted earlier, we have tried introducing this on the first day, we have tried encouraging upper-level students to introduce this approach to lower-level students, and we have tried incorporating it just-in-time. All approaches seem to encounter similar roadblocks in thinking. Our advice for others hoping to implement this approach is the following:

- (1) At the semester’s outset, identify moments that naturally elicit a deeper inquiry beyond surface-level categorization. When such a question arises, pause to acknowledge the question’s validity before reframing it more generatively. Explain to your students that this reframing technique, focusing on a “lens-first” perspective, will become a familiar technique throughout the course. Emphasize its value in fostering a more nuanced and productive discussion.
- (2) As the semester progresses, encourage students to anticipate this reframing technique. Prompt them with questions like, “You know that annoying thing I always say in response to this type of question? It applies here too. What do you think I’m about to say?” This not only reinforces the concept but also gradually shifts the responsibility of reframing to the students, fostering independence in their analytical thinking.
- (3) Towards the semester’s end, reduce the frequency of your prompts, monitoring whether students are beginning to adopt this mindset on their own. Occasionally, a simple, knowing smile and a gentle nudge, “Do you know what I’m about to say?” can suffice, signaling them to re-evaluate their approach to a question.

This gradual, supportive strategy helps ease educators and students into a more reflective and generative mode of discussion. This approach can help create a classroom environment where students feel comfortable exploring complexities and ambiguities, essential skills in the interdisciplinary field of HCI. Through consistency and encouragement, educators can foster a shift towards deeper, more critical engagement with course material, preparing students for

the nuanced understanding required in their future professional endeavors.

5 CONCLUSION AND FUTURE DIRECTIONS

In this paper, we have described a teachable moment we refer to as the “Buckets and Lenses” approach, a pedagogical strategy aimed at shifting student thinking from rigid categorization to a more nuanced and flexible perspective. Through classroom examples and discussions, we demonstrated how this approach encourages students to embrace ambiguity, fostering a mindset that helps navigate the complexities of HCI concepts. We argue, based on our own experiences, that this approach can enhance students’ cognitive flexibility and deepen their engagement with the material. Future research should refine and expand the application of the Buckets and Lenses approach by exploring its effectiveness across different learning environments, disciplines, and student demographics. Additionally, developing more structured frameworks and tools to facilitate its implementation could further empower educators to cultivate adaptive thinkers. By continuing to share experiences and methodologies within the HCI teaching community, we can collectively enhance our pedagogical approaches, ensuring our students are not only proficient in their technical skills but are also equipped with the critical thinking abilities necessary for innovation and leadership in their future careers.

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