Threshold Concepts in HCI Education

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Abstract
In this paper, we introduce the notion of "threshold concepts" to an HCI education audience, proposing the value of this framing of development and competence-building for HCI educators, students, and practitioners. We focus on two exploratory studies from the United Kingdom and United States that identify emergent threshold concepts from the perspective of HCI and UX students. We use these emergent concepts to propose research that focuses on developmental capabilities in HCI education and the barriers and opportunities that educators should be prepared to address.

Author Keywords
Threshold concepts; design expertise; HCI education.

Introduction
Sanders and McCartney [9] described a threshold concept as "*a core concept within a particular discipline, [with a] transformed view that results from its understanding [that] is specific to (and characteristic of) that discipline.*" Meyer and Land [6] likened these concepts to a portal to new, previously inaccessible, ways of thinking about a topic. Common examples include 'complex numbers' and 'limits' in mathematics, 'signification' and 'deconstruction' in literary and cultural studies, 'opportunity cost' in economics [6], and 'Fourier transformation' in electrical engineering

Characteristics of Threshold Concepts

The key characteristics of a threshold concept as stated by Meyer and Land [6]

1.Transformative (essential): they change the way a student looks at things in the discipline.

2.Irreversible (probably): they are difficult for the student to unlearn.

3.Integrative (optional): they tie together concepts in ways that were previously unknown to the student.

4.Bounded (possibly often - though not necessarily always): they indicate the limits of a conceptual area or the discipline itself.

[7]. As these examples indicate, threshold concepts are used as a lens to investigate the scholarship of teaching and learning and to inform curriculum design of many disciplines [11], with computing science being no exception [1,4,9].

Investigations of threshold concepts in computing started in 2006 with Eckerdal et al [3] with many questions being raised about these concepts in computing at early stages [1,7]. However, threshold concepts identified in computing are primarily focused on programming concepts such as 'abstraction', 'pointers', 'classes', 'recursion', and 'polymorphism' among others and include nothing in relation to human-computer interaction. The one identified exception to this gap is an example given by [8], noting 'user-centered design' (i.e., that software is designed for other people to use). They viewed this as a fundamental, unlikely reversable, and thus a potential, threshold concept as it can transform the way students view their profession and how they go about design, development and testing. This was followed by a question by [9] as to whether there are other such concepts as human-centered design that are not bounded within a single discipline. While a few studies have addressed the development of design competence, both in general [2] and in relation to HCI-specific educational barriers [10], no studies in the ACM have explicitly addressed the notion of threshold concepts. Thus, as interest in HCI pedagogy increases, we propose that this construct may be particularly useful in evaluating curricula and student learning behaviours.

The aim of this work is to 1) start a discussion among HCI educators around the value of studying threshold concepts in HCI and 2) propose a preliminary set of threshold concepts identified by analysing HCI students' reflective logs and interviews with undergraduate UX design students.

Methodology

In this early exploration, we present findings from two contexts: 1) reflective logs from HCI students and 2) interviews with UX design students. Our goal in presenting these findings is to share two different perspectives—one grounded in student-created artifacts and the other grounded in program-level reflection by students—to expand the notion of what threshold concepts might include in an HCI context.

Student Reflective Logs

In a United Kingdom context, the first author identified candidate topics for threshold concepts by examining students' reflective logs submitted as part of their coursework for the two HCI modules that he taught: Introduction to HCI (IHCI) and Advanced Interaction Design (AID). Both are optional modules taught to 3rd year undergraduate students at a university in the United Kingdom. The reflective logs for IHCI are for a set of required reading articles and papers as well as videos covering the topics of introduction to HCI, personas, scenarios and stories, designing for usability, affordances, paper prototyping, cognitive walkthroughs, and interaction design in the wild. For AID, the students were asked to select 10 topics to write from 10 lectures and 10 seminars covering a range of HCI topics.

For IHCI, reflective logs of total of 80 students (random selection of 40 students from 2017, and 40 students from 2018) were collected. For AID, the logs of all 38 students in 2017 and 66 students for 2019 were

Honest reflection
It is worth noting that the data shows that students were generally honest in their logs and when they thought a topic/concept is forgettable for example, they clearly indicated that. For example, on designing for play, a student commented "*I will likely forgot the content of this lecture as it was very content heavy, with many new concepts and theories to remember, and also because I have no prior knowledge to link it too.*" Another student who, on analysis frameworks, said "*I believe what I learned in this lecture could be things I could easily forget*" yet, when writing about 'technology as experience' seminar, said "*I believe what I read will stick with me because this is an area that I want to continuously focus on.*"

analysed. For the two years of IHCI and the 2017 AID, students were not given any structure for the reflective logs. For AID 2019, students were asked to include answers to four questions in their logs related to the main concept discussed in that lecture/seminar, whether that differed from their previous understanding, whether they are likely to forget that, and how does that concept links to other HCI concepts that they are already familiar with. As such, there were more entries that can be used as indicators to possible threshold concept from the AID 2019 class than others. For that reason, an exclusion criteria was set for that class which included accounts that reported incremental rather than transformative change, accounts that, while reporting on a topic being very interesting, do not demonstrate a transformative view, accounts from students who listed almost all topics as 'changed how I view/do x', and entries shorter than 100 words and with no deep reflection.

The analysis aimed to identify logs that reflect a transformative, irreversible, and potentially troublesome concepts. Identifying integrative and bounded concepts is more challenging, so these two criteria were not included in the analysis.

Interview with UX Students
In a United States context, the second author has worked to identify initial threshold concepts in a novel undergraduate UX program [refs removed for anonymous review]. All students in this program are engaged in a studio-based, design-focused program with a UX focus. The design of the program intentionally spirals the development of student skills, allowing the students to work towards mastery in research, prototyping, evaluation, and other relevant UX skills. As part of their curriculum, all students complete weekly reflections in a shared Slack workspace over five studios, spanning a continuous 2.5 year period. Additionally, all students complete a reflection 'vlog' halfway through their first semester of studio work. Building upon these data sources, the second author and his research team solicited four dyads—intentionally representing students with divergent developmental paths—to participate in a group interview. These requests were made approximately one year after the students' vlogs were created. We used these vlogs to identify 4-6 clips for each student, and then as part of a larger interview protocol, we played back these clips and asked probing and reflective questions, allowing both students to discuss their development as a designer. In the last portion of this interview, we asked the students to identify potential thresholds in their learning, using questions such as "If you had a conversation with your past self a year ago, what might you want to tell yourself?".

The second author analysed findings from four dyad interviews, each approximately one hour in length, with the main goal of locating transformative elements of design or HCI concepts that appeared to have furthered students' development as a UX designer.

Findings
The findings below do not necessarily suggest that the identified concepts are threshold concepts, but that these are to be considered and scrutinized as potential threshold concepts. We present the potential concepts by study context, with no goal of explicitly synthesizing concepts across contexts or arriving at a final set of threshold concepts for HCI.

Reflective Logs

Because the original reflections arose from a range of different themed weeks, we report here on examples of a range of the higher-level themes, rather than a comprehensive summary of all potential themes and sub-themes.

HCI as a Discipline

Many students' comments indicated that they viewed the HCI discipline itself as a threshold concept. For example, one student noted: "*I had no idea that the use of HCI spreads to cover such a vast array of fields…",* while another student reflected*: "Before reading this paper, I didn't realise that HCI was the culmination of many other fields outside of computer science."* Some students came to this realization while recognizing that HCI exists beyond usability, noting: "*One sentence that resonated with me was 'Usability now often subsumes qualities like fun, well-being, collective efficacy, aesthetic tension, enhanced creativity, joy, support for human development, and others.'"* Another student described: "*I had never actually thought that designers have such intricate jobs that go into such depths in order to create something that people will find easy and pleasant to use."*

User-Centred Design

As suggested by [8], students flagged user-centeredness as a strong candidate for threshold concept. As one student described: "*[Cognitive walkthroughs] made me realise that your target audience is really important when designing things and be careful about making assumptions on the user."* Another student reflected: "*[The design process] differs from my previous knowledge in that I was not aware it was defined from the 'user's perspective' … It has changed how I will view future products as I will always consider the person who will be using the product, instead of only visualising how I would use a potential interactive design."*

Fieldwork

The idea of carrying out fieldwork, and particularly qualitative fieldwork, to inform or evaluate a design was also raised repeatedly by students. First, students noted the value of "in the wild" observation of user interaction. One student described "*A subtle yet major flaw in HCI has been looking at users in a lab environment as opposed to 'wild' which I had never really considered until reading this article."* Another student mentioned that the notion of designing in the wild: "*made me re-evaluate what the most important aspects of designing a system is.."* This notion of engaging with complexity was also talked about as a 'troublesome' concept, with one student explaining: "*This is a very different concept from ones previously studying, and to me it seems a bit confusing, but I can understand how it can be beneficial."*

Some students also reflected on the value of ethnographic approaches in understanding the everyday experiences of users, with one student reflecting that: "*I think the concept of studying the target user group in a sense of working under their context is relatively new to me, so if really want to say is it affects my overall understand about conducting fieldwork. I think what I have learned in this seminar is not something that can easily forget*". Another student noted that "*[ethnography] was extremely revealing as to how the intuitive data collection strategy of observing an environment and reporting on it has a far more scientific basis which I previously wasn't aware of*

and how the planning methodology of ethnography can have a severe impact on the quality of results."

USE OF DIFFERENT ANALYTIC LENSES/THEORIES/METHODS

Students are presented with different theories and methods that can help in observation and analysis of fieldwork, such as Distributed Cognition, Activity Theory, and Ethnomethodology. While this range of theoretical perspectives and design methods represent a range of departure points for design activity, students used these perspectives as a place to reflect upon changes in their perspective in regard to the field at large. For instance, one student described "*The most interesting part…was learning about the different methods of analysing the same data, this was interesting as I had never previously thought about how from a small amount of data you could produce a lot of different types of information simply by using different analytical methods to analyse it.*" Another student identified that "*The idea of analytical perspective and its base in design theory was something I had never properly considered prior to this lecture and has informed my understanding and interpretation of fieldwork going forwards."*

While analytic lenses were specifically discussed as points of focus, so too were the range of applicable design methods. While we cannot share in detail all of the students' engagement with methods, some of the following quotes may provide insight into how specific methods shifted students' understanding of HCI and design work. For instance, one student reflected on their growing understanding of the role of personas: "*I now realise that […personas are] a lot more than some nonsense made up figure; instead they are changeable (through evaluation and updates) and useful tools for making design decisions.*" Similarly, one student described their experience considering participatory design approaches for the first time: *"I did not know of participatory design beforehand, but now I will consider it whenever implementing the design phase of a product…I doubt I will forget this lesson after hearing about how the users are 'given a voice' in a process of mutual learning for themselves and the designers…This lecture has turned design on its head for me, I always thought of it as a process undertaken by those who are creating the product, not those that are using it.*"

USER EXPERIENCE

Beyond usability, students were intrigued by the notion of designing for experience, what that actually means, and the theories and models supporting it. It is perhaps one of the topics with the largest number of comments indicating its potential threshold concept characteristics. One participant noted their area of focus, describing: "*One particular feature of UX design which stood out for me was the disparity between objective and subjective experience, prompting me to look beyond the objective function of my designs."* Another student mentioned a shift in thinking, noting: "*Things I have learnt by reading this research paper are completely conflicting to what I used to believe up till now—which was that technology is a standalone field. In reality, technology is integrating more now than ever before with the human cultures and experiences.*"

UX Student Interviews

Many of the potential threshold concepts identified in the UX student dyads represented abstract, philosophy-oriented commitments. Of these, several related directly to the intended 'hidden curriculum' [anonymized ref] of the studio sequence, particularly in

engaging students in productive failure, iteratively exposing them to new methods that were somewhat discontinuous from their project work, and the use of design briefs that required extensive framing and narrowing to tame the provided 'wicked' problem. We will describe several program-level candidate threshold concepts that students shared in the sections below:

Methodological Fluency

Many students linked their development in expertise as a designer to their development of "instrumental judgment"—or the ability to recognize and select the appropriate tool for the given task. One student described this development as follows: *"I know more methods, but I could learn the methods from a book—it's more through doing the process of doing projects and these exercises and interacting with these people that I'm now able to have confidence in what I'm doing and I'm able to kind of make a plan, be able to roll with the punches."* Another student reflected on their experience mentoring a junior member of the program: *"Also picking methods was I feel like, was a big thing. […] I terrified one of the freshman the other day, cause they're […] getting their documentation together for [a] project, and they were talking about their personas. And I was like, 'Oh, why did you do personas?' and 'How did you use your personas?' and they were like, 'What do you mean by how did you use your personas?' And they were like, we made personas. And I was like, 'Yes, but how did you?' They're like, 'What does that mean?' And I was like, 'Oh, it's fine.' They're like, 'No, tell us.' And I'm like, 'I can't, I can't tell you. […] You don't just make—[…] you don't just make personas to make personas."*

Design Failure

Another common theme was the embracing of failure, and its value in realizing greater design opportunities. In particular, students identified more capable students as a lens through which they could view their own development as designers and humans. One student, reflecting on their own failure, mentioned: *"I want [newer students] to have to go through the bumps and I want them to have to figure it out on their own because I think you come out on the other side being like a much better, not just like designer but person."* Another student described this shift in broader terms beyond UX, noting: *"I've also realized that I should be more kind to myself in ways where it's like I don't think I can just demand things for myself and expect things to change. Whereas instead I can just get a bit better with every day. I think that's all that should really reasonably—reasonably expect."*

Narrowing and Problem Framing

When describing more specific interactions within design processes, students reported problem framing as a key turning point in their thinking. One student reflected on their assumption that UX work would get easier, noting: *"I just thought that like I was I suddenly just going to know more about UX. Like suddenly I would be able to find the answers to the problems. And it's like, I don't think finding answers to problems are any easier. It's just I trust in my ability and my team's ability to do it and I'm able to get it done. And I'm just kind of more at peace with these things."* Another student reflected on the difficulty of problem framing, describing: *"[O]ne of the big things was that I just had no clue how to do [problem framing.] And you kept saying those words like 'scope your problem,' 'frame your problem.' And I was like, okay, but how do you do*

Summary of potential threshold concepts

Identified through HCI students' reflective logs

- *HCI Discipline* itself as a threshold concept.
- *User-Centred Design.*
- *Fieldwork* to inform or evaluate a design.
- *Use of Different Analytic Lenses/Theories/Methods*.
- *User Experience*: Designing for UX and not just usability.

Identified through UX students' interviews

- *Methodological Fluency*: Recognizing and selecting the appropriate tool for a given task.
- *Design Failure*: Embracing of failure, and its value in realizing greater design opportunities
- *Narrowing and Problem Framing* as a key turning point in students' thinking
- *Design Process as Flexible and Situated*: Recognizing that the design process is one's own, and is flexible and subjective

that? And then you're like, 'well it's not that simple.' And I was like I would like a formula, please. And I don't know, it was just one of those things where I just felt stuck. And then sometime last semester in the fall […] it just made sense where it's like framing the problem is not just like picking insights and then be like squish them together into a problem statement and then roll with it. It's about feeling the space and that's why like emp athy kind of comes into a lot of UX work. […] And like I said, I couldn't even explain this to myself back then. […] But it's like, basically feeling out the space, and then going back in and being like, okay, so these are the areas that we can try and help and trying to improve based off of this wide problem."

Design Processes as Flexible and Situated

One final theme, while not frequently articulated in an explicit way, seemed especially relevant to students' development as designers as they recognized that the design process was their own, and was flexible and subjective. One student described this realization as follows: "*The hard learning about—the design process is [it's] not going to be the same every time and you can't like duplicate the design process, which is like, what I feel like I was trying to do first semester. Like, oh, this worked last time; this will work again this time. Which is not always true."*

Discussion

While these two differing perspectives, datasets, institutional contexts, and national contexts provide different lenses through which to view potential threshold concepts, we do see strong parallels—although at different levels—in our findings. Through this work, we do not claim to finalize a core set of threshold concepts in HCI with this limited data collection. However, we feel that this work strongly suggests the value of such a theoretical and pedagogical investigation, strengthening the aim of this work in starting a discussion around threshold concepts and proposing a number of preliminary concepts that have the potential to be examined and scrutinized for future consideration as HCI threshold concepts.

We do wish to explicitly note limitations of our work—namely that the concepts identified by students are largely influenced by the design of the curriculum as they are mostly a subset of that curriculum in its hidden and explicit forms. Beyond this situationality and subjectivity of threshold concepts, we also recognize that the notion of UX and HCI itself is contested and somewhat subjective [5], with a lack of shared knowledge base that makes large-scale projections of threshold concepts difficult or impossible. We do, however, find value in identifying threshold concepts that apply to design as a trans-discipline (e.g., methodological fluency, use of different analytic lenses), and feel that these more abstract threshold concept candidates might be most useful for further exploration in HCI pedagogy research.

Conclusion

Our hope is that this work triggers a discussion regarding possible threshold concepts in HCI pedagogy, with the eventual goal to influence the design of HCI curricula for students and educators. We posit that attention to these concepts may guide the development of future curricula and serve as a guide for future HCI/UX students in their education and practice.

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