Moments of Surprise: Preparing Technology-Oriented Students for Interdisciplinary Work

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ABSTRACT

The design and development of interactive software systems requires specialized expertise and interdisciplinary collaboration. This paper presents an autoethnographic case study that seeks to explore the potential of teaching human-computer interaction to technology-oriented students for preparing them for interdisciplinary work. Selected teaching and learning activities are described where graduate students applied HCI design methods to their own practices in higher education and to everyday life. It is argued that such 'self-confrontation' provides opportunities for surprise and explanation seeking. Students critically reflect on their design assumptions and approaches and learn to appreciate unfamiliar design perspectives. My argument is supported by the analysis of situations that lead to surprise in the example activities. The suggested approach helps to implement dialogic teaching and learning and allows both students and teachers to develop and learn.

CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI)**; • **Social and professional topics → Informal education**; • **Software and its engineering → Requirements analysis**.

KEYWORDS

Human-computer interaction, user-centred design, dialogical teaching and learning, interdisciplinary work, surprise

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1 INTRODUCTION

Designing and developing interactive software systems requires diverse expertise. Mackay [24] argues that it is unlikely that "many individuals will become expert in everything", and what is needed instead is a balance between educating students in a major discipline and preparing them for interdisciplinary collaboration. Specialized training enables students to acquire knowledge and skills to approach design problems from a certain perspective. However, students also need to understand that different design perspectives are necessary, and Mackay [24] suggests they be exposed to the values and approaches of other disciplines. There can be no effective communication in interdisciplinary teams without mutual appreciation of each others' contributions.

This paper seeks to explore the potential of teaching human-computer interaction (HCI) to students in technology-oriented fields for preparing them for interdisciplinary work. HCI has been since 1988 one of the knowledge areas in the ACM/IEEE computer science curriculum guidelines [12]. Recommended topics include HCI foundations and user interfaces, but the most recent version [31] also recommends that students "recognize the increased importance of design methods and interdisciplinary approaches within the specialty". The current information technology curriculum guidelines even replaced the term human-computer interaction by user experience design (compare [16] and [35]). Core competencies mentioned here include the application of a user-centred design approach with multiple stakeholders and interdisciplinary design teams. An obvious way for developing these competencies in students are interdisciplinary team projects. For instance, Sörries et al. [39] describe a project-based course they developed for computer science and design students. The authors point out that the creation of such an interdisciplinary place is not possible in all settings and costs students and teachers additional effort, but "despite occasional exceptions, the quality of the outcomes and the individual learning experiences... convey the added value of interdisciplinary work" [39].

This paper is about learning and teaching activities in a more monodisciplinary educational environment. It presents an autoethnographic case study geared to hypothesis generation about the role of surprise in achieving above mentioned transformations in students' understanding. I describe classroom interactions from two courses taught by myself where technology-oriented graduate students applied HCI design methods to their own practices in higher education and to everyday life. Surprise as a 'cognitive emotion' [2] plays a key role in learning: if people experience a surprising event or outcome they seek for explanation [18]. Adler [2] recommends to use surprise occasionally as a pedagogical tool, "especially in cases where deep-seated preconceptions and assumptions are upset by vivid demonstrations". In the paper, I argue that the use of HCI design methods for students' 'self-confrontation' provides opportunities for surprise which help them to better understand the value of unfamiliar design perspectives and to critically reflect on their

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assumptions and approaches to design interactive systems. It is also argued that teachers need to be open to surprise themselves to be able to create opportunities for students to be surprised. My arguments are supported by a detailed description of selected learning activities and an analysis of situations that lead to surprise. The suggested approach helps to implement dialogic teaching and learning and allows both students and teachers to develop and learn.

The remainder of this paper is structured as follows: section 2 provides a background; section 3 presents the case study. The paper concludes with a discussion and conclusion section.

2 BACKGROUND

This section first looks at complementary, and sometimes contrasting, perspectives and approaches that HCI design offers to software engineering and related design disciplines. It considers then the use of surprise within a dialogic approach to teaching and learning.

2.1 Potential of HCI Education and Educators for Developing Students' Ability to Work Interdisciplinary

HCI is an interdisciplinary field itself with roots in social and behavioural sciences and computer and information technology that developed from a need to build more useful and more usable interactive software systems [8]. Diaper [13], Sutcliffe [42] and others argue that HCI and software engineering are design disciplines that both aim to develop software systems but differ in their focus which is more on software aspects in software engineering and more on people and context of use in HCI. According to Winograd [46], "methods, skills, and techniques concerning these human aspects are generally foreign to those of mainstream computer science". A common assumption underlying HCI design approaches such as user-centred design and participatory design concerns the need of a broader scope of design to better understand possible effects of the considered software artifact on users and to deliberately transform their (work) practices. It is further assumed that interdisciplinary design teams and an early involvement of users in design processes support the consideration of the diverse and partly conflicting needs of users and other stakeholders.

The notion of the 'reflective' or 'thoughtful' interaction designer is influenced by general design theories such as Schön's reflective practice paradigm [36] and provides a complementary view to the above described user-oriented design perspective. It puts more emphasis on the nature of design problems, which are often wicked problems [33], and the nature of design situations, which are often 'messy' and cannot be tackled by predefined methods. Designers must be able to respond to the design material that is available in a specific design situation [40, 43]. Generally, design processes can be described as processes of constructing domain-specific design representations: the final product emerges from and is shaped by the creation, refinement, and use of intermediate representations [45]. HCI research has produced various methods and notations for representing the context of use and the design rationale of software artifacts in a way that enables contributions from many stakeholders. For instance, workplace studies provide detailed accounts of work practices. Personas linked with problem scenarios and envisaged activity scenarios [34] help stakeholders to develop a shared problem understanding and to explore and systematically compare alternative solutions. Iterative design is supported by prototyping and so on.

According to Oleson et al. [28, 29], computing students experience various difficulties when faced with HCI design concepts and educators often have to struggle "to engage students, [and] to override persistent perceptions that designerly aspects of HCI are 'inessential', 'easy' or 'commonsense'" [28]. As noted earlier, technology-oriented students are not expected to acquire high-level skills in doing interviews, creating storyboards, or applying other HCI design methods (see [9] for a list of important components in HCI education). The objectives of HCI education in this context are rather that students learn to appreciate 'foreign' design concepts and methods, that they become able to relate 'foreign' design representations to their own, and thus can integrate different design perspectives. What are good strategies to achieve this? This paper explores the idea that students (and teachers) apply HCI methods to activities that are relevant to themselves (e.g., their own learning and teaching activities or their everyday life). The underlying hope is that HCI concepts and methods become more accessible and meaningful to students if they experience situations where they play both the role of the designer as well as that of the user.

Carroll [8] points out that due to the "inclusive multidisciplinarity of HCI" it is even challenging for HCI researchers and educators "to have a fairly comprehensive understanding of the concepts and methods in use" and to cope with the "tension between depth and breadth in scientific expertise". The experience of this tension and their attitude and knowledge about design processes may also support a dialogic approach to education.

2.2 Dialogic Approach to Teaching and Learning and the Role of Surprise

The proposed 'self-application' of HCI design methods requires and, at the same time, facilitates a dialogic approach to education. In dialogic teaching and learning, students and teachers ask questions, listen to each other and jointly explore alternative points of view [19]. Dialogic spaces support participants in expressing their ideas freely and reaching common understanding [3]. There are no predefined answers but students play an active role in knowledge construction [23]. To achieve this though, teachers need to "situate learning in students' own experiences" and "[s]tudents have to become aware of their own ways of knowing, or meaning-making structures" [23]. Dialogues are purposeful activities which enable both students and teachers to develop. It is essential here that teachers "demonstrate that they are not only genuinely interested in each student's potentiality, but that their own potentiality is also dependent on learning from the students" [38]. Alexander [3] speaks in this context of the teacher's liberation of classroom talk "from the safe and conventional", perhaps a precondition for surprise in classroom.

Surprise is a cognitive-emotional phenomenon that is triggered by an unexpected event or outcome and challenges internalized assumptions and beliefs [18]. The person is stimulated to pay attention to the 'surprising' event, elaborate on it and seek for an explanation [22]. Surprise causes disorientation [38] and burdens cognition [2], but it can lead to shifts in understanding and attitude

and is therefore an important factor for learning [22]. The degree of surprise (and thus learning) depends, for example, on the person's ability to recognise and respond to surprise (open-mindedness) and on the divergence from expectation and depth of disorientation [2, 38]. Surprising outcomes that require deeper explanation than others are recalled more accurately [18]. Although surprises are "not really under our control" [38] they do not happen only by accident but "[i]t is possible to design [for] experiences that surprise others" [22] (see, e.g., theatre plots). Adler [2] recommends to occasionally use surprise in teaching as intrinsic motivator for students so that they "focus self-critically on a failure of their subject matter-related expectations" [2]. Schwabenland [38] and Lucas [23] support the idea that surprise promotes students' critical reflection (an important objective in higher education). Both authors emphasize in their reflection on their own teaching that teachers can only create opportunities for surprise if they are open to surprise themselves, if they recognise and respond to unexpected effects of learning activities (called 'moments of surprise' in [23]).

3 CREATING OPPORTUNITIES FOR SURPRISE: AN ANALYSIS OF EXAMPLES

The case study presented in this section describes activities drawn from two elective courses for graduate students from the engineering and computer science department at our university. HCI design methods are applied in a playful way to one's own practices in educational and everyday settings. Moments of surprise are identified and analysed that led to more understanding and appreciation of applied methods and related concepts.

3.1 Objectives, Method and Context

I have adopted an autoethnographic lens to understand more deeply how to prepare technology-oriented students in a monodisciplinary educational environment for interdisciplinary work. "Autoethnography is an approach to research and writing that seeks to describe and systematically analyze (graphy) personal experience (auto) in order to understand cultural experience (ethno)" [17]. The author is both informant and investigator and "presents insights that might otherwise have been too subtle to elicit" [10]. Autoethnographic reports acknowledge and accommodate the author's subjectivity, emotionality, and influence on research [17] by "present[ing] both a record of activities and how the researcher made sense of those activities" [10]. The writing style is usually first person to indicate the author's involvement in the described activities.

I describe selected learning activities from two courses that I taught in the summer semester 2022 and winter semester 2022/23 respectively. The first course (with 15 graduate students) was a requirements engineering course that introduced students to methods and notations for eliciting, modelling and analysing, communicating, agreeing, and evolving requirements [27]. The focus was on user-centred approaches to requirements engineering [41] and how to capture relevant aspects of the 'system-as-is' and 'system-to-be' [44] (e.g., topics from contextual design, scenario-based design, design rationale, task analysis and modelling). The second course (with 17 graduate students) was a design-oriented HCI course focusing on the concepts of usability and user experience and related design approaches, methods and techniques (e.g., user-centred and participatory design, persuasive design, personas, cultural probes, sketching and prototyping). Both courses consisted of a weekly lecture and tutorial with physical attendance in classroom. Home assignments prepared activities in the tutorials where we jointly explored and discussed a complex theme. The goal was not to create a 'final' product (such as in student projects) but different aspects of the theme were used throughout the semester to try out methods that were introduced in the lecture part of the course. Formal and informal course feedback seem to suggest that students generally appreciated the interactions in the course (e.g., "opportunity to discuss interesting questions that appeared during the lecture", "many interactions between students with usage of additional features like stickers and desk"). It also needs to be mentioned that, due to the Covid-19 pandemic, courses at our department were taught as online courses in 2020 and 2021. Ever since the winter semester 2022/23, the majority of courses are 'classroom' courses again. The requirements engineering course was one of the few 'classroom' courses offered in summer 2022.

My interest in this research developed from my experience of teaching HCI to technology-oriented students. In the example in [14], a group of software engineering students were engaged in creating personas and scenarios about a students' software project - with the 'side effect' that they collaboratively reflected on their own failures and experiences in a previous project. A tutorial theme that concerns the participants closely is more engaging and allows them to act in both roles, the designer role and the user role. But does such 'self-confrontation' also increase their appreciation of unfamiliar design perspectives and applied design methods? Activities in the present study show a complex network or fusion of roles and require more involvement and responsiveness from my side (as teacher). Analytic autoethnography is applied to investigate the above question. This form of autoethnography is less aimed at "evok[ing] emotional resonance with the reader" but "directed toward theoretical development, refinement, and extension" [4].

3.2 Data Collection and Analysis

Collected data include course material, students' homework and my feedback, and reflective notes about my observations in the tutorials and students' comments. Sensemaking of below described activities was also supported by regular intensive conversations with another educator (not involved in the considered courses) and reading the literature. It resulted in a deeper understanding of the role of surprise in promoting students' critical reflection. The identification and description of surprising situations for students was informed by observed immediate reactions and by students' later comments about a situation.

3.3 Theme 1: Higher Education in a "post-COVID world"

In user-centred requirements engineering, participants explored how learning and teaching activities in a "post-COVID world" could look like and what technological support would be needed. Here, we look in particular at how the theme was used for practicing interviews and affinity diagramming.

3.3.1 Selected Activities. Students were asked to conduct interviews with each other with the goals of understanding more about

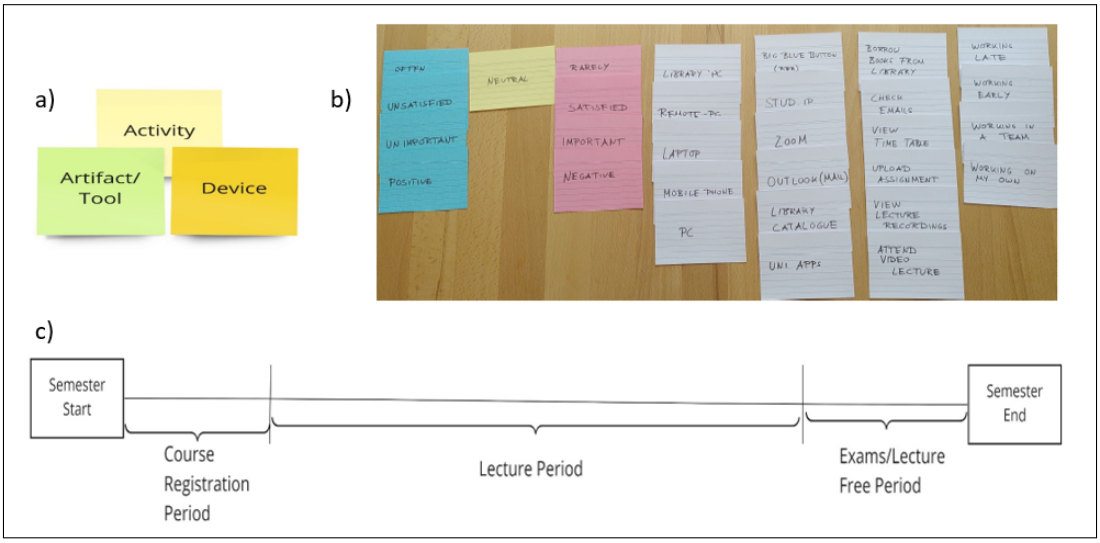

Figure 1: Ideas for visual aids and created material for interviews.

the interviewee's current studying activities and experiences and about their ideas and wishes for the future? The interviews were prepared and conducted as follows.

(1) In class: Students were briefly introduced to interviews and the Day-Reconstruction Method [21]. We discussed how the latter can be used to mitigate bias and ask more 'situated' questions in interviews. We also discussed the use of visual material to aid interviewers and interviewees. Figure 1a,c) depicts ideas for visual aids inspired by visual mappings for artefact ecologies in [7].
(2) Home assignment: Students reconstructed their studying activities over a period of 7 to 10 days. They created daily personal notes, and based on that, daily protocols with details about the goals of the activities, partners, use of digital and paper artifacts, and free comments about their experiences. Digital templates for notes and protocols were provided.
(3) Home assignment: Students prepared an interview guide. Each student analysed the protocols of a peer student to prepare questions and visual aids for interviewing her or him. Figure 1b) shows visual material prepared by a student.
(4) In class: Discussion and revision of interview guides, first in student-student pairs and then in whole class.
(5) Home assignment: Each student conducted and documented an interview with the peer student they knew from the protocols and was interviewed by another student.

Alexander [3] describes various forms of interactive settings and kinds of talks that support dialogic teaching. Settings in his framework only include classroom situations: whole class (teacher - student), group work (teacher-led/student-led), one-to-one (teacher-student/student-student pairs). However, the above mentioned home assignments were important for interactions between students and teacher. In (3), students 'listened' to their peers by reading their protocols. Student pairs discussed in (4) their results from (3). The interviews (5) were one-to-one interactions between students.

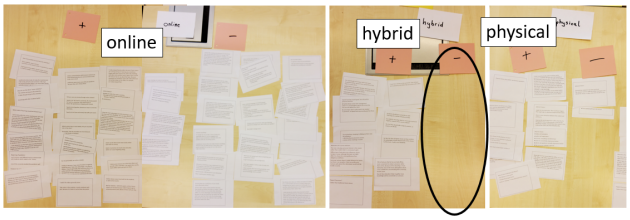

Figure 2: Fragments of a group's affinity diagram.

To prepare for the whole class discussion in (4), I read all students' interview guides and identified ideas other students can learn from as well as general flaws. For instance, there were only a few questions which encouraged interviewees to look at learning and teaching activities from a perspective other than the student perspective. We discussed how some questions suggested in [30] could be used in an adapted form.

Students played the role of user in activities (2,5), and the role of designer in (3,4,5) (see table 1 for an overview). They were co-designers in the subsequent affinity diagramming session and I joined their closing discussion. They worked in two sub-groups on identical sets of about 120 affinity cards. Most cards were created from the students' interview reports but I also used cards from a previous course. At the end of the session, we shared the sorting results. One group had, for example, categories for the organization of classes (*physical*, *online*, and *hybrid*) with pros (+) and cons (-) (see figure 2). There were several cards with statements similar to this one: *So, students should go back to university to prevent negative impacts of less social contacts. Yes, but they should offer a hybrid solution, so anyone can decide.* I asked: *What about the teacher, do they have to be present in class on an early November morning?* The ensuing discussion on recording classes revealed conflicting views (e.g., 'consumer attitudes' about learning vs. the need to keep up with 'technical progress'). In the midst of the discussion, one

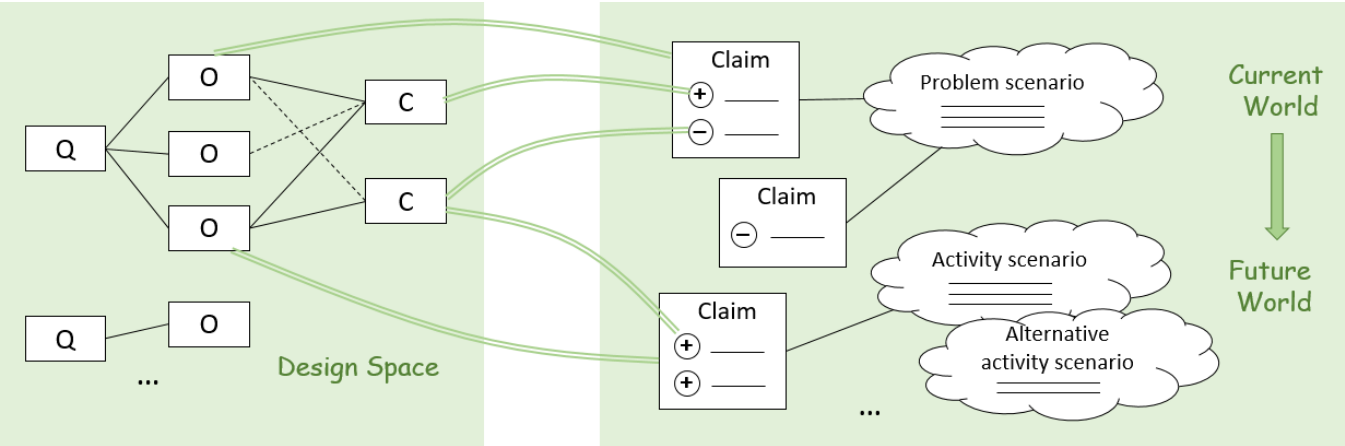

Figure 3: Relating elements of QOC diagrams [25] to claims and scenarios [34].

student pointed to the cards and said that it is interesting to see that their *hybrid* category has no cards with cons (see the encircled empty space in figure 2).

3.3.2 Moments of Surprise. I recognised in the above described activities surprising situations both for students and for myself. As I have seen in previous years, students were surprised about the degree of knowledge sharing in affinity diagramming. (In a later class, we read and discussed an essay on shared understanding in software engineering [20].) The affinity cards revealed that even students in this small group have diverse needs and views. A local student who had interviewed an international student mentioned weeks later (still in a tone of surprise) that, through the interview, he became aware of the particular difficulties international students encountered during the 'Covid-semesters'. There are the notions of role and actor in software engineering but the diversity of users and contexts of use is often overlooked [1]. In a later meeting, we explored integration approaches of uses cases (with actors) and personas [15].

However, the affinity cards also revealed 1) an almost unanimous opinion in favour of recorded lectures, and that 2) perspectives from teachers (or other stakeholders) were rarely considered by the students. It was not unexpected, still I was surprised to see it so clearly in the interview material. My view on the importance of ephemeral interactions in lectures evoked the above mentioned discussion, during which a student 'discovered' that the affinity cards do not mention any disadvantages of suggested future artifacts. The affinity diagramming session was a vivid demonstration for the need of approaches such as scenario-based design [34] that provide engaging descriptions of different design perspectives and facilitate a systematic discussion of consequences of artifact features. Scenario-based design was introduced earlier to the students but I decided, in response to the session, to revisit this approach in the next lecture.

It is common practice in our department to upload lecture material for students. The discussion in the session triggered my reflection on a perhaps deep-seated need of keeping or recording things if possible and whether this can sometimes hinder the experience of dialogue[1]. Another question concerned the meaning of 'technological progress'. A dominant assumption in requirements engineering but also in HCI design is that existing problems can be identified and solved or mitigated by the creation of 'more advanced' technological artifacts. Complex or 'wicked' problems can be tackled by capturing contextual aspects in models of the 'current world' and the 'future world' [13] to better inform design decisions but basically technology improves the world. How do existing ideas of technology 'non-use' and technological extravention fit in here?[2] In teaching, I use illustrations of current and envisaged models (see right-hand side of figure 3) and I use illustrations of QOC diagrams [25] to introduce the concept of design space (see left-hand side of figure 3). But what about positioning the 'worlds' in a (design) space instead of a timeline? I never explicitly related the illustrations as indicated by the double green lines in figure 3. The figure shows a reconstruction of the 'blackboard diagram' developed (and not recorded) in the next lecture/discussion.

3.4 Theme 2: Technology Use in Near-Future Private Spaces

The overall theme in the HCI design course was technology use in private and public spaces.

3.4.1 Selected Activities. The paper only looks at two meetings about co-reflection on artifact use at the end of the course and a home assignment some weeks earlier.

(1) Home assignment: Students received a digital handout with a short introductory text on intelligent companions evoking empathy and personal attachment. They were asked to imagine they had such a digital assistant called Sam. Six situations were described, each with a title (e.g., can technology

[1]See [5] for a discussion on persistence vs. ephemerality. I share the author's concerns that "begin with the assumption about the positive benefits of recording everything about our lives."

[2]Baumer and Silberman [6] argue that there is relatively little reflection about where and when technological interventions are inappropriate. Pierce [32] describes technological extravention as purposeful subtraction of technology from the real world which requires to understand *that-which-currently-exists* in order to make it *disappear*.

Table 1: Overview of selected activities, settings and roles played by the students.

	Activity	Setting	Students' role	My contribution
Theme 1	daily personal notes and protocols	home assignment	user	providing templates
	preparing interview guide (incl. protocol analysis)	home assignment	designer	forming student pairs
	revising interview guide	in class: student pairs with subsequent whole-group discussion	designer	analysis of students' guides (identification of ideas to share and 'weak points'); discussion facilitator
	interviews	home assignment (student pairs)	designer (interview 1), user (interview 2)	
	affinity diagramming	in class: three student groups with subsequent whole-group discussion	co-designer	analysis of interview reports and creation of affinity cards; participant in closing discussion
Theme 2	write answers to questions in futuristic autobiographies (FABs)	home assignment	user (in reflection)	providing FABs
	design fiction activity	in class: reading, watching (video), whole-group discussions	user (in co-reflection)	providing design fiction material; discussion facilitator
	roughly analysing responses to FABs	in class: individual work, whole-group analysis and discussion	designer (analysis), co-reflection	providing written responses and guide for analysis; facilitator; participant in discussion

be a friend?) and an additional set of two to four questions (e.g., how did your relationship to Sam develop over time?). Students were asked to explain how they would respond to the dilemmas. The material was taken from [11], students were told that their texts are used later in the course.

(2) In class: 1) Students read a shortened version of a story on smart houses and their potential applications for chronic dementia published in [37]. 2) whole class discussion, 3) introduction to design fiction, 4) watching a three-minutes video about connected homes[3], 5) discussing naïve vs. critical interpretations of design fiction.

(3) In class: 1) Discussion of method applied in [11] (futuristic autobiographies and thematic analysis), 2) reading: students share texts from (1), 3) "rough" analysis (whole class) guided by categories identified in [11] and discussion.

3.4.2 Moments of Surprise. I have taught design fiction only a few times so far, and then as a meeting like (2). What was not surprising was the vivid discussion in (2). There is obviously a need for critical reflection on digital artifact use in the near future. This year, I added (1) and (3) because I like the material in [11] and wanted to try it out with students. At the end of (3), I said spontaneously to the students: *now you have a deeper knowledge about user experience and related methods, right?!*

[3]https://www.youtube.com/watch?v=-kTeavB3IGg

Even if students (in the role user/participant) are engaged in discussions like (2) it may be difficult for them to understand that there is an underlying design fiction method and not 'just talking'. In (1) and (3), they were required to go beyond "passively consuming" fiction (in the user role) and to be personally engaged in the stories [11]. Students also acted as designers in (3) by analysing responses from home assignment (1). They were surprised that our rough analysis in the class could already reveal similarities and differences in students' values and attitudes as well as majority and minority views.

In preparation of class (3), I read all textual responses from (1). They contained statements such as: *most of the time our friends motivate us, help us to recover from bad incidents*; *a friend can tell me pros and cons about a situation*; *that I have feelings for him.* I asked the students whether they can find passages in the texts stating what Sam might expect from them in a friendship? - We could not find any such statement.

4 DISCUSSION

In the presented examples, students apply user-oriented design methods to their own practices. They play the role of designer but are also users in the role of informant or co-designer (see table 1). I have shown that this 'self-confrontation' provides opportunities

for students' surprise. The emotion of surprise can arise from unexpected new views on things you think you know. For instance, the described use of affinity diagramming often has the effect that students are surprised about the diverse views in their group of peers. The rough thematic analysis in the second example seems to have a similar effect. Surprising events or outcomes call for explanation (*e.g., why did I not know this about my fellow students?*), and in our context, they open up the chance to jointly revisit the applied method. In the examples, the relationship between designers and users (e.g., co-design, critical co-reflection) and the supporting role of external design artifacts (e.g., affinity cards, stories) can be discussed. Additionally, if students perceive a method as useful they become more perceptive to its underlying ideas and concepts (e.g., knowledge sharing and user experience in the examples).

In the analysed activities, HCI methods are applied in rather fragmented and playful ways and created artifacts have obvious flaws. For example, students failed to ask questions in interviews that reveal their peers' perspectives on others (e.g., *how do you think the teacher thinks...*). There is a possibility for students' surprise when discovering this in the affinity cards. Skills needed for interviewing and other HCI methods are often underrated by technology-oriented students [29] and such discoveries may increase their appreciation for these 'foreign' design methods.

Lucas [23] distinguishes between 'moments of surprise' for students and for teachers and argues that they initially arise out of a willingness of the teacher to improvise. It is the teacher who has to 'shape' situations for the students' surprise and learning. And it is the teacher who has to critically reflect upon unexpected (both positive and negative) outcomes of learning activities. However, the analysed examples also show 'joint moments of surprise'. For instance, the closing discussion in the affinity diagramming session was deliberately initiated by myself to 'simulate' unexpected and conflicting views of stakeholders. The conflict was not only simulated though, it was real due to the choice of the theme. Both students and teacher play the role of co-designer and experience surprising outcomes as detailed above. In the second example, students and teacher are participants in critical co-reflection. In both cases they are faced with 'wicked' problems and none of the knows the 'best' solution.

Surprise should not be overused as 'device of teaching', otherwise it fails to stimulate explanation seeking [2]. Additionally, students (and teachers) differ in their receptivity to surprise which involves "a certain vulnerability [...and] accepting the risk of a possibly painful unsettlement of one's beliefs" [2]. However, many students in the considered examples expressed their happiness about being on campus again (after four or five online semesters due to the COVID situation). This situation could have promoted their open-mindedness and receptivity to surprise.

The examples in this paper apply HCI design methods to early design stages which are often neglected in computer science education. The goal is to encourage students' critical reflection on assumptions and development approaches in their own disciplines. The above mentioned concepts of user experience, shared design understanding and wicked problem are often hard to teach to technology-oriented students. They can be seen as threshold concepts, a term introduced by Meyer and Land [26] to refer to "'conceptual gateways' or 'portals' that lead to... [a] new way of understanding, interpreting, or viewing something". If students successfully pass the gateway they experience a transformation in their perception of a subject that is unlikely to be forgotten and integrative [26]. I suggest that described moments of surprise and subsequent explanation seeking can trigger transformation processes that enable students to cross disciplinary boundaries.

Meyer and Land [26] also discuss difficulties in achieving new understandings. They point out, for instance, that an effort to make a threshold concept easier to understand by introducing a naïve interpretation may have the effect that students "settle for the naïve version". Studied activities of learning and teaching can complement more 'product-oriented' forms such as interdisciplinary team projects where students typically work on less complex problems. An important issue, but not discussed in this paper, is that students need to learn to systematically relate the various design representations that are created throughout the design process in order to integrate different design perspectives.

The studied approach seems to be more appropriate for graduate courses. It requires but also facilitates dialogic teaching and learning in which teachers and students engage in critical reflection. According to Lucas [23], undergraduate students often believe in absolute forms of knowledge and have less capacity to engage in critical reflection. Designers in HCI design and teachers in dialogic education share similar assumptions and attitudes. They view themselves as 'reflective practitioners' who need to respond to the specific design or teaching situation and develop professional experience by 'reflection-on-action' [36]. The described activities can support (but not guarantee) a co-development of teachers and students.

5 CONCLUSIONS

The paper demonstrates, through examples, the potential of HCI education for preparing technology-oriented students for interdisciplinary work. Within a dialogic teaching and learning approach, surprise is occasionally used as 'device of teaching' to trigger students' critical reflection and to increase their openness to perspectives of other disciplines. The ideas presented in this paper may contribute to the development of a body of Pedagogical Content Knowledge (PCK) for HCI design education proposed by Oleson et al. [28, 29]. PCK is domain-specific and contains knowledge about pedagogical strategies to teach a particular topic in a particular context to a particular audience.

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REFERENCES

[1] Silvia Teresita Acuña, John W. Castro, and Natalia Juristo Juzgado. 2012. A HCI technique for improving requirements elicitation. *Information & Software Technology* 54, 12 (2012), 1357–1375.
[2] Jonathan E Adler. 2008. Surprise. *Educational Theory* 58, 2 (2008), 149–173.
[3] Robin Alexander. 2018. Developing dialogic teaching: Genesis, process, trial. *Research Papers in Education* 33, 5 (2018), 561–598.
[4] Leon Anderson. 2006. Analytic autoethnography. *Journal of contemporary ethnography* 35, 4 (2006), 373–395.
[5] Liam Bannon. 2011. Reimagining HCI: toward a more human-centered perspective. *interactions* 18, 4 (2011), 50–57.

[6] Eric P.S. Baumer and M. Six Silberman. 2011. When the Implication is Not to Design (Technology). In *Proc. of CHI '11*. ACM, 2271–2274.

[7] Susanne Bødker, Henrik Korsgaard, and Joanna Saad-Sulonen. 2016. 'A Farmer, a Place and at least 20 Members' The Development of Artifact Ecologies in Volunteer-based Communities. In *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*. 1142–1156.

[8] John M Carroll. 2003. Introduction: Toward a multidisciplinary science of human-computer interaction. In *HCI models, theories, and frameworks: Toward a multidisciplinary science*. Elsevier Inc., 1–9.

[9] Elizabeth F Churchill, Anne Bowser, and Jennifer Preece. 2016. The future of HCI education: a flexible, global, living curriculum. *Interactions* 23, 2 (2016), 70–73.

[10] Sally Jo Cunningham and Matt Jones. 2005. Autoethnography: a tool for practice and education. In *Proceedings of the 6th ACM SIGCHI New Zealand chapter's international conference on Computer-human interaction: making CHI natural*. 1–8.

[11] Johannes Danielsson, Klara Säljedal, and Victor Kaptelinin. 2022. Employing Futuristic Autobiographies to envision emerging human-agent interactions: The case of intelligent companions for stress management. In *Proceedings of the 33rd European Conference on Cognitive Ergonomics*. 1–7.

[12] Peter J Denning, Douglas E Comer, David Gries, Michael C Mulder, Allen Tucker, A Joe Turner, and Paul R Young. 1988. *Report of the ACM task force on the core of Computer Science*. ACM.

[13] Dan Diaper. 2004. In *The handbook of task analysis for human-computer interaction*, D. Diaper and N.A. Stanton (Eds.). L. Erlbaum Associates Inc., Chapter Understanding Task Analysis for Human-Computer Interaction.

[14] Anke Dittmar. 2009. Playing with narratives. *HCI Educators 2009-playing with our education* (2009), 9–12.

[15] Anke Dittmar and Peter Forbrig. 2019. Integrating personas and use case models. In *Human-Computer Interaction–INTERACT 2019*. Springer, 666–686.

[16] Joseph J Ekstrom and Barry M Lunt. 2009. IT2008: Information Technology Model Curriculum. In *Seventh LACCEI Latin American and Caribbean Conference for Engineering and Technology (LACCEIâ€™2009)*. 2–5.

[17] Carolyn Ellis, Tony E Adams, and Arthur P Bochner. 2011. Autoethnography: an overview. *Historical social research/Historische sozialforschung* (2011), 273–290.

[18] Meadhbh I. Foster and Mark T. Keane. 2019. The Role of Surprise in Learning: Different Surprising Outcomes Affect Memorability Differentially. *Topics in Cognitive Science* 11, 1 (2019), 75–87.

[19] Rocío García-Carrión, Garazi López de Aguileta, Maria Padrós, and Mimar Ramis-Salas. 2020. Implications for social impact of dialogic teaching and learning. *Frontiers in psychology* 11 (2020), 140.

[20] Martin Glinz and Samuel A Fricker. 2015. On shared understanding in software engineering: an essay. *Computer Science-Research and Development* 30 (2015), 363–376.

[21] Daniel Kahneman, Alan B Krueger, David A Schkade, Norbert Schwarz, and Arthur A Stone. 2004. A survey method for characterizing daily life experience: The day reconstruction method. *Science* 306, 5702 (2004), 1776–1780.

[22] Jeffrey Loewenstein. 2019. Surprise, recipes for surprise, and social influence. *Topics in cognitive science* 11, 1 (2019), 178–193.

[23] Ursula Lucas. 2008. Being "pulled up short": Creating moments of surprise and possibility in accounting education. *Critical perspectives on accounting* 19, 3 (2008), 383–403.

[24] Wendy E. Mackay. 2003. Educating multi-disciplinary design teams. In *In Proceedings of Tales of the Disappearing Computer, Santorini*. ACM Press.

[25] Allan MacLean, Richard M. Young, Victoria M.E. Bellotti, and Thomas P. Moran. 1991. Questions, Options, and Criteria: Elements of design space analysis. *Human Computer Interaction* 6, 3 (1991), 201–250.

[26] Jan HF Meyer and Ray Land. 2005. Threshold concepts and troublesome knowledge (2): Epistemological considerations and a conceptual framework for teaching and learning. *Higher education* 49 (2005), 373–388.

[27] Bashar Nuseibeh and Steve Easterbrook. 2000. Requirements engineering: a roadmap. In *Proceedings of the Conference on the Future of Software Engineering*. 35–46.

[28] Alannah Oleson and Amy J Ko. 2020. Toward the Development of HCI Pedagogical Content Knowledge. In *2nd Annual ACM SIGCHI Symposium on HCI Education (EduCHI 2020)*.

[29] Alannah Oleson, Meron Solomon, and Amy J Ko. 2020. Computing students' learning difficulties in HCI education. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–14.

[30] Eva Olsson, Niklas Johansson, Jan Gulliksen, and Bengt Sandblad. 2005. A participatory process supporting design of future work.

[31] Joint Task Force on Computing Curricula. 2013. *Computer Science Curricula 2013*. ACM.

[32] James Pierce. 2014. Undesigning interaction. *Interactions* 21, 4 (2014), 36–39.

[33] Horst W.J. Rittel and Melvin M. Webber. 1973. Dilemmas in a General Theory of Planning. *Policy Sciences* 4 (1973), 155–169.

[34] Mary Beth Rosson and John M Carroll. 2002. *Usability engineering: scenario-based development of human-computer interaction*. Morgan Kaufmann.

[35] Mihaela Sabin, Hala Alrumaih, John Impagliazzo, Barry Lunt, Ming Zhang, Brenda Byers, William Newhouse, Bill Paterson, Svetlana Peltsverger, Cara Tang, et al. 2017. *Information Technology Curricula 2017 (IT2017)*. Technical Report. Technical Report. ACM/IEEE Computer Society.

[36] Donald Schön. 1983. *The Reflective Practioner: How Professionsal Think in Action*. Basic Books.

[37] Britta F Schulte, Paul Marshall, and Anna L Cox. 2016. Homes for life: a design fiction probe. In *Proceedings of the 9th nordic conference on human-computer interaction*. 1–10.

[38] Christina Schwabenland. 2011. Surprise and awe: Learning from indigenous managers and implications for management education. *Journal of Management Education* 35, 1 (2011), 138–153.

[39] Peter Sörries, Judith Glaser, Claudia Müller-Birn, Thomas Ness, and Carola Zwick. 2022. Coding IxD: Enabling Interdisciplinary Education by Sparking Reflection. *arXiv preprint arXiv:2205.02713* (2022).

[40] Erik Stolterman. 2008. The Nature of Design Practice and Implications for Interaction Design Research. *International Journal of Design* 2, 1 (2008), 55–65.

[41] Alistair Sutcliffe. 2002. User-Centred Requirements Engineering. (2002).

[42] Alistair Sutcliffe. 2013. *Requirements Engineering in "The Encyclopedia of Human-Computer Interaction, 2nd Ed.".* https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/requirements-engineering

[43] A. Telier, Thomas Binder, Giorgio De Michelis, Pelle Ehn, Giulio Jacucci, and Ina Wagner. 2011. *Design things*. MIT Press.

[44] Axel Van Lamsweerde. 2009. *Requirements engineering: From system goals to UML models to software*. Vol. 10. Chichester, UK: John Wiley & Sons.

[45] Willemien Visser. 2006. Designing as Construction of Representations: A Dynamic Viewpoint in Cognitive Design Research. *Humanâ€"Computer Interaction* 21, 1 (2006), 103–152.

[46] Terry Winograd. 1997. In *Beyond Calculation*, Peter J. Denning and Robert M. Metcalfe (Eds.). Copernicus, New York, NY, USA, Chapter The Design of Interaction, 149–161.