"Do we need an entire course about it?": Evaluating two years of teaching HCI in computer science

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Educators increasingly agree on the importance of teaching Human-Computer Interaction (HCI) to Computer Science (CS) students, but there is debate on how to best integrate HCI into CS curricula. Unfortunately, standard course evaluations typically do not provide sufficient insights for improving HCI classes. In the present article, we used a human-centered design approach to evaluate our HCI classes, building on a qualitative study with CS students from four introductory HCI classes over two years. We report on a qualitative assessment through interviews, photo elicitation and sentence completion. Specifically, we addressed four research questions: which contents were the most relevant, how students experienced the courses, how they view the role of HCI in CS, and which outcomes they perceived from the HCI courses. We gathered rich qualitative insights beyond the standard course evaluations and derived concrete enhancements for future course iterations. We discuss implications for other HCI educators and contribute recommendations for the living HCI curriculum. Furthermore, we reflect on the usefulness of our methodological approach to collect in-depth constructive feedback from students.

CCS CONCEPTS • Human-centered computing~Human computer interaction (HCI)~Empirical studies in HCI

Additional Keywords and Phrases: HCI education, Computer Science, Human-Centered Design, User Experience

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1 INTRODUCTION

As researchers and instructors of Human-Computer Interaction (HCI), we are very much concerned with designing meaningful courses to meet the students' needs. The traditional way to monitor alignment with these needs draws on standardized and anonymized course evaluation questionnaires. However, some of the results were surprising to us, such as receiving high ratings in pedagogical quality and low ratings in perceived complexity at the same time. We started to ask ourselves: Do we fail in getting across how complex HCI is [8]? Is the perceived low complexity actually a perceived quality? Or are our students simply not paying sufficient attention to the details of our field?

The present paper is grounded in the gap left by such standard student feedback for our HCI course. We report on a qualitative study with Bachelor students concerning two introductory courses to HCI in Computer Science. We were able to obtain results which are typically not available through regular course evaluations. These results contain relevant insights for enhancing HCI courses following a human-centered design approach. We contribute recommendations applicable to HCI courses beyond our own. Furthermore, we contribute to the methodologies of evaluating courses (i.e., interviews, photo elicitation, and sentence completion). These findings are relevant for other HCI instructors who hope to gather qualitative insights from the students.

2 RELATED WORK

Attempts have been made to establish a shared understanding of what "education in HCI" means. In 1992, ACM SIGCHI published a curriculum for HCI [3]. Since these days, the evolution of HCI gave rise to the idea of HCI education as a living curriculum [6] that is supposed to constantly adapt and integrate insights from HCI educators [11,23]. Discussions on the HCI living curriculum also identify challenges and appropriate strategies to address them. For example, HCI education needs to establish a curriculum, think about new ways to deliver content, define evaluation methods appropriate for HCI competencies, and provide support to HCI instructors [22]. This study contributes to two of these major challenges in HCI education [22]: how to deliver content and how to evaluate teaching.

In the present paper, we report on introductory HCI courses for Bachelor students in Computer Science (CS). With the growing relevance of HCI, more and more universities started to integrate HCI classes within CS [5,10,20]. Several associations suggested relevant contents for these classes, such as [2]. Furthermore, studies identified the most important topics, interfaces, and methods in HCI as a basis for courses [6]. HCI classes typically stress the role of design [4,11], in particular human-centered design (HCD) with a strong emphasis on empirical testing and iterative improvement [21,24].

Despite the long tradition of HCI courses in CS curricula, there are still several common problems. A frequent issue is Bachelor students' evaluation of the courses as relatively trivial, not challenging, and "soft" [1,8,10]. HCI does not have "right" or "wrong" answers, which is in sharp contrast to other CS courses [8]. Given the low overall volume of HCI in the CS curriculum [5], introductory courses in HCI often only include the basics of psychology, which might lead to the impression that "HCI is obvious" [8]. Researchers also reported differences in the style of working, with CS education being focused on individually developing software rather than collaborative work in

rapid iterations as in HCI education [4]. These issues contribute to a lack of common understanding between HCI instructors and CS students.

To address these issues, several authors advocated a more practical-oriented [1] and algorithm-based [19] approach to the course. For example, researchers suggested aligning HCI courses with particular models, such as the lifecycle model of software development [7], or Bloom's Taxonomy of topic's organization [17]. From practical-oriented challenges, the main way of improving the courses lay in the shift from early prototyping to full-cycle project development and evaluation with the incorporation of students' practical CS skills [1]. A shift from focusing on the outcomes of a design to the process of design could contribute to a better understanding of HCI [8]. How to teach these processes effectively is an area of little research [24]. In the following section, we will present how we addressed this challenge through our introductory HCI classes within the CS curriculum, before describing the research questions of this paper in section 4.

3 OUR INTRODUCTORY HCI CLASSES IN COMPUTER SCIENCE

In this paper, we report on two years of introductory HCI classes in a CS Bachelor at a European university. Our HCI classes span two courses over different semesters (see Figure 1). The course "Introduction to Human-Computer Interaction" is for the fifth semester and aims at providing HCI basics coupled with learning about the processes of Human-Centered Design in a collaborative, tutored project. The course "User-Centered Design" is an optional follow-up course for the sixth semester and aims at deepening HCI knowledge by applying it to a student-chosen project.

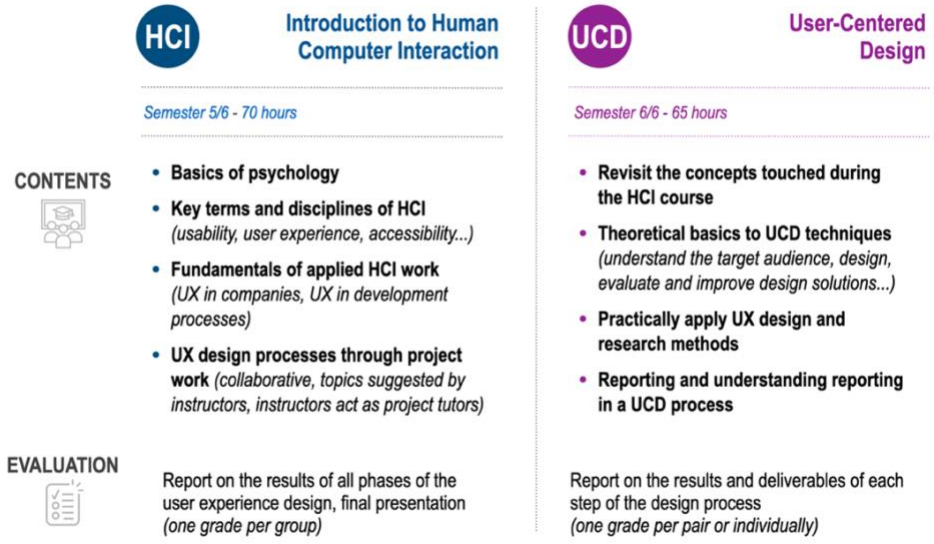

Figure 1: Overview of the two courses

Our courses (see Appendix A.1) were inspired by related publications from the HCI living curriculum. Regarding content, we followed suggestions from the above-mentioned ACM & IEEE Curriculum Guidelines [2] with a particular focus on user experience (UX) [6]. Regarding educational activities, we focused on UX design rather than

technology [4] and incorporated a collaborative educational style. We integrated activities that allowed students to apply HCI methods in realistic tasks [1] with detailed feedback, such as class discussions, exercises, and quizzes. Regarding assessment, we wanted students to acquire competencies they need to apply to the increasingly changing landscape of technology [12], such as prototyping and qualitative research skills. Thus, we wanted to concentrate on HCD as a process rather than the outcome [16,21]. Consequently, students engaged in projects covering the whole HCD process and created a report for each phase (e.g., user research to create empathy with users' needs). In "Introduction to Human-Computer Interaction", the students would collaboratively work on a predetermined project for the second half of the semester. In "User-Centered Design", each student would select a project on their own and work on it throughout the entire semester. We left it to the students to decide which HCI-related methods were appropriate for their projects depending on the users' needs. Throughout the project work, each group was tutored by one of the instructors in weekly meetings.

Finally, beyond educating students in HCD, we decided to apply a similar procedure to our courses. This paper describes a systematic study to collect qualitative feedback to improve future iterations of our introductory HCI classes.

4 RESEARCH QUESTIONS

The courses were evaluated by the regular course evaluation and received high ratings in pedagogical quality and low ratings in perceived complexity (see Appendix A.2). We also received a few open comments, but these were insufficient to derive recommendations for future improvements. Consequently, we decided to perform a qualitative study with students from the two years of HCI education in CS. Specifically, we ask the following research questions (RQ):

1. **RQ 1: Which contents of the HCI courses were the most relevant for the CS students?** As outlined in the Related Works Section, several contributions have been made to establish a standard curriculum for HCI. With RQ 1, we seek to add to this research by investigating the CS student perspective to these contents.
2. **RQ 2: How did CS students experience the HCI courses?** As teaching a course is more than just transferring content, we wanted to investigate the experiences of students in our courses. Our courses included several activities that could be unusual for CS students, such as group work on projects. With RQ 2, we seek to learn about how students experienced these activities beyond the content that are covered.
3. **RQ 3: How do CS students view the role that HCI plays in their field of study?** While integrating HCI in CS curricula is a well-established practice, a human-centered approach towards course evaluation needs to take the views of students into account. With RQ 3, we investigate the role that students ascribe to HCI in their CS studies, both in terms of general opinions about HCI and concerning the CS curriculum.
4. **RQ 4: What do CS students consider as outcomes of HCI courses?** With RQ 4, we investigate the perceived longer-term outcomes from taking the courses. These outcomes could include how they applied their learning, their attitudes, or their skills and competencies.

5 METHODOLOGY

We conducted ten interviews with students who followed both introductory HCI courses (n=7) or only the first part (n=3) between six and eighteen months ago. The interviews took around 25 to 45 minutes (average duration: 34 minutes) and were conducted remotely. The interviews were conducted in French or English by an interviewer who

was not involved in teaching the courses. We recruited participants via their student email address and compensated them with 20 €. The pre-tests with two participants (not included in the study) revealed a need to slightly adapt the question order.

The data collection happened in three steps (see Figure 2). First, we asked non-leading questions (see Appendix A.3) for all of our research questions, in particular content and methods they remembered (RQ 1), their experiences and ideas for improvements (RQ 2), their views on the role of HCI (RQ 3), and their perceived outcomes (RQ 4).

Second, before the interview we had asked participants to collect three images about their experiences (RQ 2). In the interview session, they explained their choice of images. We selected photo elicitation because the images might enable participants to communicate their experiences in a way that their words cannot [9]. Furthermore, by selecting photos before the interview, students started to remember their experiences.

Third and finally, to summarize the key points of the interview, we asked students to complete three sentences, namely "In order to make the HCI/UCD courses more relevant for future students, I would…" (RQ 1 or 2, depending on whether students refer to content- or experience-related ideas), "HCI is a topic that I find…" (RQ 3), and "The courses allowed me to…" (RQ 4). We used sentence completion to complement the other approaches [12,14].

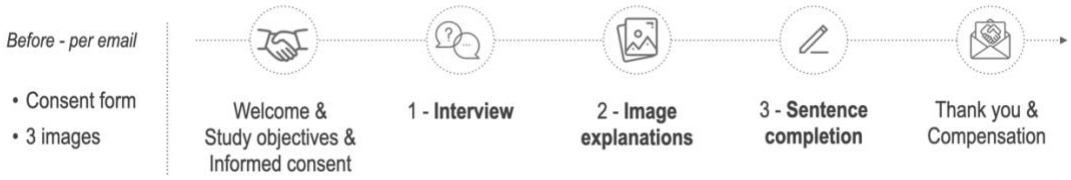

Figure 2: Overview of study procedure

All interviews were audio-recorded and transcribed, with exception of one participant who did not want to be recorded. In this case, the interviewer took detailed notes. We used qualitative content analysis to code the materials because it aims at deriving a coding scheme based on the material rather than a researcher's interpretation [16,18]. One of the authors went through the interviews and summarized statements into preliminary codes. These codes reduce the amount of material while still representing its full meaning. For example, the statement "iterating a lot, this is also something that I've learned" (P1) was preliminary coded as "learned about iteration". We went through the codes repeatedly and inductively organized them in categories. As suggested by Mayring [18], we revised these categories after coding about 40 % of the material. We performed three quality checks. First, another author independently created a second category scheme of the same interviews. We compared the two category schemes and slightly adapted them as needed. Second, we discussed our adapted category scheme in the author team to agree on the definitions. All interviews were coded by the first author with the resulting category scheme (see Appendix A.4). Third, the coding author and the interviewer systematically went through the results, discussed disagreements, and reached a consensus.

6 RESULTS

6.1 RQ 1: Which contents of the HCI courses were the most relevant for the CS students?

In general, students said their knowledge about HCI before the course was low (P5, P7) and limited to graphic design aspects (P9, P10). Only a minority reported some previous knowledge about user testing (P6, P8). After the

course, students specified which content and methods they remembered most, with an emphasis on the project work.

When asked about which specific content and methods students remember, their answers reflect how actively students engaged in learning about the content (P9: "I don't remember much from the slides. I only remember what I learned doing the class learning by doing"). The students sometimes mentioned single topics from the first half of our "Introduction to HCI" (P1, P3, P4, P9, P10), but without a consensus on which content was particularly memorable. In general, students remembered well when courses outlined how HCI-related content directly impacts working on digital products and services. Examples include class sessions where students had the opportunity to discuss with UX designers (P6) or learned about design processes in the industry (P1). A similar finding concerns some HCI methods. For example, students mentioned difficulties with user experience mapping (P1) or user stories (P4). This finding applied mainly when students learned about these methods in the first parts of the courses rather than including them in their project work. One participant reported that not understanding the purpose of the activities caused frustration, which was resolved when the project work started (P6).

When asked about the project work, students emphasized they liked working on the projects (P1, P4, P6, P8, P10). The idea of iteration in HCD became well established (P1, P10). Likewise, students were confident about methods used in the projects (P3, P4, P5). In particular, students mentioned acquiring knowledge about user testing (P10, P2: "In projects, I will use more prototyping because I now know a bit how to interpret the results of user tests").

The predominance of findings about the project work is mirrored in the photos selected by participants (see Appendix A.5). Most photos showed methods applied during the project work, such as interviewing, affinity diagrams, wireframes, or collaborative situations, mainly because of their prominence. Several students included images that pointed to the assessment dimension of projects, for example by showing screenshots or photos of used technologies.

Finally, although the perceived complexity of our courses was evaluated low in the standard course evaluations, only one student described the content as obvious (P6). This student had doubts about doing a full HCI course before taking it, but these doubts were ultimately resolved: "I do an entire course on thinking about your users when designing stuff? I know it's important but [...] I kind of know the overall idea. Do we really need an entire course about it? Yes, we do!".

6.2 RQ 2: How did CS students experience the HCI courses?

6.2.1 Educational quality

The educational quality of the courses was generally perceived as positive. The courses were "easy to comprehend" (P3) and enjoyable (P3, P5, P7, P8; P4: "the fun environment made learning much, much better"). Reasons included the materials (P5, P8, P10), the clear and coherent structure (P1, P2, P3, P6), the interactivity (P2, P5, P7, P9, P10), and the activities (P3, P5, P9, P10, P4: "I really like the creative part of it where we had to organize the stories and draw"). Overall, students felt that the courses allowed them to build competencies (P4: "I feel like they didn't pressure me to memorize everything and just pass the test but I feel like they pushed me to learn this material and improve myself in this aspect"). It was also well received that several instructors were involved (P2, P6, P8, P10) because "that made it pretty interactive because they could be a bit like hosts of the show, switch back and forth and they were all great presenters" (P5). However, some students expressed issues with some activities, such as

feeling uncomfortable during the ice breakers (P7) or when approaching strangers (P5, P6). Students also commented on time management, such as courses being too long (P6). We collected different opinions about the required workload (P3: "it wasn't a great workload, but it wasn't too easy either"; P2: "I would not be afraid to raise the level and maybe the workload because that is something possible in this course"; P6: "I think the workload was okay").

As described previously, we had two courses with similar project work. Some students pointed at the similarity between the courses (P1, P2, P4, P6, P8) but also found they were logical follow-ups (P2, P4, P5, P8, P2; P3: "the switch from HCI to UCD […] felt natural because of the introductory course of HCI"). Despite the similarities, the distinction between the courses was clear (P1, P3, P5, P8, P9). Only one participant thought there was too much repetition (P3).

Regarding the photos, some referred to personal experiences of participants (P5, P6, P7), often those with strong emotions (e.g., funny moments during the project work). Other memorable moments were unexpected activities (P5, P10) or the room where our course took place (the so-called "user lab", P8).

6.2.2 Assessment

The assessment of student learning was based on working on projects through the human-centered design process. Students appreciated this grading (P8) and the clear criteria (P1) and timelines (P9). Sometimes, students experienced parts of the project phase as frustrating, for example when they needed more information (P4) or when the tutor's feedback was not as positive as expected (P7). Our courses had both pre-determined projects ("Introduction to HCI") and free choice of projects ("UCD"), but we noted mixed opinions about this. Some students preferred free choice for picking a project (P1, P3, P5, P7), others argued that instructors should decide on the projects and group composition (P4).

Our projects encouraged students to work collaboratively in groups. This was perceived as interesting and engaging (P3, P4, P6, P7, P8), and collaboration was considered an important outcome of the course (P8, P10). In some cases, however, students suffered from unequal distribution of work (P3). In this regard, our projects benefited from so-called "logbooks" about the collaboration. They allowed the project tutor (one of the instructors) to mediate (P3: "The tutor paid attention to all our concerns and feedback […] I did not feel […] treated unjustified or something").

6.2.3 Potential enhancements

The students were happy to contribute to improving future courses (P2: "I am happy to see that our opinion counts"). Regarding the introductory HCI course, ideas included teaching statistical methods (P2), practicing agile work with instructors as SCRUM masters (P4), raising the interactivity further (P9), or providing reading materials (P3). Regarding the advanced UCD course, students suggested that it should include work on the final product (P3, P4), or even pitching the final products to an enterprise (P7). Students also mentioned providing more help for prototyping (P1, P3).

Enhancements were also mentioned in the sentence completion questions. To "make the HCI/UCD courses more relevant for future Computer Science students…", students suggested including statistical methods (P2), strengthen the project work by allowing more technical projects (P3), real-life applications (P4), allowing students to self-select projects (P7), and elaborating on the interdisciplinary connections to computer science (P1). P6 suggested making the foundational topics (e.g., psychology basics) more engaging by demonstrating their purpose, and P9

suggested raising the interactivity of these parts even further. Some suggestions concentrated on organizational questions, such as providing HCI earlier in the curriculum (P5) or splitting it into two sessions rather than one long session (P8).

6.3 RQ 3: How do CS students view the role that HCI plays in their field of study?

All students pointed out that the HCI and UCD courses are special compared to other courses in the curriculum, but complementing it nicely (P8, P9, P10). The courses were perceived as more oriented towards the applied side and address a different style of thinking (P5, P3: "it's a good contrast to have this, because you think differently during these courses"). Furthermore, students emphasized the interdisciplinary nature of HCI (P1: "So that was interesting because there was a little bit of overlap with social science, so something […] more than just coding for three years."). This interdisciplinary nature is experienced as rare (P5) and positive because "the UCD and HCI courses definitely add to the breadth of that knowledge that is being taught in this bachelor" (P3).

The high interest in HCI is mirrored by the sentence completions. To complete the phrase "HCI is a topic that I find…", students exclusively used positive adjectives like "important" (P4, P5, P8, P9), "interesting" (P3, P6, P7, P8, P9, P10), "primordial" (P2), "engaging" (P7), "motivating" (P10), and "exciting" (P1).

6.4 RQ 4: What do CS students consider as outcomes of HCI courses?

Our results provide evidence that students generally perceived the introductory HCI classes to provide added value. For example, to answer the sentence completion "The HCI/UCD courses allowed me to…", they emphasize core learnings about UX, user interfaces, and user testing (P1, P8, P10), better time management (P2) and collaboration skills (P8, P10), and generally learning about human-centered design (P3, P4, P6, P8, P9). In the following, we will present the perceived outcomes of teaching HCI from the students' perspective in three areas: applying learnings from the course in projects, higher awareness for HCI-related aspects, and particular skills they acquired.

First, several students applied learnings after taking the courses, for example testing websites with screen readers (P9). Several students stated that they integrated HCI in their projects after the courses (P2, P3, P5, P6, P8, P9). For example, students emphasized being human-centered to "have higher chances of reaching the right market" (P4) or because "you're missing the point because you need to start from a user and what's the problem" (P1).

Second, several students emphasized having higher awareness for user needs (P6, P7, P8, P9, P10; P5: "You need to communicate, you need to talk to people. You need to find out what they need and what they want and how you can help them"). HCI is evaluated as something that "makes a lot of the design choices more intentional" (P4, P8) and allows to test user reactions (P1, P7: "No matter what you think of the interface, it's good to test with users.").

Third, students reported on having acquired skills. Some of these skills relate to specific course content, such as how to perform objective user testing (P2, P4). However, students also mentioned generalized skills, for example organization (P3, P10) and communication skills (P2, P9, P1: "how to work with designers […] I can understand their language […] I want to work as a software engineer so that's pretty useful for me").

7 DISCUSSION

Based on the results of our qualitative study, we were able to acquire a detailed view of how students experienced our courses. These results allowed us to gain a better understanding of the results from the standard course evaluations. For example, we learned that the low perceived complexity does not mean that our students found the contents "too easy", but rather that they appreciated our educational approaches to teaching them. In the following,

we want to provide insights and recommendations based on the results, and discuss our methodological choices to investigate the courses.

7.1 Insights and recommendations

To synthesize, our study found generally positive feedback to our courses. Students appreciated the topic of HCI and remembered concepts well that they were able to integrate directly in their project work. The educational activities were perceived as different from other courses, but generally useful, although some concerns would need to be addressed. Based on this feedback and our teaching experience, we suggest five recommendations that might be useful for teachers using similar teaching approaches to ours:

7.1.1 Prioritize project-based learning and assessment

Our courses integrated project work following a HCD process, and student feedback was overwhelmingly positive (P3, P4, P6, P7, P8). The project work allowed students to gain experience in all phases of HCD, a positive finding similar to experiences reported by other educators [10]. The students' reports on each phase of their work provided evidence of student learning along the process of HCD rather than on a single "outcome" alone [16,21]. Researchers have often referred to these activities as studio-based pedagogy and often discussed them as an alternative to the traditional approach of HCI education [21,24], but we think that our introductory HCI classes offer an interesting approach of combining the two. Most students liked the approach of learning fundamentals first, and then applying them to a project. This allowed students to choose which method was most appropriate for reporting their results. This flexible approach matches requirements of UX professionals in the real world, and better prepares them for their future working lives [16].

7.1.2 Collaboration and group tutoring

Both of our introductory HCI classes included the opportunity for collaboration. Our study revealed a positive view of collaboration. However, the students were not used to collaborative work. Collaboration might thus run into problems, and educators should consider potential problems before they arise (P3). We made good experiences with our so-called logbooks. We asked each participant to individually fill a brief logbook outlining what they had done for the course in a week. Then, the project tutors would discuss the logbooks which allowed us to mitigate issues in the collaboration.

7.1.3 Include several instructors and practitioners from UX and HCI and applied activities in your courses

We recommend including several instructors and inviting practitioners from the fields of UX and HCI to discuss their daily work. These sessions were well-received (e.g., P6). HCI education increasingly needs to consider collaborations between academic and industrial sectors as the traditional education paths are increasingly becoming blurry [6,15]. Likewise, being able to apply learnings in interactive activities was well received (e.g., P2, P5). However, we also found that some concerns should be addressed, for example by providing support for students when interviewing participants for their class projects (P5, P6). Raising the interactivity could potentially also help to engage students more strongly in the theoretical courses which were generally perceived as less positive (P6, P9).

7.1.4 Use formative assessment to complement summative assessment

Include formative assessment throughout the course to gain insights into students' learning progress [24]. For example, we had two ungraded design activities concerning a search engine (a wireframe and a visual mockup). After the wireframe, the instructors provided detailed feedback. Students typically responded to this feedback in the following visual mockup, often demonstrating evidence of deeper reflection. These creative activities were well received (P4).

7.1.5 Test and iterate your courses

Based on our insights, we recommend continuously iterating upon previous courses. Educators can use the range of human-centered design methods to enhance courses. For example, UX curves [13] could help understand learner experience over the course of a semester, co-design could help obtain suggestions for future improvements, and interviews can give in-depth insights into learner perceptions. Qualitative methods can help inform a custom-made, course-specific questionnaire that allows a better evaluation of the students' experience than the general university evaluation questionnaire. We are also planning on implementing the suggested enhancements in future iterations of our courses.

7.2 Reflection on course feedback methodology

In this qualitative study, we used open qualitative interviews, photo elicitation, and sentence completion for course evaluation. Here, we want to reflect on our choices and suggest implications for other HCI educators.

First, the interviews allowed us to gather deep qualitative insights to complement our students' answers from the regular course feedback questionnaire. For example, we found that the low perceived complexity did not imply that the students find our courses "too easy", except for one participant who found some of the contents too common sense (P6). In the future, we will develop our own, additional course evaluation survey based on the interviews, with a specific focus on iterative enhancements to the next courses. We foresee such feedback both during the semester and at the end (when grading is complete). Additional qualitative feedback in the form of interviews will help remedy misunderstandings.

Second, we found that photo elicitation was a good way to identify the most memorable parts of the class. Students predominantly mentioned hands-on activities such as their semester projects. More theory-based, fundamental topics were not mentioned as frequently, and appear less memorable. Photos of emotional events (such as memes or frustrated people) were sometimes used to represent experiences of specific memorable moments in the course.

Third, sentence completion mainly resulted in answers that summarized previous discussions, and did mostly not provide new insights going beyond the interviews (with the exception of some further enhancement ideas). Using sentence completion after interviews might be redundant, although it was useful as a summary of key topics. We also think that the method is useful to complement written questionnaires if conducting interviews is impossible.

7.3 Limitations and future work

Three limitations of our work should be discussed. First, our courses mainly followed an empirical paradigm with high emphasis on researching user needs and testing design iterations, in line with the notion of HCD [21]. While this enhanced our students' awareness of UX-related considerations in their work, we did not explore alternatives

such as a "creative design" approach [24]. Although we occasionally included activities and content that might help the students to gain experience in these regards, we did not systematically investigate the potential of these activities.

Second, we recruited students with their student email accounts, around 6 to 18 months after the courses. While the overall number of participating students is good, some students had already left the university. For future studies, we will consider asking students to provide their private email addresses at the end of the courses. This would allow us to get an even broader picture of the impacts of our courses and to reduce the risk of self-selection bias. While student data was nuanced, we cannot rule out that our study included a selection of the most motivated students only, especially because we received only a small proportion of negative feedback. It is also possible that the personal interaction with the facilitator in the interview discouraged critical feedback. These open questions could be addressed in future research.

Third, our current setup of the courses with activities and project work lends itself better to smaller group sizes. As the size of the class grows, we will face the challenge of adapting our approach to HCI education to large groups.

8 CONCLUSION

We report on a qualitative assessment of how our students perceived iterations of an introductory HCI class we taught. We addressed the contents our students found most relevant, their overall impressions, how they saw the role of the HCI course within their Computer Science degree, and the perceived outcomes. We addressed these questions through interviews, photo elicitation and sentence completion. We reflect on this methodology to elicit in-depth constructive student feedback, and discuss how this feedback may be used by other HCI instructors.

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A APPENDICES

A.1 Course syllabus

As an example of a course syllabus, we provide the course syllabus of the 2020-2021 edition of the "Introduction to Human-Computer Education" course. Each course was slightly adapted based on feedback for the previous course and other conditions (e.g., the need to switch to remote teaching in this edition).

The first half of the course was more content-driven and introduced models, theories, and methods related to HCI (e.g., psychology, different design disciplines, …). However, we implemented several in-class activities and homework (Moodle quizzes, Q&As on Moodle). These homework activities were not graded, but students were required to participate. The instructor of the lesson checked the Moodle answers and provided feedback, for example after identifying that several students had misconceptions. The second part of the course was focused on working on the projects, with an introduction to some key methods of different UX design phases.

Table A.1.1: Course syllabus

Content	In-class activities	Homework activities
1) HCI Foundations Presentation of HCI Research Group and course instructors Presentation of course, regulations, grading criteria and projects What is HCI? (HCD, Norman doors, Three Mile Island accident) History of HCI Disciplines & subfields of HCI Key terms (e.g., usability, user experience, interaction design)	Ice-breaker activity: students introduced themselves ("If you were a technology, which one?") What is HCI? – sketching a toothbrush for children, discussion of sketches What is HCI? – Online quiz Test & discussion of a system which purposefully ignores usability (userinyerface.com)	Reading of paper: Hassenzahl, M., & Tractinsky, N. (2006). User experience – a research agenda. Behaviour & Information Technology, 25(2), 91–97 Watching video of the 1968 "Mother of All Demos" Moodle quiz, Q&A
2) Psychology basics 1 What is Psychology? (Brief history, key concepts, the human brain) Cognition Attention Mental models & conceptual models	Quizzes (e.g., "About what do you think when you hear "psychology"?") Memory tests with chunked and non-chunked terms Experiment: Stroop effect	Watch & discuss the movie "Memento" and/or "Zeitgeist Moving Forward" Sketching the design of a search engine & outline how learnings of lessons were applied Moodle quiz, Q&A
3) Psychology basics 2 Designing for experience (elements of UX, Jesse James Garrett) Accessibility & Inclusive Design Sensation & Perception Fundamentals of visual design (e.g., color theory)	Examples in video and audio (e.g., key terms of acoustics, anatomy of the ear) Brief sound design activity Activity: test & enhance website accessibility (color) Quiz on Gestalt principles and optical illusions Discussion: choose a typeface for a museum	Convert search engine sketch from last week into a visual dummy (considering feedback), annotate to clarify design choices Moodle quiz, Q&A Pick preferred project topic
4) Psychology basics 3 Interaction design (e.g., fundamental laws of interaction design, affordances) Psychological needs Emotions & emotional design	Videos on interaction design (e.g., Fitt's Law) and affective computing Activity: sketch a navigation menu for touch screens	Preparation of projects with tutors Moodle quiz, Q&A

Content	In-class activities	Homework activities
Setup of project groups	Discussion & activity: needs-driven experience design Group activity: collect positive & negative emotions	
5) Information Architecture, Dark Patterns, Persuasive Design Information architecture Persuasive design Project work	Discussion of organization principles for books, spices, … Activity: create an information architecture for a website Video: principles of persuasive design, ethics of persuasion Activity: identify dark patterns Discussion: are dark patterns acceptable? Activity: define project scope	Read ACM Code of Ethics Prepare questions for interviews with developers & designers Create a Hook Canvas (Nir Eyal) Introduction into project with tutor Moodle quiz, Q&A
6) UX in the development process Development project management processes (waterfall, agile, SCRUM…) Design processes (double diamond, design sprints, Lean UX…) Where should designers fit in the development process? Collaboration of design and development Guest talk: experience of a UX designer	Discussions about potential problems of different processes Discussion with UX designer	Read the Agile Manifesto Read articles about collaboration of design and development Prepare questions for interviews with designers Planning user research for projects with tutor
7) UX design in a company Business strategy (Blue Ocean strategy…) UX strategy Design impact on businesses (e.g., ROI) Designers' experiences	Live presentations and Q&A with three UX designers	Moodle Quiz, Q&A Continue User Research Planning for project with tutors
8) Design process: planning Repetition of UX design process What problem are you trying to address? (Business Model Canvas, Context Radar) Who are your project stakeholders? (e.g., Power Interest Matrix) Your user research plan Live interview with developer	Group activity: discuss research plans & competitor benchmarking, define goal Group activity: fill context radar for project Group activity: fill stakeholder map for project	Fill logbook Finish context radar & stakeholder map First report (topic: research question & related work for project) Weekly meeting with tutor
9) Design process: exploration Reasons for doing user research Basic rules of user research (e.g., pre-test materials, take notes…), ethics Methods: Interviews, focus groups, questionnaires, observations, cultural probes, remote user research	Classroom discussions of topics Work on second report, Q&A with tutors	Fill logbook Second report (on user research methodology and analysis) Start recruiting for user research Weekly meeting with tutor
10) Design process: ideation Qualitative & quantitative analysis of data (e.g., affinity diagrams, personas, UX mapping methods)	Activity: brainstorm and Q&A for an analysis plan Activity: brainstorming for solution ideas in project	Fill logbook Second report (on user research methodology and analysis) Perform user research Weekly meeting with tutor

Content	In-class activities	Homework activities
Ideation methods (e.g., brainstorming, ideation cards, design studio)		
11) Design process: generation Recap & case study about qualitative user research Prototyping (general considerations, strategy, methods…)	Activity: create affinity diagram of data from user research Activity: create a series of lo-fi sketches of ideas	Fill logbook Create storyboard and lo-fi prototypes for project Third report (user research results, design ideas) Weekly meeting with tutor
12) Design process: evaluation Usability testing (including remote usability testing) Other evaluation methods (e.g., standardizes usability and user experience scales, heuristic evaluation)	Activity: discuss storyboards & continue prototyping Activity: start planning of usability test	Fill logbook Fourth report (generation of ideas, usability test planning) Weekly meeting with tutor
13) Design process: live remote user tests	Perform a series of live remote usability tests	Fourth report (generation of ideas, usability test planning and results) Prepare presentation Weekly meeting with tutor
14) Design process: student presentations	Each student group presents project and recommendations	

A.2 Questions in the Standard Evaluation of our Courses

Perceived Course Complexity (not concerned, very difficult, difficult, normal, easy, very easy)

Perceived Pedagogical Quality (not concerned, very bad, bad, normal, good, very good)

Free Form answers for perceived course complexity, perceived pedagogical quality, and any useful additional comments

A.3 Interview Guide

A.3.1 Welcome & Consent

Thank you for taking the time to answer our questions. To start with, can I record our conversation? You can get back to me anytime and request that I delete your recording and answers. Your recording will only be shared with the team teaching the HCI and UCD course. Nobody else will have access to it. If you agree we might use some of your statements in publications about the course but without giving your name.

A.3.2 Study Objective

We would like to collect your experience and impressions about the 1 or 2 HCI courses in order to improve them and make them more relevant & useful for the students. So feel free to say what you think, there is no right or wrong answer. Also note that I was not personally involved in the teaching program in the year when you took part in the class, so don't hesitate sharing even critical thoughts.

Do you have any questions before we start?

Ok, then let's start.

A.3.3 Semi-Structured Interview Guide

How did you experience the course(s) overall?
What do you remember from the course(s)? What is your main takeaway? Which contents or activities stood out?
What did you like / dislike?
Did you recall any difficulties / issues?
One of your friends is interested in participating in this HCI/UCD course but wants to know a bit more about it. Could you briefly explain what is he/she going to learn? How would you describe the course to someone else?

What was your interest in HCI topics before the course?
What about now?
You took part in both the HCI and the UCD course. Why did you choose to continue?
What about the interplay between both courses?
(or) You took part in the HCI course only. Why did you choose to not continue with the optional UCD course?

The courses were part of the official Computer Science Bachelor program, how would you say they fit or not with everything else you learned during this program?

Over 6 months have already passed since your participation in both courses, in the meantime did you get any occasion to apply what you have learned?
Try to reflect on your work as a student and developer after the class. Did anything change after taking the class or did you do your work similarly as before?
In your view, what are the main factors you consider important for designing a good user experience?

Imagine that next semester you will be one of the teachers of this HCI / UCD courses.
How will you improve the course?

A.3.4 Photo Elicitation

Let's now have a look at the 3 pictures you have shared with me and that describes your experience with the courses. Could you briefly explain why you select those pictures?

A.3.5 Sentence Completion

Last but not least, could you please complete these three sentences?

HCI is a topic that I find…
The HCI/UCD courses allowed me to…
In order to make the HCI/UCD courses more relevant for future students, I would…

That was my last question.
Thanks a lot for all your comments, that will be very helpful for the future computer science students.
Do you have any other questions, comments?

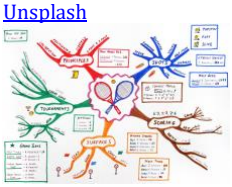
A.4 Category Scheme

Table A.4.1: Categories and Examples Used to Code the Data

RQ	Categories	Subcategories	Examples of codes
RQ 1	Content of courses	methods	learned about paper prototyping
		key terms and disciplines of HCI	remembered interaction design well
		psychology basics	learned about emotional experiences
		applied HCI work	hearing UX designers talking about their jobs was positive
		HCD project work	different stages involved in HCD
		ethical considerations	learned about ethics in courses
		general comments	had doubts about needing full course on HCI, but were resolved
RQ 2	Experiences of courses	*educational quality of courses*	
		• general experiences	course was interesting and motivating
		• educational style & activities	weekly tasks were motivating
		• course instructors	received good feedback from instructors
		• distinction between courses	UCD was logical follow-up from HCI course
		• structure	course was well-structured
		• workload management	unexpected how much work HCD is
		• time management	courses were too early in the morning
		• course setting	user lab was nice
		assessment of student learning	
		• emotional experience in groups	funny moments during group work
		• setup of groups	not worked on preferred group topic
		• grading	expectations for grading were clear
		• collaboration	collaboration went well
		issues	ice breakers felt uncomfortable
		enhancements	instructors should form groups
RQ 3	Role of HCI	*interests in HCI*	
		• before course	had some experience with visual design, but was not thinking much about reasons
		• after course	would be interested in HCI career
		role of HCI courses in CS curriculum	
		• content compared to other courses	course was special inside curriculum
		• difficulty compared to other courses	courses were easier than other courses
		• enhancements of curriculum	HCI courses should be earlier in curriculum
		• interdisciplinary nature of HCI	overlap with social sciences was interesting
RQ 4	Perceived outcomes	applications of HCI-related learnings	applied HCD processes in projects
		skills	able to use organizational skills now
		attitudes	HCI is a success factor

A.5 Photo Elicitation Category Scheme

Table A.5.1: Categories and Examples Used to Code the Photo Elicitation Data

Categories	N	Quotes	Example [a]
Methods Prototype User test Interview Brainstorming…	14	"And that was really, really interesting that we could just do everything on paper if we wanted. And we basically don't even need to develop an application or use a computer at all." (P4)	 Photo: Amélie Mourichon, Unsplash
Assessments (thematics, final project)	8	"It's also mainly what we did the majority I want to say of the semester, although that might not be true, but I think it is the majority because we have this project, and we continuously, apply the different processes on the project." (P3)	 Photo: Wikimedia Commons
Emotion & Feelings	3	"the beginning of the course, with those small projects we had to do or we didn't really know what to do, like where I felt quite a bit lost and frustrated with the course." (P6)	 Photo: JESHOOTS.COM, Unsplash
Course content (UX process, psychological basics)	3	"Because I really was blown away by: Oh, well, a simple thing as the door can be confusing! And now every time I think about that door when I'm doing a design or something. I'm like: oh, yeah, maybe some people don't see the way I do." (P9)	 Photo: Tim Mossholder, Unsplash
Collaboration	2	"That was really the cooperation aspect of these courses, that is to say we were systematically evaluated in groups and it was very focused on cooperation." (P2 - translated from French)	 Photo: Alexas_Fotos, Pixabay
Others	3	"So we learned about one aspect, and then you have the UCD HCI courses, which teach you about the user side of things, which helps you see things from a completely different perspective." (P4)	 Photo: SIVA T, Unsplash

[a] Examples were replaced by royalty-free images to avoid license issues. Care was taken to match the examples as closely to the original images as possible.