Interaction Design and Architecture(s) Journal - IxD&A, N. 13-14, 2012, pp. 7-15

Developing human technology interaction curriculum

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Abstract. During the past ten years expertise in human-computer interaction has shifted from humans interacting with desktop computers to individual human beings or groups of human beings interacting with embedded or mobile technology. Thus, humans are not only interacting with computers but with technology. Obviously, this shift should be reflected in how we educate human-technology interaction (HTI) experts today and in the future. We tackle this educational challenge first by analysing current Master's-level education in collaboration with two universities and second, discussing postgraduate education in the international context. As a result, we identified core studies that should be included in the HTI curriculum. Furthermore, we discuss some practical challenges and new directions for international HTI education.

Keywords: Human-technology interaction, education, curriculum.

1 Introduction

Curriculum as "an interrelated set of plans and experiences which students complete under the guidance of the school" [12] is considered a heart of schooling [11]. Developing a curriculum to educate the future experts is about planning, implementing and evaluating curriculum, see [11]. This development involves decisions such as what are our educational aims [12], what is the evaluation scheme, and how the external forces such as legal requirements and findings and trends in research effect on curriculum [15]. For example, the Council of European Professional Informatics Societies conducted the CEPIS Professional e-Competence Survey and is reporting an up-to-date picture of the actual e-competences of IT professionals across Europe [3] and in Finland; Finnish Information Processing Association is outlining the importance of IT in Finland [6].

In addition to general curriculum development, in technology curriculum development we have the additional challenge of how to define the triumphant

relationship of science, education, and technology education, [20]. Our understanding about this relationship will affect the science and technology curriculum directly. According Vries [20], there are three patterns of science in technology education: a science-and technology pattern, an ivory tower pattern, and a customer oriented pattern. Depending on what pattern we emphasise, the impact on curriculum development varies from education where science is raising a great variety of possible issues into education in which science is adapting to the needs of technology, [20]. In addition to understanding the general curriculum development and the relationship between science and technology education, the characteristics of the multidisciplinary domain, as we see the human-technology interaction domain is, sets specific needs for curriculum development.

In September 2007, the Tampere Unit for Computer Human Interaction (TAUCHI) at the University of Tampere and The Unit of Human-Centred Technology (IHTE) at the Tampere University of Technology initiated a joint effort to increase collaboration in the field of human-technology interaction (HTI) education and research. One of the main aims was to develop higher quality education for university students and to carry out joint internationally recognised HTI research. Both research units have their own master and postgraduate students. The focus of education at IHTE is on the usability and human-centred design of interactive products and services. TAUCHI focuses on human technology interaction development (e.g. user interfaces utilizing many modalities) by harmonising the potential of technology with human abilities, needs, and limitations. One of the main aims in our collaboration in the field of education is to create a HTI programme that meets internationally recognised needs for education. On the other hand, the aim is to provide more extensive and at the same time more systematized HTI studies for both national and international students in the area of HTI. At the same time, we hope to make our education internationally recognised and provide possibilities for our own students to include international fertilisation and studies in their university degrees.

Our starting point for the study presented in this paper was very practical, i.e. how to integrate HTI education in two universities that have slightly different focus in their curricula. To be able to achieve that integration, we must identify what is the core HTI curriculum, that is, a curriculum, or course of study, which is central and should be mandatory for all students. We carried out our study in four phases and the first two phases are reported here. First, we analysed both unit's current curricula and second, developed a new joint HTI curriculum. Finally, we discussed HTI studies within an international context.

This paper is structured as follows. First, we briefly present related work before describing our methods and materials. Following that, we outline our results and present conclusions.

2 Related work

ACM SIGCHI established its' own HCI curriculum in 1992 and 1996, see [9], suggesting two prototypical curricula, one for in computer science and one for management information systems. The third alternative, i.e. creating a separate

interdisciplinary program, was also pointed out. At that time, the focus seemed to be mainly on HCI orientation within existing computing programs.

In 2011, ACM SIGCHI conducted a research project to understand emerging subjects, topics, and challenges in the field of HCI. According to their preliminary report [1] they aim at offering recommendations for both the academic study of HCI and for the applied HCI practitioner learning. Based on the preliminary results, it seems that the importance of design processes, the general methods for ideation and design as well as general methods of usability and evaluation were seen important topics. [1]

Many universities have developed their own HCI curriculum and explored the topics that should be included in HCI curriculum, see Stanford University [16], Carnegie Mellon University [7], Lancaster University [10], or Georgia Institute of Technology [8], but HCI education has been the focus of scientific research and general curriculum development stressing out, for example, the importance of design principles and HCI design [4] as well as learning practices such as experiential learning [14]. Furthermore, characteristics of HCI education and general notions from HCI education are shared [13].

Systematic curriculum development can be done by analysing the development processes of planning, implementing, and evaluating the curriculum with models. Lunenburg [11] identified three models in curriculum development: Tyler's behaviour model [17], Beauchamps's managerial model [2] and Saylor, Alexander, and Lewis's administrative model [15]. Tyler's model seeks answers to the question of what educational purposes a school should seek to attain, what educational experiences can be provided that will likely attain these purposes, how can these educational experiences be organised effectively, and how we can determine whether the purposes are being attained [17]. Beauchamp extends Tyler's model into the managerial model, having processes of determining objectives, selecting and organising learning experiences, and evaluating the programme of curriculum and instruction as Tyler's did but added a set of rules designating how the curriculum is to be used and an evaluation scheme outlining how the curriculum is to be evaluated [2], [17]. The administrative model [15] resembles the most our approach in the curriculum development. In this model, following goal and objective definition, curriculum design is identified and followed by curriculum implementation and curriculum evaluation [11], [15].

3 Methods and Material

To be able to develop the joint HTI curricula, we must understand what the current understanding about the core skills is. We analysed, therefore, the current curricula at Master's-level education (more than 40 basic, intermediate and advanced-level courses) by examining the set of courses, and their contents, offered at both university units. The aim of the analysis was to develop complimentary HTI education to be able to develop extensive curriculum in the field of HTI. The joint analysis was carried out in three phases. First, we analysed the current content of the courses based on course descriptions. However, this was not detailed enough so we asked people responsible for the courses to identify the content and to evaluate with five-point scales to what

extent they taught the content. In the third phase, the researcher classified together with teachers the key concepts and themes of each course. The analysis consists of 27 core HTI courses of total 40 courses. We analysed the data with ThemeViz software developed by Dr Harri Siirtola to visualise the courses and themes [19].

In addition to understanding the core curriculum based on the joint analysis, we want to reflect our understanding about the HTI curriculum in the international context. We organised, therefore, the special interest group SIG at INTERACT 2009 on 28th, August 2009 focusing on post-doctoral studies in the field of HTI [8]. The aim was to collect ideas and opinions to such questions as has HTI contributed to improved IT use in practice, are existing methods and tools for the design of usable systems sufficient, and are they well connected to the kind of HTI education that is required in the future. The main purpose of the SIG was to share and discuss experiences of designing international postgraduate studies and to identify current and future possibilities and challenges that should be addressed by the HCI community. Furthermore, we discussed what would be the concrete opportunities for collaboration. At the SIG there were 27 participants coming from the UK, France, China, Finland, Sweden, Australia, South Africa, the USA and Canada. The SIG lasted one and a half hours, Prof. Kari-Jouko Räihä from the University of Tampere acting as chair. During the SIG one researcher took notes about the discussions.

4 Results and Discussion

4.1 Characteristics of current curricula

The joint analysis consists of 27 courses presenting themes that were identified altogether as 27. The themes consist of 483 subjects. Based on the joint analysis we found that both units have different focus areas in their curriculum. TAUCHI focuses on user interface development that takes into account human behaviour and how that human behaviour affects development of hardware and software, whereas IHTE focuses on usability and user experience. Some overlaps on course content were found in courses on usability, interaction design, and introduction to human-centred technology. The more detailed description of this curricula analysis and the results including the analysis tool are reported elsewhere [19].

4.2 Practical challenges

One of the most common challenges is *organising course schedules* suitable for full-time or part-time students simultaneously. For example, in Finland it is typical that many of the PhD students in the field of HTI are working full-time in industry in addition to completing their PhD studies. In Canada and the UK, many of the students work while studying like in Finland, but mainly as part-time workers during their PhD studies and their work is mainly related to their PhD thesis. In Australia, PhD students

do usually only their PhD and do not work at the same time elsewhere. This practical challenge impacts how to schedule studies, particularly during the doctoral studies. In addition, international co-operation and scheduling actions and studies can be challenging due to the fact that, for example, the schedules for semesters in different European universities differ, i.e., with the starting and ending points of the semesters there were clear differences.

Concerning the *structure of postgraduate studies* and educational systems, some other differences were perceived at SIG. It was noted that, for example, in German or South African educational systems, there are no compulsory courses, whereas in the USA, Greece, Scandinavia and Canada there are some mandatory courses. However, for example in Greece, these courses are meant to be completed in one semester. In the UK there is a more personal learning programme as well as progress reviews whereas in Australia, there are tutorials and seminars, but no compulsory courses.

Furthermore, the typical length of postgraduate studies was discussed. In Finland, the aim is to graduate in four years, but in practice, there is no official limitation on how many years it takes to graduate. It was noted that in Greece, the length of postgraduate studies is five years whereas in Australia it is from two to four years. In South-Africa, postgraduate studies take more or less three to five years. In France, the maximum amount of semester registrations as a PhD. student is three, meaning that the length of postgraduate studies is about three-and-a-half years. To conclude, the length of PhD studies varies at least from two to five years and again, this presents a challenge to curriculum development in the international context.

4.3 Motivation for co-operation

Why and how to co-operate at the international level? First, applying the EU's common COST action funding it could be possible to have, for example, training in research methods, method development and choosing what research methods to use. It was noted that a key motivation for the students is that they could learn multiple research methods. As previous experiences of international co-operation, *organising summer schools* was presented as a good alternative. During summer schools the experts of particular areas have been invited to give lectures or organised workshops.

In addition, international co-operation can be conducted *by organising international Master's degree programmes* as they have done, for example, in Grenoble in France. This type of activity may also be extended to PhD studies. Why would a PhD student want to seek courses abroad if they are not compulsory? Master's-level courses give enough knowledge about scientific methods and scientific writing and PhD students are seeking more person-to-person guidance, more or less like "consulting" and not compulsory studies. So could, for example, co-operation be based on providing possibilities to take part in research projects for a certain period? Furthermore, it would be useful if a student took courses from other universities if cooperation is established between universities and therefore students are able to seek the best available knowledge of the certain HTI research field or method. In seeking international opportunities to study, there are some HCI course databases available, including lecture materials. One of them is maintained by Georgia Tech

(http://hcc.cc.gatech.edu/) and the other in the British HCI Group server at http://www.bcshci.org.uk/education/courses/pg.

4.4 Core studies courses

Our aim was to identify the core studies courses that should be taught for HTI students and by doing this we could set goals and objectives for our HTI curriculum according the administrative model by Saylor et al. [15].

At the Master's level we identified following key skills that are well presented in our joint curricula: usability issues and human centred design, research and development on emotions, sociality, and computing, multimodal interaction, speech-based and pervasive interaction, and information visualisation. What skills could be strengthened in curricula is dependent on which unit is analysed. In general, project management, design and implementation skills were found as possible areas of improvement. Our findings related to education of sufficient skills are in line with earlier findings of Fallows and Steven [5]. They stated that knowledge of an academic subject is not enough; it is necessary for students to gain those skills, which will enhance their prospects of employment. They argue that new graduates need employability skills, abilities to retrieve and handle information; communicate and present; plan and problem-solve; and social development and interaction. [5].

Our joint educational effort started during this autumn 2012 according to the new HTI curriculum, which include core studies courses, or as we called it HTI module with 15 ECTS (see Figure 1). The HTI core module includes following courses:

- Human Information-Processing and Interactive Technology, 5 ECTS
- User-Centered Product Development, 5 ECTS
- Interaction Techniques, 5 ECTS

Furthermore, the students could specialize in either a) interaction design and research, b) development of interactive software or c) user experience design and evaluation.

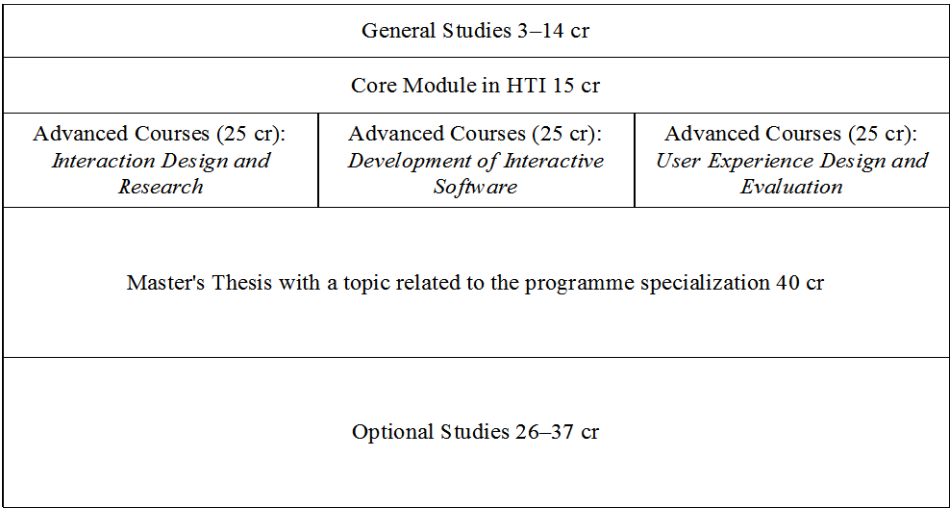

Figure 1. The structure of the joint HTI curriculum

At PhD level, based on the discussions at INTERACT SIG, we identified the following skills that are weak for HCI students at the moment: theoretical and critical thinking, understanding different research methods, scientific communication, understanding ethical issues, project management and programming skills. The list of skills that are identified to be weak among HTI students at the moment include five skills that are general and could be attached to any other field of science. Only one is related directly to technology, i.e., programming skills. Related to theoretical thinking, one of the stumbling blocks that came up is the ability to connect results and conclusions to each other. Moreover, critical thinking on student's own research and research conducted by others is weak. However, when it comes to critical thinking, the student's background and prevailing culture have an effect on what is understood as criticism and criticalness.

In addition, there are weaknesses in understanding different theoretical approaches, and students' ability to perceive how to choose and conduct different research methods in the field of human technology interaction is weak. It was also noted that, from society's perspective, understanding the ethical issues that research and development involves is important. As at Master's-level analysis, the project management skills came up at the level of PhD studies could be included in courses on research methods and scientific writing. It was also suggested that teaching writing skills should be extended to teaching communication skills, i.e., in addition to studying how to write scientific papers and reports, students need to practise how to present papers (skills of spoken communication). It was noted that, in China, the aim is to give PhD students a capability to work in an international environment and organise short courses and seminars. They have had, for example, EU-funded projects to organise student exchange and they are planning to apply funding in the future, too. But are these skills already studied during their Master's degree and therefore should they be required as part of PhD studies? After completing the Master's degree in four

years, a PhD student should choose the particular field on which she/he should concentrate.

In relation to programming skills, it is suggested that some skills can be learnt by doing and maybe without any formal courses. It was also noted that, after all, PhD students themselves are responsible for completing their studies. It was mentioned that the Finnish (or Scandinavian) educational system seems very toilsome for the educators.

4.5 Opportunities for international collaboration

First of all, it seems that more systematic co-operation is possible at Master's level, for example the Erasmus Mundus model, or maybe a common Master's programme funded by the EU. Furthermore, one of the biggest existing challenges at universities is how to make international co-operation appealing for students and how to find students for future HCI education programmes. It was noted at INTERACT SIG that, at least in some parts of Europe, the numbers of students in this field are declining. This also means that universities try to hold back good students for themselves. Concerning international co-operation, therefore, finding the funding is not the biggest challenge. It was also noted that, due to the fact that the field of HCI is very wide, the need to focus on something more domain specific in co-operation may be essential. It was also mentioned that promoting HCI education among other disciplines, for example students of computer science, could be worthwhile.

It is important to make different organisations co-operate but, in addition to that, more informal actions could be taken simultaneously, such as presenting and updating available PhD courses on the existing databases and considering the possibilities of remote education and developing some kind of continuity for the co-operation. We suggest that maybe using asynchronous communication could open some possibilities for co-operation, for example sharing video links or podcastings.

5 Conclusions

This study was an initial exploration of human-technology interaction curriculum development. Because of slightly different types of relationships between science education and technology education at the university units, we believe that there are arguments for different types of HTI education in our joint HTI Master's programme. In addition, we can develop our joint HTI curriculum, strengthening the existing curricula, i.e., education on theoretical and critical thinking, proper understanding of different research methods and scientific communication at IHTE and design and prototype implementation at TAUCHI. Our new HTI curriculum was implemented as the international Master's degree programme in Human-technology-interaction this autumn, 2012.

Future work on human-technology-interaction curriculum development will need to study how to ensure the multidisciplinary view of HTI education, how to develop international co-operation and how to solve practical challenges with scheduling and structures.

6. ACKNOWLEDGMENTS

We would like to thank Dr Harri Siirtola and Professor Poika Isokoski at the University of Tampere for their valuable contributions for the HTI curriculum development. We also thank Professors Kari-Jouko Räihä, Roope Raisamo and Markku Turunen at the University of Tampere and Kaisa Väänänen-Vainio-Mattila and Sari Kujala at the Tampere University of Technology for their feedback.

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