

TEACHING HUMAN-COMPUTER INTERACTION

Qualitative Support for an Alternative Approach

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Abstract: Traditional methods of teaching HCI and usability are not as successful and easy as is generally thought. Methods based on traditional software engineering teaching approaches have not provided the answer. This paper suggests an alternative way to approach the teaching of HCI. The method involves what we call the ‘establishment of an HCI mindset within the student’. To successfully implement the approach would require a resource base of suitable HCI material and examples that can be drawn upon. The second half of the paper addresses the issues involved in setting up and developing such a resource base.

Key words: Human-computer interaction, usability, teaching, resource base, information quality, credibility, trust.

1. INTRODUCTION

Teaching human-computer interaction (HCI) is sometimes regarded as an easy task and it has occasionally even been regarded as something that can simply be tacked onto a general course in software engineering. The focus in this case is usually on teaching a few simple rules, usability guidelines, and some information relating to methods for task analysis, usability engineering, and conceptual modelling. Although HCI is now a more established discipline in itself, this perspective on teaching HCI is unfortunately still quite common, and is linked to several proposed curricula (for example Computing Curricula 2001 (Joint Task Force on Computing Curricula Association for Computing Machinery & IEEE Computer Society, 2001). Furthermore, in many cases HCI textbooks are based on the

information/lecturing sequence of psychology, interface aspects, methods for HCI, and possibly evaluation. Although this approach may work for introductory undergraduate studies, it only provides for a small part of the knowledge that a practitioner in HCI might need. This problem becomes even more pressing at postgraduate level, where the existing books are clearly insufficient to provide effective course material.

To 'practise' HCI basically means to apply the knowledge one has about HCI to design situations, using rules and methods, at best with relevant background knowledge from, for example, computer science, psychology, sociology, and linguistics. On a more problem-oriented level, practising HCI means knowing the solution to a problem once it is apparent, which of course is very useful in itself.

'Understanding' HCI, on the other hand, means that the professional will not only know the solution (or where and how to find it), but even more importantly, s/he will know when a problematic situation will arise in the first place. Usability professionals must not only know how to do things the HCI way, but also why a situation constitutes an HCI problem and how this affects the general design/evaluation process. S/he must therefore know when and why HCI problems may or will occur, and make sure that proper steps are taken to avert them.

In this paper we argue that HCI education needs to embrace the more holistic view of both practising and understanding HCI. From this perspective, HCI education needs educational tools that will enable teachers to equip students with a good theoretical understanding of the problem situation, as well as a good knowledge of the practical application of HCI knowledge in everyday design situations. The paper proposes an alternative way of teaching HCI and usability based on this premise, and proposes the development of an HCI resource base to support this approach.

1.1 History of the Project

The origins of this paper stemmed from a number of HCI education workshops that took place between 1999 and 2001. Although many of the ideas and much of the supporting content reported upon here was put together by the authors, it is important to recognise and acknowledge the ideas of and contributions made by other workshop participants.

The first of these workshops (Cox et al., 1999) at the INTERACT '99 Conference in Edinburgh, discussed topics linked to HCI teaching material and good textbooks (or the lack of them). The majority of the existing HCI textbooks in use were found to be too broad in scope, too unspecific, or not suitable for a complete course in HCI. The need for material that supported the inculcation of an HCI mindset in the student, something that the

traditional textbooks do not do, was also emphasised. It was suggested that an example database with good or useful examples of teaching materials should be constructed.

The aim of the second workshop on the development of educational material for HCI (Kotzé et al., 2000; Oestreicher et al., 2000), at the NordiCHI 2000 Conference in Stockholm, was to investigate alternative possibilities for providing the HCI community with a qualitative resource base of educational material. This material had to be useful, accessible, and affordable. Issues considered included the identification of resources to support educators and learners, and how to make resources accessible to educators around the world.

The third workshop in the sequence (Kotzé et al., 2001), held at the INTERACT '01 Conference in Tokyo, focussed on specific topics and appropriate types of material that would be suitable for contributions to the data resource, and on how to implement the results practically. Possible quality control measures and validation procedures that could be applied to the materials published in the resource base, were also addressed.

After these three workshops the results were consolidated and supplemented by additional material, to form the basis of this paper.

1.2 Layout of the Paper

Following this introduction, a proposed alternative method for the teaching of HCI and usability is introduced. This method requires the development of additional educational resources, which forms the basis of Section 3. Section 3 consists of a discussion of the development of a reusable HCI educational resource base. Issues focused upon include the kind of resources that are required to equip teachers and learners properly; the topics to be covered in such a resource base; what is required to make these resources useful; and how to make the contents of such a resource base credible.

2. AN ALTERNATIVE APPROACH TO THE TEACHING OF HCI AND USABILITY

In this section we propose an alternative to the traditional classroom method for the teaching of HCI. This involves allowing the student to experience HCI in addition to learning the theory related to HCI and its practical applications. The method, dubbed the 'Six Golden Rules to Shake the Student's Mind' by the participants of the 1999 Workshop (Oestreicher, 2000), consists of the following steps:

1. **Read thought-provoking literature:** The first step is to lay the mental foundation for the learning experience. This is done by giving the students literature to read that will broaden their horizons. Examples of such resources are the books by Norman (1992; 1993; 1998) and good books on industrial and/or graphic design (such as Spalter (1999)), i.e. not the traditional set of HCI textbooks.
2. **Observe real users using real tools:** One way of raising students' level of consciousness concerning HCI problems is to make them go out into the real world and observe people using real artefacts (such as vending machines, doors, copiers, parking ticket machines, and video cassette recorders), and to note the problems being experienced. Reflection on these experiences in the steps that follow may kindle in the student a mental mindset of continuous awareness and observation of the usability of common artefacts.
3. **Analyse the findings in the observation:** By analysing and documenting the information gathered during the observation step, the students will be forced to try to understand and rationalise the reasons behind the problem situation. This would form the first step in the process of redesign and also increase the aspect of awareness. The analysis can start from their gained understanding, combined with ideas from the literature in step 1.
4. **Mix the results from the analysis with theory:** The observations then need to be pursued and anchored in a proper theoretical foundation. By adding theory after (or in parallel with) the observation studies, a student should be able to form a better conceptual basis, retain the theory better, and connect the theoretical knowledge to practical experience.
5. **Redesign the artefact:** By redesigning the artefact the student is required not only to criticise a design, but also to make constructive suggestions for improving the design based on aspects relating to improved usability, but also other relevant properties of the artefact, such as ergonomic design. The use of prototypes or storyboard walkthroughs is suggested to overcome the practical problems of redesigning a real-world artefact.
6. **Iterate the observation phase:** When the redesign is completed, the students need to get feedback on their own designs and/or prototypes. This can be done by iterating the observation, analysis, and redesign phases. One important part of the iteration process is that the students are encouraged to assess their own ideas in relation to the initial product. It is a very important part of HCI education to make the students realise that their solutions are not necessarily the best or optimum solutions, but that it may raise new problems in the interface.

These six rules are intended neither as a new curriculum in HCI, nor the sole educational tool in an introductory HCI course. They should rather be seen as a means of raising students' awareness of HCI issues and making

them see and understand the traps in everyday design. If the students' awareness level is raised, they will be more open to the general content of HCI education, rather than only to the specific details that are taught in textbooks. The application of the six rules can be done in a variety of ways, incorporating some or all of them, depending on the purpose and the situation.

The mixing of theory and practice does, however, require a good knowledge source, where the knowledge in the theory is suitable for mixing with the practical experiences. The use of a good HCI textbook, such as for example Dix et al. (1998) and Preece et al. (2001) will have to be augmented by an additional resource in which HCI teachers and usability trainers can find good examples of supporting material (such as real world artefacts, case studies, and examples from software illustrating both good and bad design practices). For this purpose we propose the development of an HCI resource base (not to be confused with an HCI bibliography) that would contain such material. The sections that follow will address issues involved in the development of such a resource base.

3. HCI RESOURCE BASE

The underlying belief in the development of a reusable resource base of HCI educational material, is that the reuse of existing tried-and-tested resources or knowledge to create new educational resources will lead to improvements in both product and process, i.e. better HCI educational resources, and better teaching and learning. These assumptions echo similar goals for shared resource collections in both the business world and the software engineering community (Sumner et al., 2001). It is true that the software engineering community has been vigorously promoting software reuse for years to ensure programmer productivity and software quality, and that the business world has recently started to focus on using shared repositories to support knowledge management and best practices to improve organizational efficiency. Nevertheless, until now very little research has been done to determine the effects of reuse on teaching and learning.

The development of an HCI resource base aimed at providing the HCI community with a qualitative reserve of educational material, which is useful and accessible, sets a number of challenges and raises a number of questions.

In the first place, the development of an HCI resource base is based on the assumption that providing an HCI educational resource will:

- improve the quality of HCI education by promoting the reuse of educational resources that have already proved to be effective;

- improve the productivity of HCI teachers through the reuse and sharing of resources; and
- serve in the establishment of an active HCI community of learning innovation, where best practices and resources are developed and shared (Marchionini, 1995).

It is clear that many questions and issues will arise when considering a resource base of this nature. Not all of them can be addressed in a single paper, and many would call for a major research effort on their own. In order to give some idea of what is involved, we have identified a number of issues we consider as being of primary importance. The remainder of the discussion will primarily focus on four of these: required resources and content, conceptual framework, credibility of the resource base, and the handling of cultural issues.

Before we attempt to identify possible resources that are required for successfully supporting the teaching of HCI, we have to look at why such a resource base is actually needed. One of the main issues that can be raised relates to the shortcomings of existing HCI textbooks, and refers to features that are missing or not very well treated in the current textbooks. Many of these problems are linked to the nature of the print medium, which confirms the call for an additional HCI resource base as valid. The following are some of the shortcomings of these textbooks that have been identified. The textbooks:

- are mostly oriented towards an Anglo-American reader, largely neglecting the situation and practices in the rest of the world;
- have little coverage of multicultural issues (or limited to only a short discussion on multilingual aspects);
- are predominantly centred on direct manipulation or graphical user interfaces;
- lacking a firm interdisciplinary perspective;
- focus on essential topics but miss out on lateral thinking;
- provide ineffective connections between theory and practice;
- have little or no coverage of issues relating to physical ergonomics;
- lack references to further and updated information;
- are mostly a step behind new technological developments; and
- have illustrative material that is limited to text, still graphics, and pictures.

Bearing these shortcomings in mind, the consensus is that the material to be collected, developed, and recorded in an HCI resource base should focus on topics that are not exactly textbook topics, and should not duplicate the material generally found in HCI textbooks. Instead, the material should support the theory provided in the textbooks. Each example should be explained and linked to associated theoretical issues. In cases where the

theory is incomplete or absent from available textbooks, the associated theoretical background should be provided as explanatory text, or as appropriate references to assessable sources.

3.1 Content of the Resource Base

Several types of material were identified that would be both valuable and useful to all parties concerned. Several issues need to be addressed when considering the actual content of the resources base, ranging from the people involved in using the resource base, the teaching and learning context in which the resource items can be used, to specific topics that should be included. We elaborate on these in these in this section.

The first issue addresses the target market of the resource base. Is the resource base aimed at teachers or learners, or both? Will the focus be on users from a single subject, or will it be multidisciplinary? Is the focus on both novices and individuals with prior experience? The target market will largely determine how the resource base should be structured and the type of user interfaces that should be provided.

The teaching and learning context focuses on didactic issues and the perspective from which the database items should be described, for example:

- What will the format of the material be – formal lectures, experiential, through to project-based?
- Will the tuition be face-to-face, distance (including online), or global?
- Will it be focused on individual or group work, or independent of class size?
- What will the focus of the organizational context be – private, public?

The typical content items that should be considered for the resource base need to fit in with the target group, but can be classified under three headings:

1. HCI curriculum issues, including examples of desirable, achievable and essential curricula; structure, content, objectives and principles; various perspectives for each item (for example computing-related, software engineering, ergonomics, human factors, multicultural, tools, and skills).
2. Theories from various disciplines, including the social sciences (such as psychology, linguistics, and sociology); engineering sciences (such as computing, mathematics, and electronics); education (such as learning theories, and cognitive issues); design (such as art, system, and industrial and technical design).
3. A variety of application domains, including real-time, CSCW, mobile applications, text-based, multimedia, multimodal, web-based, e-commerce, e-learning, hardware design, and non-desktop applications.

Typical items for inclusion in the resource base to support the above classifications include both low-tech and high-tech solutions to problems; cartoons and stories focusing on interactive issues; material related to country-specific cultural issues as well as globalisation; annotated 'Interface Hall of Shame' (Iarchitect, 2001) type of examples backed by sound theoretical motivations and ways to correct the problems; annotated standards, guidelines and patterns; lists of research topics; 'textbook chapters' on material not found in textbooks; lecture notes and teaching methods related to a specific theme; assignments, examinations, laboratory exercises; and collaborative links.

3.2 Conceptual Framework for Resource Base Structure

In order to be successful, this kind of resource base requires an accessible and sound infrastructure. The creation of an educational framework, with a set of dimensions that will describe the items in terms of didactic issues, educational objectives, point of view, and use, is important and necessary. It is essential that the HCI topics to be covered should form the guideline for the categorization of items in the database. During the workshop discussions it was also emphasized that users of the resource base should be made aware of the fact that the items in the database and their use are people's suggestions, and that theirs might not be the one and only way of using such items. The possibility of annotating an item with additional uses should therefore be an option.

If needed, an item needs to be accompanied by a description of the 'afterprocessing' or how to proceed after the effect has been achieved. In other words it should indicate solutions to a problematic example or confirmatory material in the case of positive engagements – in other words how to pick up the teaching principles from the example. The 'afterprocessing' might be even more important for the success than the item, or the topic, itself.

Therefore, each item should be considered with regard to:

- the purpose of the item (why you are doing it);
- the content of the item (what is going into it);
- the process of using the item (how to use it); and
- the intended outcomes when using the item (what the result will be).

Based on this, a basic framework, as illustrated in Figure 1, is proposed as a conceptual structure for organizing and recording items in the envisaged resource base. The framework essentially consists of nine components, namely:

1. a set of keywords, selected from a central dictionary of technical terms with definitions and a set of associate synonyms;

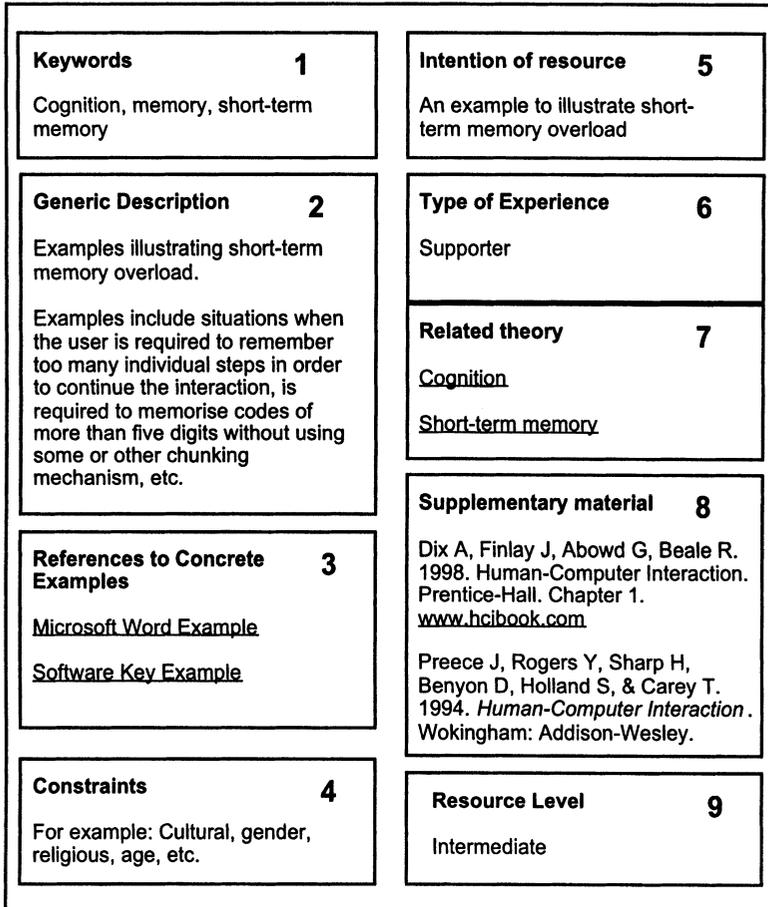


Figure 1. Conceptual framework for resource base structure

2. a generic description of the resource base item;
3. references to concrete examples (within the resource base or external);
4. constraints on the use and applicability of the resource item;
5. the intention behind the resource (why the item is there and suggestions for its use);
6. the type of experience or effect expected from using the item in the teaching or learning process (mind shaker, explainer, supporter);
7. links to relevant or associated theory stored within the resource base;
8. links to external supplementary material supporting the resource item; and
9. the resource item level (basic, elementary, advanced).

3.3 Credibility of the Resource Base

The envisaged resource base will only be successful if it is based on successful collaboration of high quality and is perceived to be credible. The key to this includes (Collings, 2001):

- commitment and mutual trust;
- acknowledgement that the work involved in undertaking collaborative work is valid academic work, in the same way as for research collaborations;
- finding ways of successfully addressing issues of intellectual property;
- avoidance of any sense of ‘commoditisation’ of HCI teaching materials;
- working in pairs or small groups (collaborative development); and
- quality of resource and learning outcomes for students.

3.3.1 Credibility and Trustworthiness

Credibility matters a great deal when computer products act as knowledge resources, instruct or tutor users, or act as decision aids (Fogg et al., 1999), as is the case with the proposed HCI resource base. ‘Credibility’ can be defined as having the properties of being believable and worthy, and has two key components:

1. trustworthiness, defined by terms such ‘well-intentioned’, ‘unbiased’, ‘truthful’, capturing the perceived ‘goodness’ or morality of the resource; and
2. expertise, defined by terms such as ‘knowledgeable’, ‘experienced’, ‘competent’, capturing the perceived knowledge and skill of the resource.

A credible resource base will have high levels of both trustworthiness and expertise (Fogg et al., 2001). Building and using the HCI resource base would require both elements. Collaboration is most effective and rewarding when all the parties trust each other. In the absence of trust, transactions would require negotiated formal rules and regulations, which are legislated and enforced (Fukuyama, 1995). To communicate successfully and efficiently, people must assume common ground in respect of world knowledge and intentions (Greenspan et al., 2000). Establishing common ground when participants are not together may cause problems (Health et al., 1997). Trust is more easily established if face-to-face communication can take place (or has taken place prior to the collaboration) (Rocco, 1998). This might pose a challenge for the establishment of the HCI resource base, and the trust users have in the resource afterwards.

3.3.2 Quality of the resource

Credibility of an electronic or web-based resource can be made to depend on several quality factors. These quality factors can be divided into two broad categories: information-related and site-related.

‘Information-related’ (content) factors refer to aspects such as the ‘correctness’ of information, and how the contained information can be validated. Several categories of information quality can be identified and should be considered in setting up and maintaining the resource base, including (Huang et al., 1999; Katerattanakul et al., 1999; Rieh et al., 1998; Wilson, 1983; Zhu, 2000):

- intrinsic information quality, denoting the fact that information has quality in its own right. The two main dimensions of intrinsic information quality are the accuracy of the information content and the accuracy of the navigation. Inaccuracy in the information leads to concerns about believability or reliability of information. Comprehension is affected by layout, navigation and orientation.
- contextual information quality, highlighting the requirement that information must be considered within the context of the task at hand. The information must be informative, relevant and complete.
- currency, measured by the time stamp of the last modification of the source; and
- source authority, generally considered a key aspect for judging the perceived quality of information and for filtering the information. Studies have shown that people depend more on the authority and credibility of sources in the online environment than on the print-based environment.

The main forms of validation of information content suggested for the HCI resource base are the use of editors, peer-review, reader voting (grading or validation of readers), as well as certification of the developers, users and the resource. The latter also relate to the issue of intellectual property rights. If we have copyrighted material, we have to make sure that both the teachers and the students are registered to have access rights for this purpose.

‘Site-related’ (form) factors include aspects related to the design and user interface, site navigation, searchability, aesthetics, levels of site consistency, the potential to print, copy, and the worldwide accessibility of the site. Two important issues central to site-related information quality are (Huang et al., 1999; Katerattanakul et al., 1999; Rose et al., 1998; Zhang, 2000):

- representational quality, referring to the format of the information. The information must be presented in a concise, clear and consistent way, must be aesthetically appealing, and must keep typographical issues (such as background, colour, text, font, and images), and the amount of information displayed, in mind. The meaning of information is affected

- by layout, navigation and orientation, interpretability, and ease of understanding – all of which are affected by the representation.
- accessibility quality, emphasising the fact that the system must be accessible but secure. It is affected by navigation efficiency (consistency, quantity, functionality and relevance of links), technical accessibility of the system, suitable and alternative search strategies, and privacy or confidentiality of the information.

3.3.3 Handling of Cultural Issues

Cultural factors, such as common knowledge shared within a culture, cultural differences in information processing, the hierarchical structure of society and workplace, and culture-specific rhetorical strategies, are major variables that would determine the usability and acceptability of the resource base. To be successful, subtle cultural nuances and cross-cultural communication issues must be addressed. Addressing issues of culture in the resource base could influence it in two ways, namely by:

1. providing examples which illustrate cultural biases and conventions; and
2. customising the resource base, based on the preferences of the user and cultural markers.

Cultural markers (Barber, 1998) refer to interface elements that are preferred by, and prevalent within, a particular cultural group. Specific cultural markers signify a cultural affiliation and are used to denote a convention in the use of a system feature. Since the envisaged resource base would be an international resource, the use of cultural marking will have to be investigated.

The major categories of cultural markers that have to be considered are:

- language, denoting the local language for the target audience;
- visuals (pictures and graphics), related to the local culture, including different categories of metaphors, icons, flags, geography, shapes, and architecture in order to make examples familiar;
- colour conventions and uses; and
- page layout, directing the scanning of information and mirroring the logical flow of the task.

Language addresses localisation on a surface level, while the last three are more closely related to the cultural level.

3.3.4 Further Research

Many of the issues discussed above would require intensive additional research in order to ensure the success of the resource base. The following

are some specific issues that can be identified as still open and unanswered, and requiring further research:

- Who would manage the resource and who would be responsible for entering the information into the resource base and maintaining the information and resource integrity (person efforts)? Collecting, cataloguing, and indexing is a very time-consuming process.
- How will copyrights and trademarks be handled?
- How would contributions to the resource base be recognised?
- How to build trust across cultures, space and conventions?
- How to manage access to the resource base?

4. CONCLUSION

This paper has presented the basis for an alternative approach to the teaching of HCI and usability. It also proposed a framework for the development of a resource base of material that will be essential for the success of the proposed alternative teaching approach.

The foundations for the first steps in this alternative approach to the teaching of HCI and usability have been laid in the ideas developed as a result of the three workshops. The second step is already halfway fulfilled in that a large number of exercises and examples have already been gathered by various HCI teachers around the world. The challenge lies in bringing these together in a coherent and motivated way.

To collect this source of knowledge would require a major effort, and in order to make this manageable we can foresee the need for the implementation of a simple classification scheme that will have to be standardised – the third step. The final step will therefore consist of the gathering of data in connection with the implementation of the above-mentioned classification system. It is envisaged that over time the system will evolve and expand to include a wider classification of topics and representation.

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