Participatory Design in a Human-Computer Interaction Course: Teaching Ethnography Methods to Computer Scientists

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Abstract

Empirical evidence shows the ability for computer technology to deliver on its promises of enhancing our quality of life relies on how well the application fits our understanding of how things work. Software designers need to apply methods that provide insights into the user's mental model of the application's target task and to invite the user to be an active participant in the design process. This paper reports on our efforts to design an HCI curriculum around ethnographic techniques of data gathering and paper prototyping. Initial results are presented that study the course's effects on student's attitudes regarding approaches to software design and their long term design behavior.

1 Participatory Design

Design is a creative activity of making artifacts that are usable for some specific task. Software design in particular strives for creating products that enrich the interaction between humans and computer applications. While the software programmer/engineer is concerned with developing reliable, robust, and maintainable software, the software designer is concerned with creating products that fit within the user's overall activities, enhance productivity, and produce a satisfying experience [21, 7]. To accomplish this goal the software designer needs to be able to apply knowledge of human goals, capabilities, and limitations with knowledge of computer capabilities and limitations [13].

While it is important for a software product to provide the necessary functionality to perform its intended use, it is also important that this functionality be presented in a manner consistent with the user's understanding. For example, the DOS operating system provided all the necessary functionality for managing files and folders from a command line. But the graphical user interfaces and the desktop metaphor of Apple's Macintosh and Microsoft's Windows have transformed the personal computer operating system into a product that can be used easily by the most non-technical users because their presentation fits users' conceptual understanding of managing files and folders.

An array of anecdotal evidence (e.g., [12, 16]) and significant empirical evidence (e.g., [8]) reveal that the ability of computer technology to deliver on its promises, improving our productivity and enhancing our quality of life, rests squarely on how well the application fits our conceptual understanding of how things work [8]. Left to their own devices, computer programmers take a "systems-centered point of view", concerned about "how the software works and what parts of it do what" [8, p. 217-218]. The predominant users of the number crunching era were willing to put up with a high threshold of indignation (the highest level of behavioral compromise a user is willing to make to accomplish their goals) [17]. The users of the new era are less so. They do not want to know how the inner mechanisms of the machine work; rather they want to know how the machine will work for them. This is exactly how we need to design such systems: the application should fit the user's conception of the process, "the user-task model", while the inner mechanisms, "the engineer model", should be as transparent as possible [3].

In the area of Human-Computer Interaction (HCI) research, a number of approaches have evolved to meet this challenge. These include User-Centered Design [8], Human-Centered Systems [2], Participatory Design [10], and Contextual Design [1]. Though they differ in their techniques, these approaches have a general common vision of seeing "the interplay between human activity and technological systems as inextricably linked and equally important aspects of analysis, design, and evaluation" [2, p. 3]. The different techniques find ways to interject the designer in the user's world and the user in the designer's world in order to develop a shared conceptual model of the task and the context in which it is being done [10]. The main goal of the project reported in this paper is to develop a curriculum using an experiential learning environment for this important aspect of application design.

1.1 Why Bother Teaching Participatory Design?

The difference between a software designer and software engineer has been compared analogously to the difference between a building architect who designs a structure and a contractor who builds it [21]. While there are some exceptions (e.g. Stanford's Center for HCI study, and larger companies such as IBM which have design and usability labs), in most environments, it is still the computer science programmer doing both design and development, like an architect who both designs and constructs the building. So it is very important that we educate computer science students in techniques of software design that embrace the human activity as an integral component of the analysis, design, and evaluation.

Early in the participatory design process, the designer engages in analysis activities that provide an insight into the user's conceptual model or mental model of the tasks for the system that is being targeted for development [9]. Mental models are cognitive artifacts that are created as we interact with our environment that we use as a dynamic representation or simulation of our world [6]. These models "provide predictive and explanatory power for understanding the interaction" [11]. Norman [11] distinguishes between a *conceptual model*, which is a reasonably accurate and consistent representation of the target system, and a *mental model*, which is the user's cognitive representation of the target system. If the designer can devise the conceptual model in ways that reflect a user's mental model, then the application designed from the conceptual model will be more easily understood and fit more naturally into the user's activities [12].

Participatory approaches to design are becoming more prevalent in industry. Consultation with St. Louis based companies that use such design approaches affirmed that this approach to software design is becoming a standard of practice. Members of the software design teams from Tripos Corporation and Edward Jones provided insightful comments during the course redesign, and Grant Consulting helped significantly with the course redesign and design of our usability lab.

2 Overview of the HCI Course

The HCI course presents material on human aspects of interaction design, on technological aspects of interface design, and design methodologies. The laboratory component is intended to study design in practice. Exercises include practicing design and data gathering techniques, critiquing existing software packages, and constructing interface elements.

In the Computer Science curriculum at SIUE, the HCI course is a required course. It is taught in both 15-week fall and spring semesters. Course enrollment is usually between 15 and 30 students. Students tend to take the course in their junior year just prior to the Senior Project Capstone Course. The HCI course provides students with the basis for performing the design work in their capstone projects. Projects are solicited from the University and local community. Because these are actual projects with non-computer professional users it is important that the students understand how to interact, gather data, and design with users who do not have a technological background.

The prerequisite to the HCI course is “Interaction Programming”. This course provides the students with an understanding of event driven programming, graphical user interfaces (GUI), and one language to program GUI’s. This is a second language course for the students.

The HCI course is structured around the steps in the Contextual Design approach [1]. The steps in the process include: user interviewing and observation, data modeling and model consolidation, brainstorming, paper prototyping, and usability testing (high fidelity prototyping). Working in teams of 3 or 4, the students complete a semester long design project. The project is given to them in a high level description with very little hard specifications. Milestones corresponding to the steps in the process are set to provide students feedback during the process and to insure they are making progress.

3 Approaches to Teaching Ethnographic Skills

Contextual design relies on ethnographic techniques from anthropology [10, 19, 15, 4, 5]. Ethnography is a method of research in which the researcher gathers data within a natural setting that involves a dynamic network of interrelated variables. No attempt is made to control variables within the setting, for this could alter or destroy the phenomenon being studied. The purpose of ethnographic research is to attempt to understand what is happening naturally in the setting, and through interpreting the data gathered to see what implications can be formed from the data. Ethnographic research is also known as *qualitative* research.

The instrument used to gather data in the study is the researcher. Data can be gathered through interviews, observations, and document analysis. Questionnaires containing open-ended questions may also be used. Sessions are often videotaped for viewing from different perspectives. In studies involving computer software, traces that capture user selections are often built into the software to provide the researcher with a more detailed set of data of user actions and choices. Validity of this type of research depends heavily on the skill, competence and rigor of the researchers. Data is gathered using more than one of the data collection methods. The researcher crosschecks data and interpretations by pitting data obtained from one source against that obtained from another source in order to confirm information and to explore inconsistencies. Data analysis begins with and overlaps data collection. The final product produced from an ethnographic study should be a “thick description” of the situation, so that the situation appears sufficiently realistic, and so that others in examining the description can determine whether the implications drawn from the study can be applied to other settings. Throughout the contextual design process, members of a design team

engage in activities requiring the same skills used by ethnographic researchers [19].

While contextual design provides a data rich environment for design, it is important that it be skillfully applied. The risk of misinterpreting observations, disrupting normal practice, and overlooking information is high [18]. Validated ethnographic methods have established guidelines for performing the user study, analyzing the data, and reporting the results [15]. Like other notable areas of computer science, ethnographic skills must be experienced and practiced to fully learn their potential as well as their theoretical underpinnings [14].

Design Step & Concepts	**Exercises**
Contextual Inquiry • Gathering factual data • Observation skills • Interviewing skills • Partnership relationship • Writing field notes	Observation • Out-of-class • Observe an individual doing a public activity • Develop field notes Interviewing • In-class and out-of-class • Practice open-ended interviewing skills • In-class critiquing • Develop field notes Role Playing • In-class • Observe a design interview (role play) • Develop field notes (used for modeling exercise)
Work Modeling • Provide a graphical representation of data • Organizes data around 5 specific aspects: Information flow, sequence of task steps, artifacts used in the task, cultural setting, and physical setting. • Develop shared (team) understanding of the user's model	Work Modeling • In-class • Teams of 3-4 students develop flow, sequence, and artifact models • Teams practice the process of "working-on-the-wall" Brainstorming • In-class • Teams brainstorm design ideas that support the implications recognized in the work models. • Ideas presented to the class

Table 1: Design Concepts and Exercises

Two aspects of the redesigned curriculum for the HCI course have focused on students' development of these skills. First, materials and exercises that focus on observation, interview and data interpretation skills are now part of the course. Second, students in the course have the opportunity to use these skills with real potential users of their term long design project.

The HCI course solicits potential software users from the introductory computer science courses in an approach similar to the way upper division psychology courses on empirical methods are taught by soliciting voluntary subjects from lower division courses. The student volunteers are offered extra credit for participation. In the design project, each HCI student is required to interview/observe 2 potential users. So, a design team of 3 will have data gathered from six people. This gives them a good basis for design. After creating a paper prototype, the design team tests the prototype with three of their original interviewees. This provides members of the design team with both a way to refine their design and to validate their ideas.

The projects consist of tasks universal enough that a general population will have some experience with the task to provide useful information. For example, one project focused on creating a time management system geared toward academic studies, and another focused on an application for creating academic schedules.

The course is structured around the milestones of the contextual design process. Prior to the due date of each milestone in the design project a combination of in class and out of class exercises are used to help the students learn the concepts and skills of the next design step. Tables 1 and 2 describe this approach.

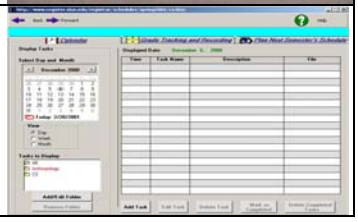
Project Milestone	
Work Models & Consolidation • Graphical representation of data • Visualization of implications of data • Team consensus of data interpretation • Seeing data across multiple users	
Paper Prototype • User/designer partnership • Maximal feedback for minimum effort • Iterative refinement	
High-Fidelity Prototype • User/designer partnership • Formal usability testing	

Table 2: Project Milestones

4 Results

Formative evaluation was used during Fall 2000 and Spring 2001 to identify the strengths of the HCI course redesign and changes to be made for subsequent semesters. The instruments used in the formative evaluation included both likert-scale and open-ended questionnaires, student interviews, evaluation of student-produced videotapes and work models, and observation of classroom exercises. The evaluation resulted in modification to some exercises designed to teach ethnographic techniques.

The project looks at two general questions in terms of the HCI students: How well do the course materials and lab experiences translate to an understanding of design principles and practices? How well does the HCI students' understanding of design principles and practices relate to their actual design practices?

4.1 Student Understanding of Participatory Design

Based on data from surveys, interviews, observations, group work models, and analysis of videotapes of interview sessions, paper prototyping sessions and final projects presentations in the HCI course, students do understand participatory design principles and practices. HCI students regularly discussed ways their volunteers influenced the initial project design, and changes they made in their prototypes based on feedback from the volunteers. In interviews, HCI students with prior computer programming and design work-related experience regularly commented on how their experience with participatory design techniques in the HCI course had changed the way they now "looked at things at work." Several lamented that while they now understood the way design should be done, based on their experiences "unfortunately that is not the way it is done in the real world." Another student remarked, "This course is a refreshing change to the usual CS/Math courses. I believe that it will help me a lot in designing interfaces that are actually what the user needs and understands."

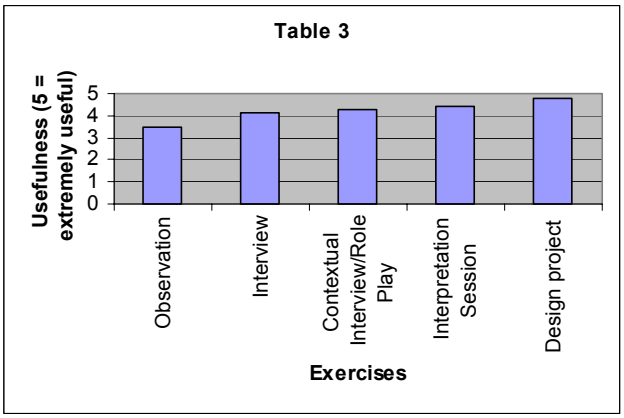
Students were surveyed with respect to the value of the HCI course activities and exercises in helping them understanding ethnographic techniques and components of participatory design (Table 3). The exercises they valued most involved practicing skills, such as interviewing and data interpretation, which they used later in completing the final project. All rated the experience of doing the final project most highly.

4.2 Student's Use of Design Techniques

The second question involving the HCI students looks at how well the students related their understanding of participatory design principles and practices to their actual design practices. In order to address this question, design practices of students in the two-semester senior project course are being studied. Not all students in the senior project course were involved in the redesigned HCI course, though all students reported some exposure to the contextual design process. We are currently in the process of following a second group through the first semester design phase of the senior project course. Results reported here are gathered from questionnaires, examination of project directors' weekly reports and interviews, with students who completed the first semester of the senior project course in Spring 2001.

Four teams with four students each completed the first semester of the senior project course in Spring 2001. Students who had completed the revised HCI course led two teams. Each of these teams also included a second student who had completed the revised HCI course. No members of the other two teams participated in the revised HCI course, though both team leaders reported some familiarity with participatory design techniques.

Several similarities and differences were noted in the teams' approaches. Each team relied heavily on interviews with users to understand the users' needs and how the project activity was currently being done. Teams with leaders from the revised HCI course taped sessions with the users so members could review the interviews at later stages of design. The other two teams did not record sessions with users. Team leaders from the revised HCI course identified the interviewing exercises from the prerequisite HCI course as particularly valuable as they gathered information for their project design. Team leaders from the other two teams both identified interviewing skills as something they believed should be included in the prerequisite HCI course. One team led by a leader from the revised HCI course reported "informally" using the work models. The remaining teams reported that they had not used the models in arriving at their designs. None of the teams used paper prototyping during this phase of the project design, though all indicated that they expected to use it as they completed the projects in the next semester.



5 Conclusions

The revised HCI curriculum with the inclusion of ethnographic techniques and the use of voluntary subjects has increased students' understanding and appreciation of participatory design. In the words of two different students, "this course has made me look at my job in new ways." Students rated the course project involving student volunteers as users as extremely helpful in understanding the process of contextual design. Over the two semesters of this study, each group completed all stages of the conceptual design process to successfully design a product based on user input.

Based on preliminary results of studying long-term attitudes toward design, the approach taken in the revised HCI course seems particularly successful in raising student awareness of the importance of the user as a partner in the design process. We are continuing to study this aspect of the HCI curriculum over the 2001-2002 academic year

terms by following how the second group of students approaches design work on their senior projects.

Two unexpected aspects of the study we are examining are the effect of student-perceived instructor bias and access to an HCI lab. The instructor who ran the senior projects course in the first part of our study has a background in software engineering and has never taught HCI. His approach to project analysis follow traditional software engineering requirements gathering which do not require the type of user interaction we are teaching. A second aspect is access to an HCI lab. As part of this project, a lab was designed to support user interaction and team design activities. Because of the construction time, the first class to complete the redesigned HCI did not have the benefit of this lab, while the second class had the full benefit of the lab. We anticipate that the specialized designed lab itself will effect student's understanding of the process and their commitment toward it.

A recent study by Sugar[20] reports that design students take a novice, surface approach to interpreting user's actions from the results of usability testing. This results in only "band-aid" type changes to design. As Sugar notes, the results of this study indicate the importance of embedding usability testing in a larger creative activity. We believe that by including the ethnographic techniques in the design process students are able to form a more complete user model through which usability test results can be interpreted in a deeper, more meaningful way.

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