Experiences Applying an Enquiry-Based Learning Approach to the Teaching of Human-Computer Interaction

Victor M. Gonzalez, Manchester Business School

Abstract

This report presents the approach followed to improve and reorient a module introducing the fundamental principles of the interaction between humans and computers. This project aimed to achieve a better and more contextualized understanding by students of the theoretical foundations of the discipline called Human-Computer Interaction (HCI). Through a number of activities, projects and presentations, students connected those foundations with their own practice, professionals' practice and other people's practice. The students moved from learning from 'textbook' examples to learning by doing. They investigated, designed, prototyped and evaluated an interactive technology with the support of real users of these products and professionals from industry. Overall, the approach was successful and enhanced the learning experience. However, more work is required to systematize the approach and achieve a better balance between the associated costs of implementation, learning benefits and students' satisfaction.

Background

The Human-Computer Interaction (HCI) module is offered as part of the Information Technology Management and Business (ITMB) programme in the Manchester Business School. The programme is oriented to achieve a balance between business skills and the understanding of the design, adoption and application of information and communication systems and technologies. The HCI module is offered to our first year students as a core foundational module, which is a pre-requisite for other modules in the programme. Students from some of

the programmes offered by the School of Computer Science also enrol in this module as an option.

HCI is a sub-area of Computer Science and Information Systems that focuses on the study of the way people interact with information and communication technologies. These interactions include personal computers, laptops, mobile phones, game consoles and even cash machines. HCI draws its foundation from fields such as Psychology, Ergonomics, Computer Science and even Sociology (Sharp *et al.*, 2007).

Because HCI is a first year undergraduate module, we teach the foundations of the subject. It is later followed by more advanced and application-specific modules. The principles of good interactive systems are defined by technologies that are informative, easy to learn, useful and, most importantly, meet their purpose.

To teach HCI means to teach principles and foundations. These principles and foundations are concerned primarily with design rules that are justified, discussed in context and illustrated with examples. We often noticed that students were able to make sense of these rules and concepts, but sometimes found it difficult to apply this knowledge beyond the examples discussed during the lectures. Before the implementation of this project, the HCI module was a purely lecture-based module, assessed with a project (30%) and an exam (70%).

One main purpose of the project was to bridge the gap between those things discussed in the lectures and the students' everyday practice. The project, funded by the Centre for Excellence in Enquiry-Based Learning (CEEBL), made it possible to develop the HCI module using a different pedagogical approach. The emphasis was placed on helping students to connect theory more effectively with practice, by providing them with a variety of opportunities to experience how the principles are applied by professionals in their everyday practice (*i.e.*, designing and creating new interactive technologies), as well as to link those principles to the students' own context.

Rationale

The Enquiry-Based Learning (EBL) approach we took was based on providing students with the opportunity to have direct contact with real world situations. The idea was to let them see how the concepts and theories we were discussing in the classroom shaped the context, practice and lives of other people. The goal was to have students serve as observers of those contexts,

as well as participants (see Spradley 1997). We wanted students to get involved and engage with people as a way of helping students understand the relevance of these concepts.

There were three main dimensions to this project that were aimed at connecting theory with practice.

Connecting with one's own practice

A fundamental aspect of this approach was to have the students reflect on and analyse how they use technology in their everyday lives, and then use this information to gain a better understanding of why things have developed as they have. This exercise asked students to use theory and then apply that theory to their own relative contexts.

Connection with professional practice

We wanted the students to understand how professionals, who use these theories, models and concepts, applied them to real-world projects; how businesses were defined around these concepts; and what kind of effort was required for those industries to operate. The goal was to provide students with a complete picture, by giving them an accurate account of professional practice, an opportunity to see the connections with other related professional areas, and actual scenarios in the market. By emphasising the practicalities of professional work, we thought that students would be more likely to see the relevance of those things we were studying in the class.

Connecting with people practice

Finally, we wanted the students to learn from those who were using the products that had been created by industries, but applying the theories and concepts which we discussed in the module. We wanted them to interact with real users, understand users' contexts and needs, as well as obtain their feedback. The idea was to move from an idealistic model of clients/users happily working with the products to a scenario where students were able to see people interacting critically with the products.

There are probably more ways to connect theory and practice, and perhaps our selection was influenced by the topics we teach in the module. Nevertheless, we believe that good lessons can be taken from this approach and applied to other modules.

Approach

Defining a context of study: energy management in homes

Energy saving has become a huge topic in the last couple of years. The UK government has made significant investments in developing new schemes to guarantee a reduction in the CO_2 emissions by implementing technologies and training programmes that can help people save energy in their homes (Darby 2006). Given its relevance, we decided to use this example to establish the context for our EBL project.

Two types of energy monitors were provided by companies in the UK. These devices measure electricity consumption in households in kilowatts per hour, as well as rates in Pounds Sterling. The devices can also measure CO_2 emissions and provide a variety of reports on things such as monthly consumption, comparisons against thresholds, etc. Figure 1 shows pictures of the two types of energy monitors used in this project.

Figure 1. Energy monitors. Wattson (left), Eco-eye (right).

These energy monitors were well suited to the purpose of the HCI module: the information presentation was a key aspect of them; their operation was relatively simple; and the design of new interfaces for such systems seemed to be within the scope of a one-semester module.

The energy monitors were used as the central element in both the student projects and a number of EBL activities carried out during the semester.

Connecting students with their own practice – the 'discovery activities'

During the semester there were four Enquiry-Based Learning activities, called 'discovery activities', that were used and aimed at having students explore how the knowledge of HCI applied to their own practice. For instance, the first of these activities asked the students to visit the Arndale Shopping Centre in Manchester. They were asked to go and locate one of the information kiosks and observe for some minutes how people interact with them. Using a

model we discussed in class, the students were able to understand the physical, social and cognitive aspects defining the information kiosk and reflect on the way information is presented in public displays.

Later during the semester, students were asked to analyse their own energy consumption at home. They were asked to measure and determine how much it cost to make a cup of tea by turning on the kettle. The goal of the activity was to define the energy cost in comparison with other things, such as the cost of a pint of beer, a mobile phone or a gym membership. The purpose was to make students realise and consider new ways of presenting information in more meaningful ways for the users by connecting energy costs with other, seemingly more tangible, everyday expenses. These 'discovery activities' provided an Enquiry-Based Learning experience to specific ideas or parts of the module. Depending of the nature of the module, similar activities could be included in other areas.

Connecting students with professional practice – Intel and Namahn speakers

In the last ten years, HCI professionals are emerging as well-defined field experts: some are independent usability consultants; some work as part of software development teams or IT departments; and some are part of government bodies dealing with accessibility issues. To give students the opportunity of interacting with professionals, we invited two speakers from industry to give presentations: one of them coming from Namahn, a user-centred design consultancy based in Brussels; and the other one from the User Experience Group at Intel in the USA. One of the speakers came at week four and the other at week eight. Figure 2 shows some pictures of the talks.

Figure 2. Speakers from Industry discussing projects with students.

The first speaker, Philip Corriveau from Intel, provided a view of the product design cycle, illustrating it with an example from his company (*i.e.*, The Classmate PC). He did a great job mapping each single phase of the design process for a hypothetical scenario of designing a new interface for a home energy meter. The second speaker, Joannes Vandermeulen from Namahn, emphasised the practicalities of selling this type of service to customers; discussed the way that a team of interaction designers can be organised; and provided advice, in terms of what knowledge is more or less relevant to HCI for interaction designers.

These talks were clearly peak points in the module, and students were quite excited and happy with the talks. Because the speakers were fully aware of the goals of the EBL approach and the content of the module, these talks were not the typical industry talks; they were part of the module and connected very well with the rest of the material.

Connecting with people's practice – interacting, interviewing and designing for people

The most central part of the module was for students to learn about principles of interaction design and apply that knowledge to the design of prototypes for interactive systems. The energy monitor served as the model. The project involved, as its main goal, the design of an interface for an energy monitor that would be more informative for users. Based on students' understanding of the current meters and how people use them, students were asked to design new prototypes.

In order to work on their design, the students followed the next stages. First, they had to interact with people using those devices. Four families and a group of four students who shared a house were asked to use an energy monitor for eight weeks. The students interacted with these groups twice. The first meeting was before the meter was installed. The students visited the families/students and conducted an interview about energy usage at home and other related issues, such as finance management. The purpose of the interview was to gather information for an energy meter based on current needs. Figure 3 shows pictures of students interviewing participants.

Figure 3. Students interviewing participants in their homes.

With this information students designed a prototype of an energy meter and went back to interview the people again in order to get feedback (Figure 4).

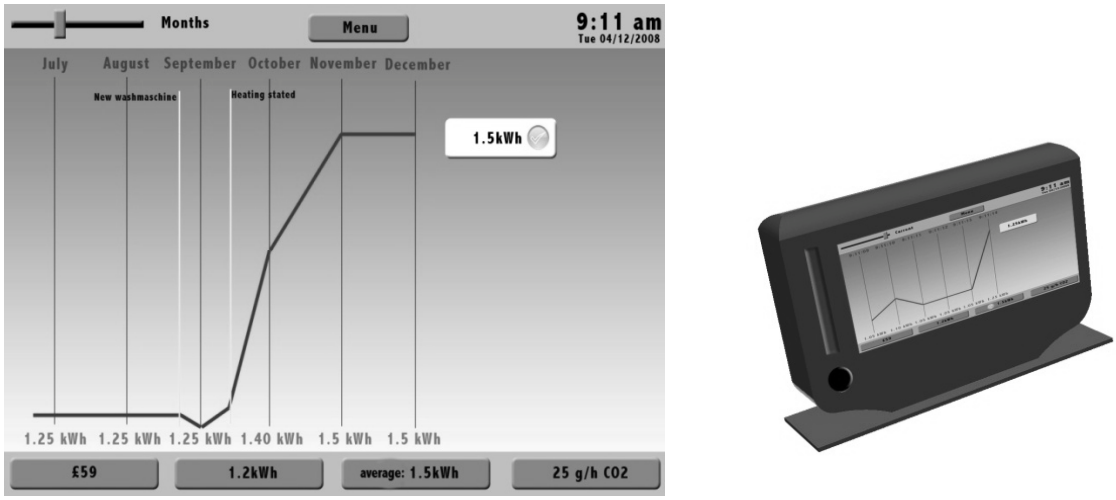

Figure 4. One of the designs produced by students.

By the time the second meeting took place, the families/students had used the energy meters for about five weeks, so they had enough knowledge about its functionality to give proper feedback on the products.

Figure 5 shows pictures of students conducting evaluations of their designs with users following a prototype design approach (see Snyder, 2003).

Figure 5. Students receiving feedback for their designs from real users.

These two moments of interaction with people using real products and facing real challenges made an important difference to the way students understood the issues. The face-to-face meetings with users also impacted on how students reflected on the issues and wrote about them in the final reports. Furthermore, the final reports showed evidence that students really valued this direct approach, as they were able to make more sense of what users needed and apply this understanding to their designs.

Assessment

In order to reflect the changes to the module orientation and nature of projects and activities, the forms of assessment for the HCI module were modified. The module was assessed by exam (65%) and coursework (35%). Furthermore, the coursework was team-based and students received 60% of their marks based on their team's work and the remaining 40% from their individual contribution. Teams worked together on two pieces of coursework that were to be submitted during the semester. Each piece of coursework had to be presented as a team report of about 4,000 words. Teams also worked together during four lab sessions, which were also introduced as part of the modifications for this module. The EBL activities, described previously, were the only pieces of individual work. Completing the EBL activities gave extra credit to students (up to 5% of the total). About 35% of the students completed at least one of the four EBL activities.

Evaluation

The project was evaluated at the middle and end of the semester. An online questionnaire was designed to complement the feedback form distributed by the Undergraduate Office of the Manchester Business School and served to evaluate particular aspects of the EBL approach used in the module. Students were asked to complete the questionnaire voluntarily and anonymously.

The first questionnaire, given out during the middle of the semester, was completed by15 students (28% of the group). The second questionnaire, distributed at the end of the semester, was completed by 16 students (29% of the group). Most students responded positively to the approach taken, as well as to the results. However, the first questionnaire revealed a sense of dissatisfaction with both the teamwork element and the feedback received for the first piece of coursework. This information was quite useful and resulted in some teams being asked to meet with the course coordinator to discuss ways to improve their performance, and the feedback to the second piece of coursework being modified. Table 1 shows and compares some results from the questionnaires.

Question	**Average result First Questionnaire**	**Average result Second Questionnaire**
The teaching I received was excellent.	4.0	3.4
The material I studied was intellectually stimulating.	3.8	3.467
The EBL exercises significantly enhanced my learning.	3.4	3.333
The skills I developed will be valuable.	4.067	3.867
The feedback I received on my work was helpful.	3.993	4.133
The marking scheme for the assignments was clear.	2.533	3.267
The lecturer presented material clearly and at an appropriate pace.	3.933	3.6
The level of supporting course material was appropriate.	3.8	3.6
The lab sessions enhanced my understanding of the subject.	3.2	2.933
I would recommend this course to other students.	3.733	3.8
Working with my team was a good learning experience.	3.267	4.071
I believe that the content I learned in HCI will be useful and relevant for my professional life.	3.733	4.0

Table 1 Results of questionnaires, based on the Likert scale (strongly agree (5), agree (4), neutral (3), disagree (2) and strongly disagree(1)).

The results indicate variations from the first to the second questionnaires in most of the items. Interestingly, the more acute variations are positive and refer to issues that were addressed as a result from the first round of feedback.

In the open questions section, some students expressed concerns with the team work approach. The following comment summarises some of these concerns:

> *The assignments I feel could be improved. If one or two people in your team decide to not pull their weight or put little effort into the assignment your own individual mark will suffer. I feel a better way to do this would be to work as a team but your mark is your own individual mark, i.e. not affected by other members of the group. This is because if the marking is kept as it is at present an individual who has put no effort into an assignment could in fact get a better mark than someone who has worked hard simply because of the team they have been placed in.*

Clearly, the team approach did not work very well for some students; however, this issue is something that other colleagues and I have experienced with other modules and, therefore, is not necessarily an issue that is exclusive to an EBL approach.

Further Development

The implementation of an EBL approach is a worthwhile but certainly time consuming investment. The preparation for this project required starting work on the module much earlier than usual in order to contact companies providing equipment, to arrange the speakers from industry and to assemble all the resources and materials for the activities. Clearly, the lessons learned will facilitate any future implementation of an EBL approach for similar modules. However, this type of time investment will always be required because the relevance of topics (*e.g.*, energy usage and monitors) will change and new, contextualised projects will need to be identified. Moreover, the investment in adopting an EBL approach pays off by improving students' engagement with the topic and providing them with a positive and formative experience.

It is perhaps important to note that students participating in this project were in their first year of their degree programme. Considering the modules and the type of content they will be learning in the next two years, one can expect that the EBL experience has better prepared them to obtain more from those modules. I noticed some initial evidence of this within at least two of the project teams. After the end of the semester, they continued working on their prototypes. I conducted four additional design sessions with them to discuss ways in which their designs for a new energy monitor could be taken to the next level and properly evaluated.

Ideally, one would like to find ways to systematise the approach and achieve a better balance between the associated costs of implementation, learning benefits and students' satisfaction. Clearly, this approach can be done with the same module or with other related ones. As a result of running a number of modules based on an EBL approach, it is hoped that a set of well-

defined 'best practices' for HCI can be developed. A goal for the future is to rethink the ways that team-based work is introduced as part of the EBL approach. From talking to students and analysing the questionnaires, it seems to me that the struggle to coordinate fieldwork along with design activity eclipsed the overall value of the learning experience for many of the students.

This project has demonstrated the importance of creating real-world opportunities for students. However, it does not mean that we have to get away from theories and conceptual discussions or ignore fundamental principles and ideas – all this content has to be taught in a HCI module. In order to create perdurable knowledge and memorable experiences, we need to provide context and everyday scenarios that are close to the students' own experiences. They need opportunities where they can interact and apply what they have learned, so that they are able to come to the realisation that sometimes not everything works as it does in the textbook.

Acknowledgements

This project could not have been achieved without the trust and complete support of the CEEBL team in particular Adele Aubrey, Kim Comer, Peter Whitton, and Norman Powell. My appreciation also goes to the team of assistants for this project: Charlotte Kelsey, Dan Hagos and Pranoy Bhattacharjee, as well to all the students taking the BMAN10641 module (HCI) during the 2008-2009 academic year.

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