Employing Virtual Worlds for HCI education: A problem-based learning approach

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Abstract

In this paper we describe our experience focused on teaching an introductory course in HCI by employing a 3D virtual world. Our main pedagogical philosophy is presented which claims that problem-based learning activities are necessary for HCI education. To this end, appropriate new interactive media such as virtual worlds that can support these activities must be embedded in the educational procedure. The learning activities and the interactive tools that were used are presented. Key findings and educational implications are discussed.

Keywords

HCI education, problem-based learning, HCI design, interface design, virtual worlds

ACM Classification Keywords

K.: Computing Milieux - K.3.1: Computer Uses in Education - K.3.2 Computer and Information Science Education

General Terms

Case Study, HCi Education

Teaching HCI

The rapid increase of users and availability of digital information on the internet has increased the demand to create successful products through improved usability and user experience. Teaching HCI has become a very challenging task for instructors in educational and research institutions. Traditional HCI education primarily focused on teaching the foundations and principles of HCI and facts about interaction models and technologies. During the last decade, due to the growing demand of the technology market, HCI education has focused on extending the traditional curriculum by teaching competence in designing interactive products with hands-on approaches. An alternative teaching method of HCI is the studio approach. [1] and [2] have established a design-focused, studio-based course that integrates and reinforces learning by requiring students to apply the knowledge and skills to real-world design objects. This approach involves teamwork, collaborative learning, interactive problem solving, presentations and peer review. Reports and observations of instructors and moderators have shown that this approach improves students' comprehension, collaboration and problem solving skills. More recently 3D virtual worlds have gained the attention of researchers and practitioners, especially for education and training purposes. Nevertheless the use of such worlds for HCI education is quite limited and relevant case studies are very scarce in the literature [3].

This paper presents authors' experience while teaching an introductory HCI course in the department of Computer Science at the University of Cyprus. A 3D virtual world was developed in order to provide a fertile environment for students who had to develop interactive interfaces following a problem-based learning approach. The structure is as follows: we start by presenting our pedagogical philosophy regarding HCI education; then we describe the virtual world and the tools that were implemented to support students' work. Next, the course and the problem-based learning activities are presented and the paper concludes with the discussion of key findings and educational implications.

Our pedagogical approach

Our pedagogical philosophy in order to teach the complicated and multifaceted issues of an HCI course relies on the basic tenets of constructivism. According to constructivism "*learning environments should support multiple perspectives or interpretations of reality, knowledge construction, context-rich, experience-based activities*" [4]. More specifically we have chosen Problem-Based Learning (PBL) as a key learning and teaching practice that is directly related to constructivism. It has been widely adopted during the last 20 years in both traditional and online educational settings [5]. PBL incubate experiential and social learning and calls for an active rather than passive approach to learning that leads to the development of critical thinking skills. When it comes to teaching and the development of educational modules and courses, the main premise of PBL is that problems can be the stimulus and focus for the student/learner activities [6].

Typical PBL contexts require learners to work in small groups to investigate a real-life problem. Most of the times there is an instructor who acts like a moderator and there is access to a wealth of resources that help learners find a solution to the problem. According to [6] it is about a process of acquiring knowledge and skills through a staged sequence of problems: Clarification of the problem, identification of the needs to address the problem, individual learning/study and application of the newly acquired skills in order to solve the problem, are the main typical stages in a PBL situation.

Employing a Virtual World for teaching HCI design

Virtual Worlds (VW) or MUVEs (Multi User Virtual Environments) provide tremendous possibilities for complex processes such as collaborative learning, problem – based learning, decision making etc. Due to their inherent unique characteristics they have gained a lot of attention by both researchers and practitioners. More specifically, there are numerous distinguished characteristics in VWs that can transform and enhance the quality of learning and educational activities. Recent research studies [7], [8] argue that virtual worlds are fertile environments for implementing PBL processes. For instance they can facilitate learning tasks that would be impractical to undertake in the real world, they facilitate the transfer of knowledge and skills to real situations through contextualisation of learning and they lead to increased intrinsic motivation and engagement [9].

In this study, we employed a VW that was based on open source software. The world server was installed in a standalone PC using the OpenSimulator platform [10]. OpenSimulator (OS) platform was chosen instead of the more popular world of Second Life (SL) mainly because the cost was much lower (for example there are no charges for image uploading) and at the same time this platform provides most of the functionality of SL and graphics quality is quite high.

The course

The course -the focus of this case study- is called Introduction to Human-Computer Interaction (CS435), a new 7.5-credit (ECTS credits) undergraduate course. It was offered during the fall semester of 2010 by the Department of Computer Science at the University of Cyprus and it was intended for 4th year computer science students. The course took place three times weekly, twice for 75-minute theoretical lectures and once for a 120-minute hands-on lab. The total number of students were 40 (57% male, 43% female) with ages varying from 20-24.

Content and learning activities

The course content was primarily concentrated around principles of interaction design, usability and user experience, including key components of HCI such as requirements specification, task analysis, system design, prototype implementation, heuristic evaluation, usability testing etc. A group-based activity complemented the lecture material that focused on critical areas of HCI. Groups of 2-3 students prepared a literature review on a specific area (e.g. cognitive walkthrough) and performed a 20 min presentation, followed by questions from the class and the instructors. In addition, there were a total of 2 assignments for this course. The first was a 2-week individual assignment and the second assignment was a two-month group-based project of 3-4 students. Assignment 1 aimed to introduce the students to basic usability issues. Specifically, they were asked to choose any interactive device, describe its tasks and evaluate its usability.

The problem-based learning activity

Assignment 2 aimed to teach the students all the phases of the User-Centered Design (UCD) process with an emphasis on interface design, utilizing a Virtual World. To undertake the learning tasks and activities, the VW was employed where the users had to use in-world collaboration tools and techniques. Most of the students did not have any previous experience with such a VW. Thus, a series of introductory tutorials on virtual worlds, OpenSim and Second Life were conducted (i.e., how to configure an avatar, how to create objects, etc.).

After the introductory courses, the students were assigned to design and develop interfaces for several interactive systems (e.g., Realtor's Agency, Online Game Shop, University's Management System, Smart Home Management System, etc.) utilizing the VW. The interface design of each system was based on the Logical User-Centered Interactive Design (LUCID) methodology. Some indicative tasks the students had to undertake throughout the design/development cycle were: i) literature review on similar systems, ii) determine the typical users of the system, iii) analyse the interface's design, following the Hierarchical Task Analysis (HTA) methodology, iv) design and develop the system's interface prototypes, v) design users' navigation model.

In order to provide the main infrastructure for a problem –based learning activity and therefore enhance the collaboration affordances of the virtual world, four tools were implemented using the LSL Scripting language (figure 1):

a) "InterfaceElement" which is an object with scripted behavior that can be used as a user interface component in students' working prototypes.
b) "Resource" is an object that links to external web resources.
c) "Comment Recorder" is a tool to record and playback user messages.
d) "Annotation" is an object that contains a written message.

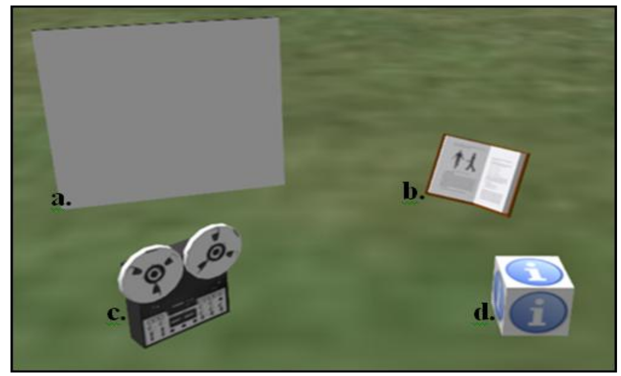

figure 1. The interactive tools for the PBL activities.

During this two-month study, the students participated in a weekly problem-based learning activity through the VW. All students and the instructors created their avatar in the VW and communication during the PBL activity was mainly done through the world. In each session, the students were initially given a problem (e.g. develop interfaces that support the three primary user tasks) (figure 2 presents a snapshot of a team working with an interface). They discussed it using in-world chat tools and wrote notes such as, what information was known, what information was needed and they specified an action plan for working on the problem. Furthermore, the students engaged in independent study on their several learning issues, by accessing digital libraries and educational sites and resource people (i.e., other avatars in the VW). Then, students shared and evaluated the resources they've gathered for the various learning issues and reviewed what they had learned from working on the problem. Throughout the PBL session, the instructors were acting as facilitators and mentors. For instance they kept asking the students to consider issue like "*what is it that you don't know?*" or "*where can you find that information?"* or "*what do you think should be done next?*". The facilitators didn't provide clues to any of these questions, but rather, prompted the students to consider "next steps" and processes along the way. Table 1 integrates a typical PBL process as described in [11] with the interactive tools and activities in the VW.

figure 2. Students working a prototype in-world

Typical PBL activities	**PBL activities and tools in VW**
1) Students are presented with a problem	The basic problem was: "Design interactive interfaces for the system of your choice according to the main user tasks you have identified"
2) Students discuss the problem in small groups. • They clarify the facts of the case. • They define what the problem is. • They brainstorm ideas based on the prior knowledge. • They identify what they need to learn to work on the problem, what they do not know (learning issues). • They reason through the problem and they specify an action plan for working on the problem	• Introductory lectures were given on the PBL processes, the OpenSimulator environment and the LSL scripting language • Chat tool were used for collaboration and the "Annotation" object to make notes and clarify and define the problem and the learning issues
3) Students engage in independent study on their learning issues outside the tutorial. This can include: library, databases, the web, resource people and observations	• The "Resource" object was utilized to access external Web resources. • The "Comment Recorder" and "Annotation" objects were also used to record user messages and make notes while studying the learning issues respectively
4) They come back to the PBL tutorial(s) sharing information, peer teaching and working together on the problem	• Chat tool and the "Annotation" object was used to share the findings of each student • The "InterfaceElement" object was used as a shared interactive canvas thus helping them to work together
5) They present their solution to the problem	• The "InterfaceElement" object was used in order to present their solution
6) They review what they have learned from working on the problem. • Participants engage in self, peer and tutor review of the PBL process and reflect on each person's contribution to that process	• Chat tool was used • Students were "flying" from island to island to see the work of their peers

table 1. PBL activities and tools in VW.

Key findings and educational implications

As instructors and moderators during this PBL process, we made in-world observations and right after the end of this study we conducted structured interviews with the students participated in this study. Despite several technical problems with the server that emerged during the last days of this study, the positive outcomes outperformed the negative ones. Key positive outcomes were:

- Collaborative learning platform: according to the students the VW was an effective and efficient platform for a fruitful collaboration during this problem-based learning situation

- Improvement of communication skills: many students felt that the collaborative tools in hand helped them in a great extent to share ideas for the design process and manage resources throughout this study

- Persistence of the VW: students liked the fact that they could continue the work of their colleagues at any time

- Transparency of the VW: students commended the ability to see the work and the progress that other groups had achieved at different distinct times. Such kind of transparency was unprecedented for the most of the students and they felt more engaged and motivated

- Motivation has increased: Students expressed many positive feelings despite the fact that they faced numerous technical problems. In fact they showed great enthusiasm, especially during the first week of introductory tutorials that were dedicated on virtual worlds, Second Life and Open Simulator. Participation in labs during the two-month project was almost 100% in all sessions. It is interesting that the majority reported that the VW had ingrained in their lives during that semester by further using it for entertainment purposes at their homes.

As already mentioned the problems of this PBL study were related mostly with technical and not educational issues. For example some interactive objects were not working as intended in some cases while the use of voice chat was quite problematic. Some technical problems caused service unavailability during the last week of the study and sometimes led to loss of students' objects and artefacts. As a result this caused students' frustration and irritation. In addition some students kept complaining about usability issues of the environment mainly in terms of efficiency and effectiveness focused on objects' manipulation.

Moreover, students made several suggestions for future development. Many of them stated that they would need more 2D functionalities such as the possibility to embed and share applications from their desktop environment to the VW, to co-edit documents etc. Some students (those who were more technical-savvy) also asserted that the VW would have to be more "authentic" in terms of representational fidelity.

Tutors' observations

Our personal experience as tutors and facilitators verifies the most of the aforementioned key positive outcomes and problems. First, we observed that designing interfaces within the VW is a very time consuming process in comparison to a more "traditional" approach e.g. by using a web editor or other development environments. The vast majority of the students were unfamiliar with this approach in both technical and educational terms. They had to deal with a new environment whose novelty posed some extra difficulty on their efforts. On top of it they had to go through a problem-based learning process, which demands an active participation and a greater intention to explore things and construct knowledge instead of passively absorbing it. To this end, we stress the difficulty for introducing such a teaching and learning approach and we need to admit that there is a lot of room for improvement when employing virtual worlds in HCI education.

Another important issue we observed had to do with students' virtual identities. We noticed that many students spent many man hours for developing the look of their avatars or chatting about the appearance of the avatars and many of them kept changing them from time to time. Some of the students were feeling very comfortable with their avatars while others not. Some students were complaining and felt that their presence was inadequate. This may be explained by the fact that students did not have extensive prior experience with such worlds. On the other hand the fact that all participants knew each other beforehand, made us (the authors) think that they would be more confident and relaxed. Such an issue becomes more crucial in learning situations where the participants do not know each other. Therefore issues of developing a virtual identity, issues of trust and self-efficacy are of paramount importance when implementing a PBL process in a virtual world.

In conclusion regarding this case study, we believe the primary goal of developing a more motivating and challenging approach of teaching HCI was met. In particular, teaching and learning HCI by employing the 3D virtual world increased the general level of intrinsic motivation and interest to learn. Through the assessment of their work and according to their overall performance, we saw that the students achieved greater retention and integration of knowledge by seeking for information and trying out their skills as opposed to listening passively to lectures; they became more flexible in processing information and meeting obligations and they increased their communication skills by using the interactive tools and inhabiting the virtual world for a two-month period. Thus, we believe that students benefited from employing virtual worlds in the teaching process following the problem-based learning approach.

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