Learner-Centred Design and Evaluation of Web-Based E-Learning Environments

Conference or Workshop Item

LEARNER-CENTRED DESIGN AND EVALUATION OF WEB-BASED E-LEARNING ENVIRONMENTS

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ABSTRACT

Designing E-learning is a combination of pedagogical design, usability and information architecture. E-learning environments should have intuitive interfaces and clear information design, allowing learners to focus on learning. However, there is often a mismatch between what an on-line educator thinks the learner would learn, and what a learner thinks he will, and then has learned from the course. In addition, there is sometimes a mismatch between how an educator wants to teach and what is represented on the interface by the instructional designers. Such mismatches affect the learner's experience and his motivation for E-learning.

In this paper, we will first discuss the source and nature of these mismatches. Next, we will discuss whether usability techniques in the HCI literature are appropriate for evaluating E-learning environments for the learner experience. We will then propose a combination of requirements elicitation and usability techniques for learner-centred design and evaluation of Web-based E-learning environments. The proposed methodology is based on our experience of conducting empirical studies for evaluating user-system interactions in E-Commerce contexts.

Keywords

E-learning environments, Web-based E-learning, Usability Evaluations, Learner-centred design, Learning effectiveness

1. INTRODUCTION

E-learning can be delivered through CD-ROMs, video and audio tapes, interactive TV and other electronic means. However, in this paper we will focus on Web-based E-learning environments.

The aims of proposed research outlined in this paper are to: (a) highlight the contributions HCI educators can make towards the improving the design and usability of E-learning environments; (b) outline the participation of HCI educators in the collection and analysis of the data related to mismatches that hinder a learner's experience with Web-based E-learning environments; (c) propose a methodology consisting of a combination of requirements elicitation and usability techniques for learner-centred design and evaluation of Web-based E-learning environments. In the long-term, we anticipate that the application of this methodology will lead to the development of a set of empirically-grounded evaluation instruments to support learner-centred design and evaluation of Web-based E-learning environments.

1.1 Research Context

The management thinker Peter Drucker asserts that the productivity of knowledge workers will be the decisive factor for survival in an economy that is "*highly turbulent and highly competitive, prone to abrupt shifts as both the nature and the content of relevant knowledge continually and unpredictably change. The information needs of businesses and of executives are likely to change rapidly"* [15]. E-learning offers a cost-effective opportunity to build the skills of the knowledge workers required to cope in the knowledge-based economy of this century. However, the role of E-learning and its impact will depend on the quality of the learner's experience.

Statistics indicate that attrition rates are currently high in E-learning, and learners frequently do not complete on-line courses [8]. The results of a study based on 4148 on-line learners performed by the Corporate University Exchange indicate that the drop-out rates are about 70% compared to an average of 15% for classroom training [16]. Reasons offered range from "E-learning is E-boring" to "we got what we wanted and quit". Other factors that have been cited in the literature ([8], [12]) are: poor usability, insufficient engagement between learner and the course content, inadequate support by tutors, and ineffective collaboration with other learners.

It is, therefore, important that the structure and content of an E-learning environment is based on a pedagogical approach with theoretical underpinnings that help to answer

basic questions such as: *why* the environment is being developed; *who* the learners are; and *what* their expectations are.

1.2 Theories of learning

There have been recent efforts to apply theories of learning to E-learning environments [10]. However, E-learning presents a *new* way of learning which may not necessarily map on to known theories of learning and knowledge development. For example, Lev Vygotsky developed a theory of the development of higher mental functions. One of his most profound assertions centred on the notion that knowledge and learning are culturally and socially constructed through dialogue with a teacher or peer. His idea of the *zone of proximal development* (ZPD) states that students have limitations in the amount of progress they can make from their starting point, but with the help of a teacher giving appropriate interventions and scaffolding, their understanding can expand further than it would if left alone [17].

The ideas of Vygotsky and works of Jean Piaget, Jerome Bruner and other theorists in the field of cognitive science have been labelled *constructivism*: encapsulating the idea that learners are active constructors of their knowledge, rather than passive recipients. Another approach, known broadly as *behaviorism* [7], advocates behaviours and skills as the goals of instruction and does not account for any mental processes that occur in learning. In contrast to constructivism, behaviourism embodies a model of the learner as a solitary driver for developing understanding.

Academic learning is considered as a process of constructing knowledge where the individual is an active processor of information. Despite the characterisation of academic learning as a constructivist process, the pragmatic constraints of learning and teaching in higher education (HE) institutions pose clear restrictions on the use of pure constructivism. In [10], the authors argue that E-learning environments in HE should adopt pedagogical models that are not *fundamentalist* in nature but allow for complementarity between behaviourism and constructivism. However [10] and other recent E-learning texts (e.g. [9], [2]), do not focus on the *actual* learning experiences and the interaction of a learner with an E-learning environment.

2. MISMATCHES IN E-LEARNING EXPERIENCES

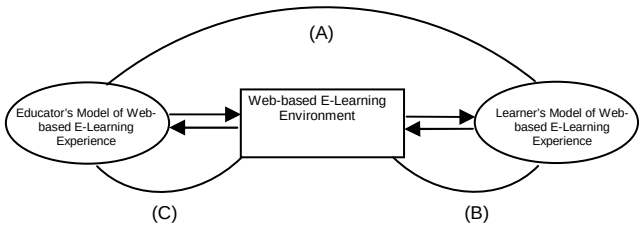
The *educator* has a pedagogical strategy about what he intends a learner to learn from the E-learning environment. However, the learner's background, skills, ability to deal with technology and prior knowledge will influence his learning. The learner's expectations might be different from what he experiences while interacting with an E-learning environment. These expectations may have been set by his requirements of undertaking the course, or by course advertisements, brochures, and course descriptions.

The *instructional designer* might design the E-learning environment in a way which may not be appropriate and as per the information architecture (pedagogical structure) envisaged by the educator. The instructional designer will apply his prior experience and knowledge to the design of E-learning environments. These previous experiences will influence the structure and content of the E-learning environments, which may be inappropriate or inadequate for the learning that was planned by the educator.

These mismatches that occur between what was intended, what is actually being delivered, and what is being perceived by the *learner* may affect the learner's experience and motivation for E-learning. A learner is liable to drop-out or feel de-motivated if his learning experiences don't match with his expectations.

Figure 1 shows the three different sources of mismatches between:

- the learning experiences that an educator intended and what was perceived by the learner, indicated by (A) in the figure;
- the expectations of the learner and his actual learning experiences - (B);
- the conceptual structure intended by the educator and the information architecture of the learning environment as designed by the Instructional designer - (C).



Though there are theories of learning, some of which we mentioned earlier, and guidelines for Web design and usability, there isn't any systematic and ***integrated*** guidance in the literature to support the design and evaluation of Web-based E-learning environments for a positive learner experience.

3. APPLYING USABILITY EVALUATION TECHNIQUES

The usability evaluation techniques in the HCI literature [11] such as heuristic evaluations, user-based observations, standards inspections, and so on can be applied to elicit usability problems with the Web interfaces of the E-learning environments. Cognitive walkthrough can help evaluate the learnability of the user interface: is it easy to 'learn' how to interact with the interface? However, none of these usability evaluation techniques can provide

information to the designers and evaluators about the learning effectiveness of the E-learning environment: whether the E-learning environment helps the learners to achieve the learning tasks that were envisaged by the educator.

A number of expert-based (heuristic inspections) methods for the evaluation of instructional multimedia have been proposed in the past few years, such as Interactive Multimedia Checklist [1], Multimedia Taxonomy [5], and guidelines for instructional design [3].

However, an empirical study [4] which assessed the effectiveness of some of these methods found that although the expert evaluators were successful in predicting usability problems, they had difficulty in identifying certain types of learner problems, such as comprehension and learning support. Their study concluded that design of an instructional multimedia application should take into account learner characteristics, such as their prior knowledge, personal motivations, and expectations, and these learner-characteristics should be incorporated into the design of evaluation material for expert-based methods.

We have found no reports of work describing the application of expert-based methods mentioned above to Web-based E-learning environments. Nor is there any information about how effective they would be at eliciting the mismatches we discussed earlier. However, based on the principles of user-centred design (UCD), it is important to involve both educators and learners to determine the sources and causes of mismatches in an E-learning experience, and so expert-based methods are unlikely to be suitable. In the next section, we propose a methodology consisting of a set of requirements elicitation and usability evaluation techniques to investigate the mismatches. We plan to apply the proposed methodology on Web-based E-learning courses run by the Open University (OU) and will recruit 30 students on three courses.

4. METHODOLOGY

The methodology is structured in three stages.

The ***first stage*** focuses on eliciting learners' expectations of, and experiences with the on-line courses. This will involve eliciting data from the students at the start (what they expect to learn), during (what they are experiencing) and after the course (what they feel they have learned). At the start of the course, semi-structured and laddering interviews [13], either face-to-face or on phone with the students will help elicit their expectations of learning, goals, motivations and beliefs about the Web-based E-learning course that they are about to start. Providing a structured diary to the students and asking them to keep a record of any critical incidents during the course, will help to elicit the problems they are facing. At the end of the course, a number of follow-up semi-structured laddering interviews either face-to-face or on phone will help capture their perceptions: what's it they have learned, their experiences and impressions of the course.

Semi-structured and *opportunistic* exit-interviews with students who drop out from these courses will help elicit the reasons for their leaving the course: their initial expectations, problems they experienced and reasons for their leaving.

In the data collected, *obstacles* to learner's learning experiences can then be identified. We define *obstacles* as those aspects of the E-learning environment, which make it unpleasant, onerous, inefficient, or impossible for the learner to achieve a positive learning experience. These are situations when learners' experiences fall below their expectations. Obstacles could be usability problems with the interface, or technological problems, or inadequate collaborative opportunities. The critical incident analysis can be applied to document and analyse the obstacles.

The ***second stage*** of the methodology focuses on the educators (or authors) of the courses. This involves investigating what these educators think the learners will learn from the course. At the OU, courses are seldom written by a single author and the course-writing model consists of a course team with 3 or more authors who write units (chapters). So for us at the OU, this stage will involve conducting group interviews with the course team.

An inductive analysis [14] of the collected data from educators for each of the courses being investigated will provide insight into the educators' expectations of learning experiences and a collection of obstacles that they expect in learner's learning. In addition, the group interviews with educators will help to elicit the conceptual structures of the courses as envisaged by the educators.

The ***third stage*** of the proposed methodology involves applying a usability evaluation instrument. We have identified an instrument for Web design which is theoretically-grounded in HCI and cognitive psychology and has been empirically-tested during our research and consultancy work of evaluating interactive environments. We will enhance this instrument by incorporating the relevant heuristics from literature that we are already familiar with: visual design [6] and instructional design [3].

An evaluation instrument of the kind that integrates usability heuristics, Web design guidelines, and principles from visual design and instructional design can then be applied to conduct heuristic evaluations of the Web-based E-learning courses. This will help to identify the information architecture of each of the courses (being investigated) as embodied and explicitly conveyed in the learning environment. The heuristic evaluations will also yield usability and information architectural problems with the Web interfaces of these courses.

The anticipated outcomes of the three stages of the methodology are a set of obstacle-catalogues: one catalogue of obstacles related to students' experiences,

obstacles that the educators think might happen, and obstacles elicited during heuristic evaluations. An analysis of these obstacles will help:

- Identify the mismatches (labelled (A) in Figure 1) and the impact of these on the learning experience;
- Identify the mismatches between the learner's expectations and his experiences – ((B) in Figure 1);
- A comparison of the conceptual structure that the educators intended with the information architectural design that is actually embodied in the learning environment ((C) in Figure 1).

Following the analysis of the obstacles, requirements and design solutions should be proposed to resolve the mismatches and obstacles. These requirements and design solutions will range from strategies to get learners' requirements 'right', Web interface design issues, to issues related to pedagogical design and information architecture. The requirements and design issues can then be consolidated into an evaluation instrument of Web-based E-learning quality.

5. ROLE OF HCI EDUCATORS

As HCI educators, we are already sensitised to UCD, and we should be able to appreciate the learned-centred process more than our colleagues in other disciplines. In addition, we are also aware of the user interface design (and to some extent instructional design) principles - so we are in a better position to understand the instructional design and usability aspects of E-learning environments.

Since most universities are using some form of E-learning for HCI teaching: such as a discussion forum, or putting up the resources on a virtual learning environment (e.g. Web CT, Blackboard system), it places HCI educators in a fortunate situation of gathering and analysing data regarding the mismatches and understanding the learners' expectations. This will help provide guidance for better and effective design of e-learning environments.

We invite other HCI educators to apply the techniques that we have discussed in this paper to identify the mismatches. This will not only help them to improve their own E-learning materials but if they share their observations with us, we would be able to compare our findings in a distance-learning organisation with those from the blended learning solutions in traditional universities.

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