Investigating Students' Perceptions of the NTU's edveNTUre: Implications for Design Patterns in E-learning Systems

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Abstract
Designing e-learning systems is challenging and demands a more rigorous engineering approach, testing and re-testing with real users. Hence, this paper is about employing an engineering approach, getting empirical feedback of users' perceptions of e-learning systems and analyzing them for design patterns that are usable and useful in ensuring efficiency, effectiveness and satisfaction of e-learning systems as perceived by users. Using a case study of a local university's e-learning platform, Nanyang Technological University's edveNTUre in Singapore, this paper reports a pilot study linking users' perceptions to design patterns. The paper concludes with a discussion on utilizing design patterns in helping designers and developers of e-learning systems to shorten and make effective the design process. We believe the work carried out in this preliminary work holds promise in a systematic design process for e-learning systems and interactive systems in general.

Introduction

Learning with technology has brought about many new expressions. Many educational institutions are using educational tools in the form of e-learning in course delivery. E-learning or electronic learning is generally referred to as computer-enhanced learning. Urdan and Weggen (2000) define e-learning as the delivery of content via all electronic media, including the Internet, intranets, extranets, satellite broadcast, audio/video tape, interactive TV, and CD-ROM. Werner (2001) defines it as "learning by using a Web browser to access instruction delivered on a network or on the Internet". According to a glossary compiled by Kaplan-Leiserson (2002) of ASTD's (American Society for Training and Development) Learning Circuits, 'e-learning' covers a wide set of applications and processes, such as Web-based learning, computer-based learning, virtual classrooms, and digital collaboration. Rosenberg (2000) considers e-learning on "the use of Internet technologies to deliver a broad array of solutions that enhances knowledge and performance". Avegeriou (2003) sees the importance of meeting the needs of three categories of stakeholders:

- *Learners* as primary users of the e-learning systems created to satisfy their needs;
- *Instructors* as teachers who use the e-learning systems to coach, supervise, assist and assess the students.
- *Administrators* provide support and ensure smooth running of the e-learning systems.

In this paper, we report a pilot user study to investigate learners' perceptions of design patterns that are important for e-learning systems, and discuss implications of mapping design patterns to learner-centred user interfaces. We believe the work carried out in this preliminary work holds promise in shaping an approach to designing learner-centred interface design for e-learning systems, and hence, interactive systems in general.

Our Pilot Study

As a pilot study, the Nanyang Technological University's e-learning platoform, called edveNTUre, was selected because it is regarded a good e-learning system having won several international awards. Previous user studies on edveNTUre have been conducted from teachers' and students' perspectives. From the teachers' perspectives, the utilization of the features in edveNTUre had a negative outlook but overall satisfaction was high for the features that had been used. From the students' perspectives, utilization of the features was mostly in the content area (uploading of course materials, online lectures and online quizzes) compared to communication features (email, virtual chat, group pages and discussion boards) (Eng, 2003).

Objectives and Motivation

Hence, using a case study of edveNTUre, the objectives of this quantitative study were:

- Objective 1: To determine students' satisfaction on usability and effectiveness of edveNTUre in helping them to accomplish tasks;
- Objective 2: To investigate design features in edveNTUre considered by students that are important and useful; and
- Objective 3: To elicit new design patterns that may be useful for edveNTUre.

This pilot study is part of a series of user studies conducted to gather qualitative and quantitative data on learners' perceptions of e-learning systems, with the aim of describing learners' models. The approach taken in this pilot is novel since both qualitative and quantitative evaluation techniques will be conducted on proprietary e-learning systems used in local universities in Singapore. Insights from qualitative evaluations are beneficial in helping us to understand the reasons why problems occur, but, to help designers compare and evaluate the effectiveness of e-learning systems, designers need robust, quantifiable metrics. For qualitative evaluations, we made use of Carroll's powerful but underutilized Claims Analysis (Carroll, 2000) to inspect the interaction issues faced by the students and their expectations of these systems (Theng et. al, submitted). For quantitative evaluations, we conducted user surveys on students' perceptions on the usability and usefulness of the design elements on the interfaces of these systems, analyzing the data using exploratory and confirmatory factor analysis, which are not commonly applied in understanding clusters of useful interaction design elements (Theng et. al, 2008).

Questionnaire Design

A questionnaire instrument was designed to meet the objectives. We made the following assumption that the successes of e-learning systems could be measured by two popular measurements: (i) usage; and (ii) users' satisfaction.

In achieving Objective 1, questions asked were about frequency of usage since studies such as Celderman (1997) concur that the more the user uses a system, the more likely the system will be a success. Other questions involve repeated visits as much of the success of these educational technologies depends on the ability to engage the learners as suggested by a study by Brinkman (2007). Usability has a big impact on the success of e-learning applications, and questions on e-learning systems being usable/useful were asked.

Satisfaction is considered and found to be a crucial component in the effectiveness of e-learning systems (Chute, Thompson and Hancock, 1999; Smith, 1998), a careful analysis of the different aspects of users' satisfaction is essential for evaluating e-learning courses (Chute, Thompson and Hancock, 1999). To address Objective 2, questions that were concerned with the satisfaction of the edveNTUre's features were asked such as satisfaction level of the resources used in terms of availability, accessibility, quality, effort, navigation features, screen design and layout, and provision of support services.

Table 1 shows the respective questions addressing Objectives 1 and 2, and the questions were rated on a Likert scale ranging from "1 (least agreed)" to "5 (most agreed)".

In Objective 3, questions asked were about general comments of edveNTUre in terms of usability and usefulness, and comparison with other e-learning systems. In this study, we selected three popular e-learning systems: (i) ATutor (see http://www.atutor) ; (ii) CyberExtension (see

http://rightreasontech.com/Managed_Learning_Environment/CyberExtension.php) ; and Moodle (http://moodle.com/).

Protocol

The survey instrument was sent out in two modes – in hardcopy and/or via email attachment – over a period of two weeks from 17 July to 7 August 2007. The returned questionnaires were checked and incomplete questionnaires were discarded.

Table 1. Objective 1 and Questions Asked

Objectives	Relevant Questions
Objective 1: To identify the design features existing in edveNTUre that are useful to NTU students	Q1: Frequency – How often do you access edveNTUre during your school semesters? Q2: Reason – For what reasons do you visit edveNTUre? Q3: Usage of resources – Which resources do you use under "Courses"? Q4: Usefulness and Usability, *In terms of:* 4a: I can obtain the resources and services I need when using edveNTUre's Courses. 4b: Using edveNTUre's Courses would enable me to accomplish my task or project more effectively. 4c: I find edveNTUre's Courses easy to use 4d: My interaction with edveNTUre's Courses is clear and understandable 4e: Assuming I currently use edveNTUre's Courses, I intend to continue my use in future. 4f: I intend to increase my use of edveNTUre's Courses in future. Q6: EdveNTUre's effectiveness – Overall, how would you assess the perception of effectiveness of edveNTUre's Courses? *In terms of:* 6a: Overall usefulness. 6b: Overall usability. Q8d: Experience with e-learning systems.
Objective 2: To determine the student's satisfaction and perception of effectiveness of edveNTUre in helping them to complete tasks.	Q5: Satisfaction – What is your satisfaction level of the resources used? *In terms of:* 5a: Availability 5b: Accessibility 5c: Quality 5d: Effort 5e: Navigation features 5f: Screen design and layout 5g: Provision of support services Q7: E-learning – What is your view on e-learning?
Objective 3: To elicit new design patterns that may be useful for edveNTUre.	Q9: Please rank three e-learning systems in terms of usability and usefulness. . Q10: Rank 3 design features in e-learning systems that you will most like to see in edveNTUre and give reason(s) to explain your choices.

Findings and Analyses

Fifty-three respondents completed the questionnaire of which 57% (n=30) were males and 43% (n=23) were females. The respondents were between 21-30 years old (77%, n=41), followed by 31-40 years old (19%, n=10) and lastly 41-50 years old (4%, n=2). Majority of the respondents were graduates (64%, n=34), postgraduate students (21%, n=11), and undergraduates (15%, n=8). These respondents came from 7 out of 15 schools in NTU: (i) School of Communication & Information (40%, n=21); School of Electrical & Electronic Engineering (26%, n=14); Nanyang Business School (15%, n=8), School Civil & Environmental Engineering (7%, n=4); School of Chemical &

Biomolecular Engineering (4%, n=2); School of Mechanical & Aerospace Engineering (4%, n=2); and National Institute of Education (4%, n=2).

Here, we report findings and analyses on students' perceptions on the importance/usefulness of features, and their satisfaction with edveNTUre in helping them to complete the tasks.

Objective 1: Perceptions on Usability of Features

Almost all the respondents (85%, n=45) had used edveNTUre to perform an activity or work. Thirty-nine (76%) respondents used it to assist them in their project work, 12 of respondents (23%) used edveNTUre for personal reasons. Table 2 shows the % of respondents who rated statements on the usability of edveNTUre on a 5-point Likert scale (1-5).

Table 2. Responses on Usability of EdveNTUre

	1 (LEAST AGREED) ← Likert Scale → 5 (MOST AGREED)				
Questions on Usability	**1**	**2**	**3**	**4**	**5**
I can obtain the resources and services I need when using edveNTUre's courses.		13% (n=6)	14% (n=8)	49% (n=26)	24% (n=13)
Using edveNTUre's courses would enable me to accomplish my task or project more effectively.		7% (n=4)	55% (n=29)	38% (n=20)	
I find edveNTUre's courses easy to use.		4% (n=2)	23% (n=12)	56% (n=30)	17% (n=9)
My interaction with edveNTUre's courses is clear and understandable			14% (n=8)	73% (n=39)	13% (n=6)
Assuming I currently use edveNTUre's courses, I intend to continue my use in future.	4% (n=2)	14% (n=8)	13% (n=6)	60% (n=32)	9% (n=5)
I intend to increase my use of edveNTUre's courses in future.	14% (n=8)	19% (n=10)	42% (n=22)	21% (n=11)	4% (n=2)

Objective 2: Perceptions on Usefulness of Features

Table 3 shows the % of respondents who rated statements on satisfaction of edveNTUre on a 5-point Likert scale (1-5).

Table 3. Responses on Satisfaction with EdveNTUre

	1 (LEAST SATISFIED) ← Likert Scale → 5 (MOST SATISFIED)				
Questions on Satisfaction	**1**	**2**	**3**	**4**	**5**
Availability (available for use?)		4% (n=2)	26% (n=14)	47% (n=25)	23% (n=12)
Accessibility (readily available to be used)		4% (n=2)	30% (n=16)	43% (n=23)	23% (n=12)
Quality (is information current, accurate and complete?)		19% (n=10)	34% (n=18)	40% (n=21)	8% (n=4)
Effort (easy and convenient to use?)		4% (n=2)	19% (n=10)	60% (n=32)	17% (n=9)
Navigation features		8% (n=4)	42% (n=22)	43% (n=23)	8% (n=4)
Screen design and layout		19% (n=10)	36% (n=19)	42% (n=22)	4% (n=2)
Provision of support services (e.g. FAQs, helpdesk)	11% (n=6)	34% (n=18)	43% (n=23)	11% (n=6)	

Objective 3: Overall Comments of edveNTUre and Comparison with Some E-Learning Systems

a. Overall Comments of edveNTUre

61% (n=32) of the respondents accessed edveNTUre more than four times a week while 36% (n=19) accessed edveNTUre one to three times a week during the school semesters. They did not generally have problems using edveNTUre as they already had some previous experiences with other e-learning systems. Among the features provided by 'courses' in edveNTUre, features that were used more often than others were: (i) course documents; (ii) course information; (iii) assignments; (iv) tests and quizzes; (v) announcements; (vi) photo gallery; and (vii) discussion board. In addition, two other features were also identified having given three e-learning systems that they would like to see in edveNTUre: (i) calendar; and (ii) online chat.

Table 3 gives students' perceptions on usefulness/usability. Overall, the respondents gave favourable feedback: (i) 62% (n=33) agreed that edveNTUre was useful in providing useful form of information/services; and (ii) 58% (n=31) believed it was beneficial in their learning process. There were, however, those who did not like edveNTUre as a mode of learning: (i) 40% (n=21) preferred face-to-face interaction to using edveNTUre; and (ii) 8% (n=4) disliked using edveNTUre.

Table 3. Overall Comments on EdveNTUre

	1 (LEAST AGREED) ← Likert Scale → 5 (MOST AGREED)				
Overall Comments	**1**	**2**	**3**	**4**	**5**
Overall usefulness (e.g. provides useful information/services)			38 (n=20)	56 (n=30)	5 (n=3)
Overall usability (e.g. easy to use)			42 (n=22)	53 (n=28)	5 (n=3)

Some problems encountered by the respondents seem to concur with findings from other studies (e.g. Costabile, 2005; etc.). Here, we highlight some of these problems and their suggested design solutions:

- *Problem 1*: New users can be confused not knowing how to proceed, especially using a service for the first time or following a new learning path.
  Solution 1: Platform mechanisms considered should support users, especially novices, in their activities. Whichever activities the users perform, they should be efficiently structured and visualized, and the platform tools made easy to use. Whenever an error occurred, the platform should be able to provide the user appropriate support so as to allow him to manage it.

- *Problem 2*: There is a lack of mechanisms highlighting lesson structures and high priority topics, particularly those scheduled for a specific learning session.
  Solution 2: Visual design of tools and e-learning elements are to be properly presented. The activities performed by the users are efficiently structured and visualized, specifically for the course structure that needs to be clearly visualized. In terms of the effectiveness of teaching or authoring, highlighting high priority subjects and the hierarchical structure of course subjects are necessary.

- *Problem 3*: Users are linked to a wrong didactic unit.
  Solution 3: The platform tools allow learning and preparation of lessons effectively with personalization and access facilities supported. Cross-references through state and course maps are highlighted or a consistent visual conceptual map allows easy movements among different learning subjects. Thus, all these features are beneficial to both lecturers and students, allowing lecturers to appropriately structure the didactic materials and also exploit different media so students can choose personalized logical paths to learning contents.

- *Problem 4*: Searching of educational materials to study is met with problems.
  Solution 4: The platform mechanisms are provided for search by indexing, keywords or natural language. The activities a user performed in this scenario are efficiently structured and visualized. Search for documents should be facilitated by clear specification of keywords for each subject

- *Problem 5*: Users face frustration whenever there was a temporary network disconnection and have to start from the beginning with things they are doing.
  Solution 5: System could be used off-line, preserving the tools provided and learning context in which the users are engaged in.

- *Problem 6*: Users are not able to check their progress on how much they have learned.
  Solution 6: The system could carry out an analysis of the activities in which a student would likely to perform, and thus the system has an effectiveness of authoring: providing assessment tests to check on one's progress at any time.

- *Problem 7*: Communication tools prove to be not much use, and they do not provide a selection of features.
  Solution 7: The system, having considered all the needs a student chooses to learn at a distance, has influenced the learning effectiveness by supporting communication. Both synchronous and asynchronous communication tools are provided. Thus collaborative learning, either managed for one or more learners through synchronous and asynchronous interactions, can be implemented.

b. Comparison with Three E-learning Systems

From the ranking given by the 48 respondents, all three e-learning systems (that is, ATutor, CyberExtension and Moodle) were each ranked by 16 respondents for being the best e-learning system. In answering the question on their views of in comparison with useful design features of the three e-learning systems 70% (n=37) respondents gave their feedback in order of preferences as shown in Table 3. For example, 49% (n=18) stated using "calendar" feature as a useful feature, and the reasons given (see Table 3, Row 1).

Table 3. Useful Features Identified in the Three E-Learning Systems

Useful Features	% (no.) respondents	Reasons
Calendar	49% (18)	Serve as reminder for tests, assignment due dates Convenient for marking due dates See new updates as a red marker Keep track of dates Note events
Organized links/Drop-down menu/Content navigation	41%(15)	Ease of use Find required content quickly and easier Making full use of the spaces in a webpage Ease of navigation
Online-chat	27% (10)	Able to chat online with fellow classmates without using "MSN" Present a listing of online users so as to let other users know who they could interact with
Queue of assignments	22% (8)	Keep track of assignments Able to attend to urgent or latest assignments quickly
Grade-book	16% (6)	Keep track of academic grades

From Users' Perceptions to Design Recommendations: Move Towards Design Patterns

Not surprisingly, e-learning has its own skeptics. Some maintain that e-learning, when used in controlled settings, can only supplement traditional education and not a complete replacement for a quality education. Others suggest that online learning reduces social interactivity amongst students. Regardless of the interaction that occurs in a chat room, for example, it is deemed that students in a virtual learning environment will always lack the human socialization and networking aspects possible in a traditional education.

Since an e-learning system is basically a platform with an environment of a number of integrated services and tools used for learning, communicating, teaching and managing learning materials, many problems met by the students had been found to be associated with such integrated services and tools (Theng et al., submitted).

The pilot study highlighted useful and usable as well as important features in edveNTUre, and comparision with other e-learning systems help us elicit useful features for edveNTUre. However, in making suggestions of solution to solve problems, the individual solutions were at best solving specific problems. But, limitations and constraints still exist which prevent the creation of a standardized design of solutions. Although we can continue to carry out more user studies, whether quantitative and qualitative to obtain design solutions, they may give us design solutions that are still specific to the e-learning systems studied. And, user studies are expensive. There is no end to the number of user studies conducted to get an exhaustive list of useful design features. We argue that since the common design features detected in most systems and confirmed by user studies, designers and developers should work towards implementation of design patterns, a set of standardized design features, in e-learning systems for future use and reuse (Tidwell, 1997). According to Chung, Thompson and Hancock (2004), design patterns, compared to guidelines and heuristics, are different in capturing design knowledge. Some varying definitions of design patterns are:

- Alexander, Ishikawa, Silverstein, Jacobson, Fiksdahl-King, and Angel (1997) see "a design pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice".
- Chung, Thompson and Hancock (2004) advocate that "patterns are simply just another tool used for creating high-quality solutions, and are used to complement guidelines and heuristics and not to replace them".
- Avgeriou, Vogiatzis, Tzanabari and Retalis (2004) think that "patterns are not created in a 'big bang' but rather are mined or discovered after several times of carrying out the same solution, usually by different people, in a given problem".
- Dearden, Finlay, Allgar and McManus (2002) suggest that the good thing about "a design pattern is that it captures the important parts of a problem and solution in a specific context and because it is presented in such a way, it is able to be adapted and applied in different settings".

Conclusion and On-Going Work

Designing e-learning systems is challenging and demands a more rigorous engineering approach, testing and re-testing with real users. This pilot study is about exploring an engineering approach, getting empirical feedback of users' perceptions of e-learning systems and proposing design patterns that are usable and useful in ensuring efficiency, effectiveness and satisfaction of e-learning systems as perceived by users. Using a case study of a local university's e-learning platform, this paper reports a pilot study linking users' perceptions to design patterns.

But, "design" of any system is seen as both a science and an art. It is a science in that it realises an emphasis towards a principled, systematic approach to the creation and production of an artefact (or portal, in this case). It is an art in the creative conceptualisation, expression and communication of the design ideas with a touch of aestheticism for the intended community of audience or users. Therefore, designing e-learning systems is challenging and demands a more rigorous engineering approach, testing and re-testing with real users (Dix et al, 1998). It is also challenging in that there has to be some level of "attractiveness" and "aesthetic appeal" as users' expectations are more sophisticated.

However, in designing systems and seeking improvements, it is sometimes tempting to propose the implementation of various new features which, in the end, may or may not enhance the website, as cautioned by Wixton (2003). Whether it be an aesthetic make-over or a re-design of the underlying information structure, there will be a need to find out whether the changes suggested do, in fact, have the desired outcome prior to implementation (Gray and Saltzman, 1998) and this is where the paper falls short. In spite of this, the paper does venture to make a few broad recommendations that could form the basis for further investigation for edveNTUre, and propose further investigation into useful design patterns that cut across e-learning systems.

More user studies need to be done with different user profiles and preferences to link users' perceptions to design patterns, so that a standardized set of design patterns can emerge for e-learning systems.

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