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Interfaces and Templates in Computer-Assisted Learning: Students' Assessments and Preferences

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Abstract

This study analyzes students' preferences in using specific components of multimedia interfaces in computer supported learning. As combinations visual elements such as text, images, video and sound are commonly used in current on-line systems in education. The proper alignment between these elements and students' expectations become critical for cognitive and constructive learning; it also improves students overall satisfaction with on-line learning experiences. The templates related to the most commonly used teaching strategies were designed and evaluated by on-site college students, conducted through a survey that evaluated the design and placement of typical graphic elements on web pages. In this paper we assessed the usability and the quality of tested interface elements as they were perceived by students. The outcomes of our research suggest that expectations of graphic interfaces differ depending on many factors, including field of study, demographics, familiarity with computer technology, perception of pleasant appearances, interactivity, and learning styles.

Keywords: Interface design, interface templates, learning styles, agglomerative clustering

Introduction

The E-learning instruction requires implementation of the best practices in the graphic user interface (GUI) design as it strongly influences the learning effectiveness and student satisfaction (Johnson 2004). The GUI is an important part of a design of any educational software, it directly affects learners (Zaidel, 2010), mainly because of their learning styles and preferences. Simplicity, structure, consistency, and tolerance (Stone, 2005) are the most important principles of interface design. There are varieties of essential elements that are considered for effective GUI design of on-line educational websites (Gunawardena, 2005), these should lead to successful on-line teaching and learning. The interface design process (Whitlock, 2001) includes alignment with objectives, logical sequence of content, attractive method of presentation, proper language, clear signposting, questions and problems to review, feedback on progress, testing capability, ease navigation, and modular structure of presentation.

In structuring content for web design, it is necessary to divide content into manageable modules. Mapping ideas into logical learning paths helps learners to navigate around materials and see the relationships between presented concepts (Dorman, 1999). Building motivational attitude using multimedia elements is considered to be one of the methods increasing students' interest in learning. Studies indicate that multimedia instruction improves visual aspects of communication, provides dynamic learning experiences, increases learning results and adjusts to learning preferences (Wang, 2008; Zaidel 2007). Most researchers agree that computer-supported instruction enriches students' learning achievements, by increasing students' interest in learning (Davis, 2000). In general, if multimedia elements are included in educational website, students tend to have more motivation to study than when multimedia elements are not present (Hede, 2002).

User-centered GUI design involves considering needs of users throughout the design and development process. It focuses on how the users utilize a computer system to interact with learning environment and perform desired task. The main principles of learner-centered design require the active involvement of users, anticipation of interactions between user and system, iterative design, multidisciplinary design approach, inclusion new mobile and wireless technologies, user-centered evaluation and high level assessment (Peslak, 2005; also: ISO, 1997).

In computer-supported learning the student must be presented with friendly, obvious and predictable pathways through the site content. Navigation buttons should be placed in logical positions such as either the top of the screen or at the bottom; the consistency in the position of the elements is essential (Jerram, 1993). Excellent interface design establishes an intuitive and efficient navigation environment (Krause, 1996) for learners. The best practices in the interactive learning environment should include content structuring, navigation modeling, and interface presentation structuring (Liang, 2009). Interactivity refers to the active participation of the learner in the learning process and its essence is learner control over performed actions. Learners can be encouraged to navigate their own paths through the material, or they can use embedded sequences including on-line connectivity to glossaries, concept maps or graphic organizers with various links between information. The implementation of interactivity directly affects learner's control in an on-line educational experience.

Purpose

The goal of this study was aimed to study the students' preferences of multimedia interfaces in computer supported learning among students from variety of educational backgrounds including familiarity of technology, learning style, and demographic. Students would feel more efficient and would employ higher levels of cognition if they could study with the instruments they prefer.

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The dynamic use of interface templates that match students' needs will positively influence students' learning outcomes. The evaluation of student characteristics combined with their preferred GUI is one of quality factors improving computer supported learning.

Method and Model

This research was conducted by a survey which was designed to find out how computer interface impacts students' learning outcomes through accommodating textual, multimedia and visualization elements in an asynchronous e-learning environment. To further analyze multimedia interface preferences and users' perception of cognitive benefits from computer supported learning, the factorial analysis clustering model described below was used to explain dynamics of the e-learning experiences.

Let's compute matrix $R[r_{ij}]$ where r_{ij} is the correlation coefficient between survey data column "i" and column "j"; i,j = 1, 2, … ,n. For this matrix the eigenvalue-eigenvector equation can be written as:

(1) $$(R - \lambda I)\, x = 0, \quad x \neq 0$$

This implies that $(R - \lambda I)$ is singular and hence that

(2) $$\det(R - \lambda I) = 0$$

Eigenvalues are roots of the above polynomial equation. Lets $\lambda_1, \lambda_2, \ldots, \lambda_n$ be eigenvalues of matrix R and let $X_1, X_2, \ldots\ldots, X_n$ be a set of corresponding eigenvectors.

(3) $$X_j = \begin{vmatrix} x_{1j} \\ x_{2j} \\ . \\ . \\ x_{nj} \end{vmatrix} \qquad j = 1, 2, \ldots.., k;\ k \leq n$$

In the above model each eigenvector $[X_j]$ explains variability among correlation coefficients in terms of a smaller number of unobservable conglomerate characteristics called factors. Eigenvalues are in proportion to the amount of variation in the total sample accounted for by each factor. Note that the eigenvalue is not the percent of variance explained but rather a measure of amount of variance in relation to total variance. Factor loadings x_{ij} are correlation coefficients between "n" original variables (survey questions) and computed factors. Coefficients with the highest absolute values are used to assign names to a factor.

Data Selection

The participants of the survey were 114 college students from Management Information Systems class, Multimedia Graphic Design class, and Senior Electronic Portfolio class. The survey was conducted during Spring Semester of year 2009 at small Mid-west university. The diversity of

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students' selection expanded the possibility of answers to the survey instrument because students from variety of academic majors would have different perspectives of the learning style which would lead to vary outcomes.

The survey administered on paper had 15 questions related to interface design/implementation and 10 questions assessing the Kolb's learning style (Kolb, 1983) of each participant. After the data was collected, it was entered into Microsoft Excel, where each row represented responses of an individual student. Each survey question was converted into choices/variables, and placed sequentially in 91 columns.

Data Analysis

In first step the Pearson Correlation Coefficient was used to prepare data for further analysis as described in Chapter 3. Next for using correlation table as an input, all eigenvalues were computed with QR algorithm. For the eight largest eigenvalues the corresponding eigenvectors were computed using an inverse iterative algorithm, these eigenvectors define each cluster. For cluster definition the arbitrary level of 0.18 was selected as minimum threshold value of loadings used to select variables describing cluster properties. The summary of this data is presented in eight tables enclosed below. For negative loadings the corresponding survey option was modified to a variable describing opposite choice(s) to original survey question.

Table 1. Cluster 1: Male students who are unfamiliar with online learning.
This cluster explains 10.7% variability of the data.

Variable	Loadings
Male	0.21
Students not School of Education	-0.21
Preferred only textual content	0.25
Preferred any page except page only with an image	-0.25
Preferred any page except the combination of text and image	-0.24
Preferred any page except page with learning objectives	-0.18
No colorful or especially designed button	-0.22
Preferred white background	0.19

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Table 2. Cluster 2: Students who evaluate on-line presentation interface based on page functionality.
This cluster explains 8.6% variability of the data.

Variable	Loadings
Often use of dictionary common term	0.27
Very important to make and save their own notes	0.21
Students that do not like warm background	-0.19
Students preferring bright background	0.2
The webpage should accommodate student's learning preference	0.26
Student's learning preference are not important in on-line instruction	-0.2
Ability to change theme color in the page layout	0.21
Students with theorist learning style	0.18

Table 3. Cluster 3: Male students from education major with reflector learning styles negative about testing/feedback but without own vision related to interactivity.
This cluster explains 7.4% variability of the data.

Variable	Loadings
Male	0.21
Students from School of Education	0.18
Students desire to take quizzes	-0.21
Students with mostly negative opinions about feedback	-0.24
Students do not like light and bright color style in the website	-0.28
Ability to change theme color is the very important feature	0.19
Students do not have theorist learning style	-0.23
Students with reflector learning style	0.25

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Table4. Cluster4: Students primarily with activist learning style, familiar with educational interfaces, focusing on pleasant view of the interface.
This cluster explains 7.2% variability of the data.

Variable	Loadings
Friendly interface can be assessed for the web page	-0.2
Friendly interface is very important	0.27
Importance of ability to save notes depends on the subject studied	0.19
Table with text on web page is not preferred format of interface	-0.2
It is no benefit from considering learning styles in interface design	-0.22
Pleasant look is important criterion describing quality of webpage design	0.2
Students that are not pragmatists	-0.22
Students with activist learning style	0.23

Table 5. Cluster 5: These students like easy navigation; they focus on the results, but not on the learning process.
This cluster explains 7% variability of the data.

Variable	Loadings
Proper navigational elements in educational websites have some importance	0.22
Proper navigational elements in educational websites are very important	0.23
User-friendliness of interface is very important	0.22
Students recognize needs to have on-line dictionary linked to instruction	-0.22
Students have positive attitude toward receiving feedback	-0.2
Students like to receive feedback after every question	0.13
It is better to receive feedback after every question than at end of test	-0.24
Students do not like interface with white background	-0.25

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Table 6. Cluster 6: Students who prefer formal/traditional design of educational Web sites including enforcement of sequential learning.
This cluster explains 6.7% of variability of the data.

Variable	Loadings
Students that are not from education major	-0.18
It is some importance in the ability to personalize content page by making and saving own notes	0.2
Students like to receive feedback after every question and summary at the end of the test	0.24
Students prefer black and white type of interface on educational website	0.2
Students do not like warm colors on educational website	-0.19
Students do not see advantage of having navigational side strip on the page	-0.21
Students prefer links to images implemented by graphics	-0.26
Audio does not enhance the on-line instruction in their major	-0.25

Table 7. Cluster 7: Students of both genders and different majors focusing on pleasant look of Web page and visual representation of content.
This cluster explains 6.3% of variability of the data.

Variable Descriptions	Loadings
Students not from Management Information Systems major	-0.2
The importance of navigational elements depends of the Web page	0.2
The interface containing text and image is not recommended	-0.51
Students that like to learn from full screen images	0.18
Plain button is not good example of navigational element	-0.19
Images that are half of screen size are not adequate for learning	-0.24
Images that are 3/4 size of the screen can be used for learning	0.19
Hypertext link to image is the most suitable image interface	0.19
Method of content presentation is the most important criterion describing quality of webpage design	0.23

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Table 8. Cluster 8: Male students focused on learning, preferring traditional interface. This cluster explains 6% of variability of the data.

Variable Descriptions	Loadings
Male	0.21
Negative attitude towards difficult/complicated interface design	-0.25
Friendliness of interface is very important	0.24
Students with moderate need for the "common term" dictionary included in the on-line website	0.23
Testing and self assessment should be possible at any time during learning	0.21
Heavily formatted text is not recommended for learning	-0.21
Web site page should be colorful	-0.18
Students prefer balanced combination of light and bright colors on educational website	0.18

The analysis of the survey data provided information to divide students into eight no-exclusive clusters. Analyzed clusters explain 59.9% of variability of survey data.

Results

Students' learning preferences were interpreted in eight clusters. The eigenvalue for each cluster was used to estimate variability of the data explained by selected variables. In general, variations of demographic and academic major have been observed as variables defining clusters' characteristic more often than other variables.

Students in Cluster 1 prefer the simplest black and white interfaces. They do not see any reason to use images and any additional information embedded in the Web page, for example learning objectives.

Students, who have some understanding of the learning processes, are grouped in Cluster 2. Their major is unspecified, but most of students are from school of Education; prevailing learning style is theorist.

Students in Cluster 3 perceive the look and feel of the website as important; most of them represent reflector learning style.

Students in Cluster 4 prefer an interactive style of learning. They place an importance on the interface friendliness.

Students in Cluster 5 are very goal oriented in their learning. They prefer to have lots of feedback both during and after test taking. They asses the web site based on ease of use.

Students in Cluster 6 prefer a simple online interface and they are familiar with e-learning. They are focused on their own learning effectiveness and like to check their progress during the learning session.

Students in Cluster 7 feel that the method of content presentation and delivery is very important, preferring visual interface in their courses.

Students in Cluster 8 prefer a balanced color interface with traditional design but including tools that help to learn effectively.

Summary

Some of the students who took the survey had on-line learning experience, increasing reliability of the data. The survey showed that most students preferred to align learning styles with on-line instruction or students' responses were linked to their learning styles. Moreover, the students' majors, genders, and subject areas had an influence on their response to the design of instructional layouts; the most influential on the method of content presentation was the major of students. It was observed that friendliness of interface was very important to learners, with some students preferring simple and traditional design, reducing their confusion in an asynchronous on-line environment. As indicated, each cluster identifies the needs and wants of individual groups, and they have common viewpoints expressed by variables defining a cluster.

In conclusion, on-line educational interface design should accommodate students' learning styles, website navigation system and subject areas. It is necessary to use specific learning models to fulfill above objectives in an asynchronous E-learning environment.

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