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# ACCESSIBLE E-LEARNING: EQUAL PEDAGOGICAL OPPORTUNITIES FOR STUDENTS WITH SENSORY LIMITATIONS

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## Abstract

*The transformation of the world into a highly technological place has led to the evolution of learning from traditional classroom to e-learning, using course management systems (CMS). E-Learning offers a range of advantages over traditional pedagogical methods, providing a bridge for students with sensory limitations, who otherwise, find themselves at a disadvantage. This study evaluates the accessibility, usability, interactivity, and responsiveness of popular CMS, and examines if an accessible and usable CMS impacts the performance of physically challenged students. For this purpose, university students having sensory limitations were surveyed. The results revealed some interesting facts about online education, besides identifying an area of improvement.*

## Introduction

The transformation of the world into a highly technological place has led to the evolution of learning from the traditional classroom to online learning or e-learning, that involves acquisition of knowledge distributed and facilitated electronically. Courses are delivered through course management systems (CMS), such as Blackboard.

Unlike traditional learning, e-Learning is more accommodative of constraints of access, time, distance, etc. In particular, it benefits individuals with sensory limitations, including vision or hearing impaired, dyslexic, etc, who face hindrance in classroom learning. Hence, it is imperative to provide equal access to Web content for such students. In this context, accessibility refers to Web-based information being viewed, navigated and read by people with sensory limitations, using assistive technology, providing equivalent learning experience.

Two federal laws have been passed that apply to the accessibility of educational Web sites. The ADA states that equal learning access must be provided to all, including educational materials placed on the Web (ADA Accessibility Guidelines 2000). Section 508 of the WRA requires federal agencies to make IT accessible to persons with disabilities (WRA 1998). In the global context, the W3C sets technical specifications and standards for the Web (W3C/WAI 1997).

Course management systems (CMS), like Blackboard, WebCT, etc.; have gained popularity for delivering Web-based content in higher education. Instructors without Web designing skills can use CMS for convenient online material placement. Over 1400 institutions worldwide use Blackboard (UWO Web Accessibility Guidelines). The mandate for accessible Web pages should be addressed in CMS's Web pages as well. Both the infrastructure and content must be accessible for accessibility of online courses. A concerted effort by the academia is necessary to highlight the issue of accessibility of CMS to developers, instructors and institutions in general.

This study takes a holistic approach of online education for individuals with sensory limitations. It examines the level of accessibility, usability, and richness of a popular CMS. It proposes that online higher education, with

adequate levels of the aforementioned attributes, can provide a fertile ground for academic success for highly motivated individuals with sensory limitations. The pertinent research questions are as follows:

1. Can e-learning provide equal learning opportunities for students with sensory limitations?
2. What is the state of accessibility and usability of contemporary CMS as tools of e-learning?
3. Do accessible CMS's enhance the performance of students with sensory limitations?

## **Theoretical Development**

### ***Accessibility***

Extensive research has been conducted in many domains concerned with this subject. Guidelines for building accessible applications are published by many organizations. The Trace Center at the University of Wisconsin maintains a list of well-written, representative publications at their Web site (Brunet, et. al, 2005). Jacob Nielsen has provided guidelines specifically for Web-based applications. The insights captured in these guidelines are critical to the successful delivery of an accessible application (Brunet, et al., 2005). Accessible design is intended to enable universal access to interactive systems, regardless of user impairments and preferred client technology. Such design supports specific needs of physically challenged individuals (Universal Usability Guide).

A critical factor in design for accessibility is design for assistive technology, like screen readers, adapted keyboards, and built-in support. A variety of challenges must be addressed for accessible design. For example, distinct design responses are necessary to support blind users, as opposed to users with partial vision. In the former case, a key concern is providing appropriate encoding of content for screen readers, as they cannot read text that is part of an image (Englefield, et al. 2005).

In her field study, Weir Lori (2005) suggested that while developing course materials, instructors must possess the knowledge about: perceptions of tasks and information for students with learning disabilities; understanding the content without sound by deaf students; accessing the CMS and its material by visually impaired students using screen-readers; and participation in chat sessions by individuals with physical limitations. This could result in design changes having universal impact. Soliciting feedback from students and spending time with them as they learn are simple yet powerful ways to gain an awareness of course-material accessibility (Lori, 2005).

### ***Usability and Design***

According to a 2003 report of DRC (Disability-Rights-Commission), 45% of problems in Web sites had to do with usability, rather than accessibility. Quality e-learning Web resources should be usable and not just accessible. However, due to excessive focus on accessibility owing to fear of litigation, usability fails to draw similar levels of attention.

Usability has taken an engineering approach, identifying principles and common practices, resulting from system design (Nielsen 1993). With the Web emerging as a predominant interface, basic usability principles of an IS were extended into the Web environment. Nielsen (2000) included navigation, response time, credibility, and content. A key challenge in building a usable Web site is to create good links and navigation mechanisms (Radosevich 1997). Usability includes consistency and the ease of getting the Web-site to comply with users' requirements, clarity of interaction, ease of reading, arrangement of information, speed and layout. Appropriate design of user interfaces includes organization, presentation, and interactivity (Shneiderman 1998). Ability to support greater interactivity of the Internet facilitates online information gathering (Jarvenpaa and Todd 1997).

### ***Media Richness***

Media richness refers to a medium's relative ability to convey messages. Media have been classified as face to face, telephone, personal documents, impersonal documents, and numerical documents. These have been extended to include e-mail (Markus 1994), and "new media" computer-mediated and video communication (Dennis and Kinney 1998). The specific influence of a given medium is often dependent on the task being performed (Daft and Lengel 1986). Finding information that is of high quality within the computer-mediated context is an important element (Hoffman et al. 1995, Dickson 2000).

## Learning Motivation

Learning motivation is an influential factor of learning outcome, especially in the e-learning context, where no instructors or peer classmates are physically present to motivate the learner in an online education program. In their investigation of the role of team learning in an online MBA program offered by University of Ohio, Huang et al. examined the correlations among virtual team learning, learning motivation, and learning outcome (satisfaction). One of their research questions was: Is learning motivation associated with students' perceived learning outcome in an online MBA program? They reported that learning motivation was significantly correlated with learning outcome. (Huang, et al. 2005)

## A Model of Perceived Success of Learning

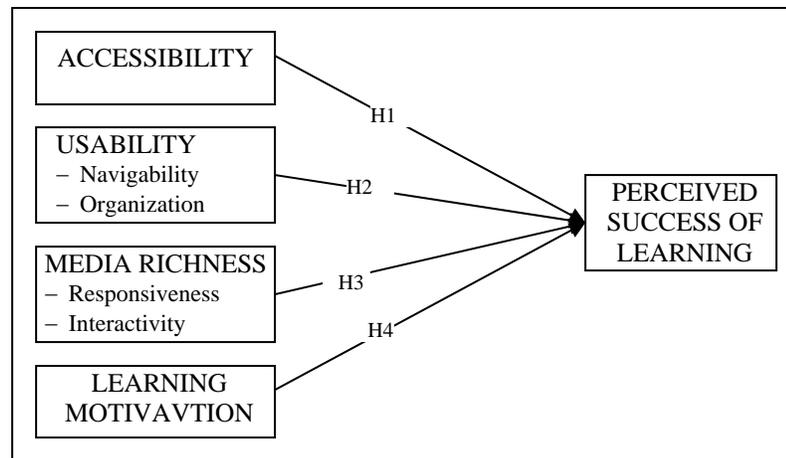


Figure 1: Research model

This study attempts to adopt a holistic approach to accessible e-learning. The idea is to include design principles adhering to usability and richness of an IS. Hence the model developed includes four independent constructs namely accessibility, usability, richness, and motivation. The dependent construct, perceived success by the student, includes successful class participation and learning performance.

The four hypotheses are stated as:

- H1: The perceived success of learning of physically challenged students will be positively correlated to the accessibility of CMS used for e-learning.
- H2: The perceived success of learning of physically challenged students will be positively correlated to the usability of CMS used for e-learning.
- H3: The perceived success of learning of physically challenged students will be positively correlated to the richness (in terms of interactivity and responsiveness) of CMS used for e-learning.
- H4: The perceived success of learning of physically challenged students will be positively correlated to the learning motivation of physically challenged students enrolled in courses using CMS.

## Methodology

Owing to the nature of the topic, the literature review had to be very extensive. The sources ranged from academic to practitioner journals, US and UK Government Web sites, and agencies promoting accessible e-learning. The academic journals came from diverse fields such as Information Systems, Management, Organizational Behavior, Education, Computer Science, Sociology, Psychology, etc. Data was collected via survey method. Considering the novelty of this topic, and due to the small number of physically challenged students pursuing higher education, this work represents a preliminary study that intends to test the validity of the model and the instrument. This also explains why a convenient sample was used for the study.

## Study Settings and Subjects

Participants in the study sample were individuals having limited sensory abilities, using computer exclusively through an assistive technology, (screen reader for sight impaired), enrolled into a course partly or fully delivered via CMS, (Blackboard in this case). Blackboard is used for posting lecture notes, completing assignments, taking exams, communicating, viewing grades, etc. These individuals were approached via the Office of Disability Services at each institution. These offices are primarily responsible for providing support to students with sensory limitations. A total of 32 students agreed to participate in this survey, including 22 sight-impaired and 10 hearing impaired.

## Operationalization

The survey instrument had to be designed to collect data to support the four hypotheses. An extensive literature search was conducted to trace validated instruments containing items used to operationalize the various constructs involved in this study. For ACCESSIBILITY, items from the Brunet et al (2005) study were used after modifications. The items on USABILITY, MEDIA RICHNESS, and PERCEIVED SUCCESS were borrowed from the Palmer (2002) study on e-Business, and slightly modified. For items on LEARNING MOTIVATION, the Huang, et al. (2005) study was used. After assembling appropriate items for each construct, the instrument was finalized, comprising of 22 items (Instrument available on request).

## Data Analysis

Data analysis began with descriptive statistics (Table 1.) and reliability tests of the measures. All Cronbach alphas were above the acceptable value of .70 (Nunnally, 1967). For convergent and discriminant validity, factor analysis was performed in addition to scale reliability. Factor loading (Table 2) of most items was satisfactory (>0.7). No items were dropped due to small sample size.

**Table 1. Descriptive Statistics & Internal Reliability**

Covariance Matrix Demonstrating Internal Reliability						
	Accessibility	Usability	Media Richness	Learning Motivation	Perceived Success	Cronbach's Alpha
Accessibility	1.0					0.915
Usability	0.2693	1.0				0.879
Media Richness	0.5149	0.3148	1.0			0.906
Learning Motivation	0.4430	0.4432	0.6333	1.0		0.810
Perceived Success	0.8329	0.6455	0.7927	0.6551	1.0	0.833

**Table 2. Factor Loadings**

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
<b>A1</b>		0.873				<b>U1</b>			0.811		
<b>A2</b>		0.859				<b>U2</b>			0.748		
<b>A3</b>		0.760				<b>U3</b>			0.675		
<b>A4</b>		0.788				<b>U4</b>			0.844		
<b>A5</b>		0.810				<b>U5</b>			0.843		
<b>MR1</b>	0.703					<b>LM1</b>					0.749
<b>MR2</b>	0.726					<b>LM2</b>					0.720
<b>MR3</b>	0.685					<b>LM3</b>					0.694
<b>MR4</b>	0.843					<b>PS1</b>				0.809	
<b>MR5</b>	0.791					<b>PS2</b>				0.603	
<b>MR6</b>	0.785					<b>PS3</b>				0.661	

Data was subjected to multiple regression (Table 3), using mean of each construct, indicating significant regression model ( $F=7.220$ ,  $p=0.000$ ) and adjusted  $R^2 = 0.445$ . Support for H1 and H2, and lack of support for H3 and H4 were also established (Table 4).

**Table 3. Regression Analysis Results**

Analysis of Variance					
	SS	DF	Means	F-Ratio	P-value
Regression	9.044	4	2.261	7.220	0.000
Residual	8.456	27	0.313		
Total	17.50	31			

**Table 4. Does Data Analysis Support the Hypothesis?**

Hypothesis	Coefficient (p-value)	Supported
<b>H1:</b> The perceived success of learning of physically challenged students will be positively correlated to the accessibility of CMS used for e-learning	0.392 (0.020)	YES
<b>H2:</b> The perceived success of learning of physically challenged students will be positively correlated to the usability of CMS used for e-learning.	0.328 (0.037)	YES
<b>H3:</b> The perceived success of learning of physically challenged students will be positively correlated to the richness (in terms of interactivity and responsiveness) of CMS used for e-learning	0.260 (0.169)	NO
<b>H4:</b> The perceived success of learning of physically challenged students will be positively correlated to the learning motivation of physically challenged students enrolled in courses using CMS	0.044 (0.815)	NO

## Results

The mean cumulative ACCESSIBILITY score of the CMS was 5.14 on a scale of 1 (strongly disagree) to 7 (strongly agree). Overall accessibility of Blackboard received a score of 5.9; ease of uploading and downloading with an assistive technology received 5.18; ease of communicating received 5.48. The data supported the hypothesis that accessibility is positively correlated to learning success.

The mean cumulative score of USABILITY of Blackboard was 5.05. Overall navigability received a mean score of 5.2; layout received 5.06; making Blackboard do what was needed received 5 or higher. Hence, Blackboard was overall quite usable. Data supported the hypothesis that usability is positively correlated to learning success.

The mean cumulative score of richness was 3.6, with low levels of customizability, feedback, with no provision for FAQs. Data did not support the hypothesis that richness is positively correlated to learning success.

The mean cumulative score of LEARNING MOTIVATION was 5.48. Item on interest in learning through Blackboard received a score of 5.8; performance level of the respondents received 5.5; effort put into the course received 5.1. Despite the high score, the variance in data failed to support the hypothesis that learning motivation is positively correlated to learning success.

PERCEIVED SUCCESS of learning was operationalized by three items. The item on comfort level of online discussion received a mean score of 6.01, while that for level of performance in online exams received 4.65, and preference of online learning over traditional learning received 5.44

## Discussion

As is clear from the data, Blackboard, a widely used tool of e-learning, was found to be satisfactorily accessible and usable to physically challenged students enrolled in courses that employed it for pedagogy. However, it was not interactive or responsive, attributed to the mode of implementation. This necessitates the need for a new approach by the administrators of Blackboard, to make it more interactive and responsive by being customizable, provide

solutions to commonly encountered problems related to its use through FAQs, and have provision for feedback from the students.

It was also observed that the students, who were either visually, or hearing impaired, were more comfortable in learning and participating through a CMS. This could be attributed to the fact that e-learning in general, and CMS in particular offer a medium that presents information simultaneously in both audio and visual modes. For example, a lecture slide delivered over the Blackboard enables a student with vision impairment to hear it with a screen reader, while a student with hearing impairment can read it visually. Both these groups would have had access to part of the lecture in a traditional class as the instructor cannot speak out each word that he/she writes on the board, or vice versa. Hence, an accessible CMS represents an excellent realization of the slogan "Equal Opportunity for All."

## Conclusion

Online learning, by its very nature, offers a range of advantages over traditional, off-line methods. If designed to promote accessibility for physically challenged students, it presents a pedagogical means that does not discriminate on the basis of abilities. Course management systems, as tools of e-learning, provide equal opportunities of participation and performance for such students. Designers need to develop these systems according to the design guidelines that adhere to accessibility and usability principles. Besides, these systems must be designed for customization, provided with tested solutions to commonly encountered problems in the form of FAQs, and allow for providing user feedback.

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