Developing and Validating an Instrument to Assess the E-learning Environment at a Public Higher Education Institution in Malaysia

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Abstract

As Knowledge, Communication and Technology (KCT) plays crucial role in the restructuring of the educational system in this new millennium, e-Learning is seen as an effective means to stimulate this process, especially on the teaching and learning aspect. The introduction of e-Learning has become an important factor in reshaping the educational environment, particularly in the Higher Education System (De Boer et al, 2002). In order for e-learning systems to take advantage of these technologies so as to be successful, effective and of a quality comparable with the well received traditional learning systems, the e-learning systems must be designed and constructed with care, using a thoroughly scrutinized approach which embraces well-designed procedures and techniques (Colette, 2001).This paper describes the development and validation of the instrument to assess the e-learning environment at Universiti Sains Malaysia (USM). The blueprint of the e-Learning project was thoroughly studied to ensure that the instrument is comprehensive in assessing the e-learning environment. This is complemented with a series of focus group interviews with students. The instrument was answered by a total of 226 randomly selected students from USM. Factor analysis, both exploratory and confirmatory, was performed on the data and the result indicate that in assessing the E-Learning environment there are six distinct factors: technology, course content, teaching and learning material, teaching and learning environment, learning strategies, and support. The psychometric properties of the instruments are as follows; GFI=0.88, AGF=0.87, RMSEA = 0.061, NFI = 0.88, CFI=0.89, PNFI = 0.77, and PGFI =0.84.

***Keywords**: E-Learning, Instrumentation, Validity, Reliability*

Introduction

The presence of Internet basically has shifted society from the paper-based into the digital world (Lanham, 1993). It has transformed the stand-alone personal computer into a networked station that enables worldwide communication. The advance developments of technologies that enable greater storage capacity and high-speed transfer contribute to the effectiveness of information sharing across vast distances and at different time zones. The emergence of Internet not only makes the accessibility to information easier; it also facilitates the changes in the nature of today's education (Kurshan & Dawson, 1992). The use of networked technologies and wireless devices has mediated the transition from traditional classroom learning to electronic learning or e-Learning.

Even though e-Learning predominantly depends on technology in delivering the lesson; the core component is connectivity, in other words the use of Internet or Intranet to interact. The use of desktop tools alone like PowerPoint, CD-ROM and DVD in delivering lessons is not e-Learning. E-Learning covers a wide set of applications and processes, such as Web-based learning, computer-based learning, virtual classrooms, and digital collaboration. The key element of e-Learning is the delivery of content via Internet, intranet/extranet (LAN/WAN), audio and videotape, satellite broadcast, interactive TV and CD-ROM.

In line with the rapid development in ICT, the education system is experiencing drastic changes both in terms of its philosophy as well as the approach. These changes are far more apparent in higher education system, at least in the Malaysian context. E-Learning has become an integral part of higher education. The education system is being moulded to suit the development in ICT where the technology is used to facilitate effective learning. However, restructuring the teaching methods to maximize the benefits of e-Learning requires attention to basic policy foundations that influence the behaviours of faculty members, administrators and students apart from designing, implementing, and monitoring the learning activities.

E-Learning at University Sains Malaysia

USM is the first university to start the distance learning program in Malaysia. It was then popularly known as the off-campus program. In this mode of education, students are provided with course modules and are required to attend regular face-to-face tutorials at designated centres. These tutorials are conducted by lecturers from other academic institutions who are employed by the university on a part-time basis. In addition, these students are also required to attend full time courses in campus during their final year. With the rapid development of ICT, there was a major shift in this distance learning mode. Online learning had replaced the requirement for frequent face to face meetings.

The e-learning or web-based learning had effectively closed the accessibility gap and extended the opportunity for tertiary education to almost all eligible prospects. The e-Learning Model in USM has four major components, namely the Learning Management System (LMS), virtual library, blended mode pedagogy (web-based instruction and face-to-face), and ICT helpdesk. All these components were built upon a reliable network infrastructure, or the so-called e-Learning server farm or LAMP, the acronym for Open Source Linux, Apache, MySQL, and PHP. This network also supports Off-Campus students nationwide. The Centre for Knowledge, Communication and Technology provides the technical support.

In e-learning, unlike the traditional learning environment, the interaction can be multifaceted between: instructors and learners; learners and learners; and individuals and group. This is further complicated by free accessibility, in E-learning communication can take place any time any where (Nuttall, 2002). E-learning is best supported by learner-centered approaches that allows for numerous interactions. As a result, effective teaching with technology demands a shift in instructional practices from a teacher-centered approach to a more learner-centered or constructivist approach (Jonassen, 2000). Thus, the role of instructors shifts from that of transmitting knowledge to the new role as facilitators, guides or coaches, and mentor. Gibbons and Fairweather (1998) noted that the use of computer technology assisted students in their interaction with more complex materials and as such the facilitator and the discussion material should be able to accommodate all possible differences and provide learning activities that enhances collaboration and cognitive engagement.

Having the infrastructure and technology alone does not make an institution a successful e-learning provider, what is more important is the right environment for students' learning. The power of technology to support learning does not depend so much on the technology but on how the available technologies are used in facilitating learning (Rogers, 1999). Therefore, facilitators should provide intellectually stimulating and technology rich environments for students without undermining sound pedagogical practices (Anderson & Becker, 2001). A focus on mere technology may not help to transform classroom practices and enhance students' learning; sound constructivist practices that focus on teaching first and technology second could possibly lead to effective e-learning practices that support students' learning. This paper reports the development and validation of a specifically designed instrument to assess the effectiveness of the e-learning environment at Universiti Sains Malaysia (USM).

Research Design

This study used both the qualitative and quantitative approaches; focus group interviews were used to generate the dimensions as well as the specific indicators to assess the effectiveness of the e-learning environment while questionnaire survey was used to establish the psychometric properties of the instrument.

Instrumentation

The procedure used to develop the instrument followed the eight-step process of instrument development suggested by Churchill (1976). The instrument development process consists of: defining the construct, identifying the domain, generating items, collecting preliminary data (piloting), purifying the instrument, collecting fresh data, further purifying the instrument, and evaluating the reliability, validity and dimensionality of the instrument.

Based on literature and focus group interviews, the effectiveness of the e–learning environment was defined as a six dimension construct comprising of *technology*, *course content*, *teaching and learning material*, *teaching and learning environment*, *learning strategies*, and l*earning support*.

Six focus group interviews involving students of USM were carried out to gauge their perspective on the E-learning at the university and its effectiveness. The results of the focus group interviews were later transformed into a questionnaire that was used to gauge students' perception on E-Learning environment at USM. A total number of 226 students responded and factor analysis, both exploratory and confirmatory were used to establish the psychometric properties of the instrument.

Results: Psychometric properties of instrument.

The psychometric properties of instrument refer to the soundness of the instrument in measuring the intended construct. This is one of the major concerns in social science studies since most constructs are difficult to be measured objectively. The psychometric properties of the instrument was evaluated in terms of validity, and the reliability.

a) Validity

The validity of the instrument refers to its' ability to measure what it purports to measure. Since the validity of the study very much depends on the validity of the instrument used, it is an important issue to be addressed. Broadly, validity refers to how accurately a particular construct is translated into measurable behaviours. Among the types of validity discussed in this paper are: face and content validity, convergent validity, concurrent validity, and dimensionality.

i) Face and Content Validity

Clearly specifying the domain of the construct, generating items that exhaust the domain, and purifying the resulting scale should produce a measure, which is content or face valid and reliable (Churchill, 1976, p. 70). Since a thorough review of the literature was carried out to determine the constructs, and focus group discussions were used to generate specific indicators to measure the defined construct, necessary steps had been taken to establish sound face and content validity. Furthermore, the final questionnaire was evaluated by a group of experts in the field of educational administration. The factor analyses, both exploratory and confirmatory, provided evidence that empirical evidence (students' ratings) converge with the theoretical description of the construct. Table 1 illustrates the items that were assigned theoretically and the items that load statistically to the common factors.

Table 1: Instrument to E-Learning environment (dimensions and items)

Dimension	Statistically derived items	Theoretical explanation
Factor 1 (Support)	5	Support provided to students by the university
Factor 2 (Material)	4	Teaching and learning material used for the course
Factor 3 (Technology)	4	ICT technology deployed in delivering the course
Factor 4 (Learning strategies)	3	Learning strategies emphasised in the course
Factor 5 (Learning strategies)	3	Learning strategies emphasised in the course
Factor 6 (Teaching and learning)	4	Teaching and learning environment
Factor 7 (Mixed factors)	4	Consists of items belong to factors such as support, material, and technology)
Factor 8 (Course content)	4	Course content , the soft skills
Factor 9 (Course content)	2	Course content , the soft skills

ii) Convergent Validity

Some researchers claimed that each of the items in the instrument can be treated as a different indicators to measure the same construct. Thus, the convergent validity of the instrument can be determined using Bentler Bonnet coefficient (delta), scales with delta values of 0.90 or above demonstrate strong convergent validity (Ahire et al, 1996).

To determine on which dimension the items in the questionnaire load, an exploratory factor analysis was performed. Items that were statistically loading to the common factors were then compared with the relevant theories (refer to Table 1). After dully considering the theory as well the statistical outcomes, items that load to factors that cannot be explained theoretically were dropped and the exploratory factor analysis was performed on the reduced number of items. Items with factor loadings greater than 0.5 for each component were then subjected to confirmatory factor analysis. Table 2 describes the components and the number of items for the dimensions as well as the Bentler-Bonnet Coefficient for the various dimensions of E-Learning environment.

Table 2: Dimension and items of E-Learning environment

Dimension	Number of Items	Bentler-Bonnet Coefficient
Factor 1 (Technology)	4	0.89
Factor 2 (Learning strategies)	6	0.89
Factor 3 (Course content)	6	1.00
Factor 4 (Material)	4	0.97
Factor 5 (Teaching and learning)	4	0.92
Factor 6 (Support)	5	0.90

iii) Concurrent Validity

It is the ability of the construct to distinguish between groups that are theoretically different (Sekaran, 2000). In this paper, the concurrent validity was established comparing the differences in students' rating on the various dimensions of the E-Learning environment with '*motivation to learn'* with the assumption that student with different level of motivation will view the learning environment differently. The Independent-t test was used. Motivation to learn was measured using a battery of eight items. Respondents' motivation level was defined as *high* or *low* using the median of the average 'motivation' score. Table 3 displays the results of the t-tests.

Table 3: Concurrent Validity Analysis

E-Learning Environment	No. of items	Mean	SD	t-value	p-value
Technology	4				
High Motivation		5.5422	.85465	3.75	0.000
Low Motivation		5.0577	.98657		
Learning Strategies					
High Motivation	6	6.0451	.50421	4.91	0.000
Low Motivation		5.6971	.52250		
Content					
High Motivation	4	5.8431	.71933	4.12	0.000
Low Motivation		5.4369	.71343		
Material					
High Motivation	4	5.7706	.66839	3.94	0.000
Low Motivation		5.4065	.67851		
Teaching and Learning Environment					
High Motivation	4	5.9196	.64376	3.13	0.002
Low Motivation		5.6440	.63613		
Support					
High Motivation	5	5.6541	.89143	3.27	0.001
Low Motivation		5.2286	.97702		

The results indicate that for all the six dimensions of E-Learning environment, there are significant differences between the two groups (high motivation and low motivation). The respondents belonging to the '*High Motivation'* group have higher mean scores for all the six dimensions compared to those in the '*Low Motivation'* group. This is an evidence of good concurrent validity.

b) Dimensionality

Dimensionality is a process of evaluating the "belongingness" of the items to certain dimensions in the construct. For the instrument to be dimensionally sound, items should only measure the dimensions that they theoretically belong to. The confirmatory factor analysis (CFA) is used if the dimension for the construct is supported by a sound theory and the researcher has a reasonably good knowledge of the number of dimensions while the exploratory factor analysis (EFA) is used when the researcher is uncertain about the relationship between the items and latent factors (Ahire at.al, 1996).

Since the construct E-Learning Environment was defined using both existing literature and focus group interviews, both the EFA and CFA were used. The exploratory process was used to explore the relationship between the latent factors (dimensions) and the observed variables (items), while the CFA was used to confirm the relationship (Sureshacandar et al., 2002). The principal component analysis was used as the extraction method for the EFA and the factors were rotated using the Varimax rotation method with Kaiser normalization. Prior to that, a reliability test was performed and only items with an index greater than 0.4 were considered for factor analysis.

The EFA provides a seven-factor solution with 62.37% total variance explained. However factor 5 and 6 measures similar domains, the issues related to learning, thus these two factors were combined and defined as learning strategies for further analysis. The Bartlett Test of Sphericity gives a very small p-value (0.000), indicating that there is a statistical probability that the correlation matrix has a significant correlation among at least some of the variables (Hair, Anderson, Tatham & Black 1995). Furthermore the Kaiser-Meyer-Olkin Measure of Sampling Adequacy is also very high, 0.863, indicating that the latent constructs can predict the variability of the responses in the observed variables. Table 4 shows the result of the factor analysis.

Table 4 : Factor analysis on the reduced items

	Dimension of E-Learning environment						
Item Numbers	Support	Technology	Learning Material	Teaching& Learning	Learning Strategies	Learning Strategies	Support
B38	0.8009						
B36	0.7469						
B37	0.7346						
B35	0.7008						
B39	0.6694						
B3		0.7440					
B6		0.7440					
B2		0.6656					
B5		0.6656					
B27			0.8024				
B28			0.7586				
B29			0.5586				
B26			0.5449		0.4457		
B32				0.7538			
B33				0.7164			
B31				0.6036			
B34				0.5415			
B20					0.8246		
B21					0.7021		
B12					0.6529		
B14						0.7407	
B13						0.6493	
B15						0.5560	
B17							0.7138
B18							0.6823
B16						0.4225	0.4254
B19							0.5154
Variance Explained	12.41	9.85	9.42	8.24	8.20	8.00	6.26

The confirmatory factor analysis was performed to complement the result of the exploratory factor analysis. The CFA was performed by carrying out path analysis using structural equation modeling. A measurement model was specified and the model's overall fit was assessed to determine how well the empirical data fit the theoretical model. The CFA is a procedure to assess the discrepancy between the variance-covariance structures of the data set with the model implied variance-covariance structure.

A wide range of goodness-of-fit indices was used to assess the model fit. The fit indices are categorized into the following categories: (1) overall fit (absolute fit), (2) comparative fit to a base model (incremental fit), and (3) model parsimony. In this paper, several goodness-of-fit indices from the three categories of indices in assessing the measurement were used. The selected indicators include the χ^2 , GFI, RMSEA, AGFI, NFI, CFI, PNFI and PGFI.

In the confirmatory factor analysis procedure, the number of factors and the items loading to each factor were specified and the hypothesized measurement model was then tested for model fit. In assessing the e-learning environment the following models were tested: i) six-factor oblique, ii) six-factor orthogonal model and iii) one factor model. The six-factor oblique model is a measurement model that hypothesized complete correlations between all the dimensions. On the other hand, the six-factor orthogonal model assumes that the dimensions are not correlated with one another. The one-factor model is a uni-dimensional model where all the observed variables are linked directly to one common factor.

Table 5 shows the fit indices for the proposed models. All the fit indices indicate that the six-factor oblique model is the superior model. The six-factor oblique model provides a better fit to the data compared to the six-factor orthogonal model, and the one-factor model. The parsimonious indices also suggest that the six-factor oblique model gives the most parsimonious fit to the data.

Table 5: Fit indices comparing the three models

Model	χ^2	df	GFI	AGFI	RMSEA	NFI	CFI	PNFI	PGFI
6-factor oblique	549.31	278	0.88	0.87	0.061	0.88	0.89	0.77	0.84
6-factor orthogonal	730.48	299	0.81	0.78	0.080	0.70	0.79	0.61	0.69
One factor	1116.45	299	0.68	0.63	0.11	0.54	0.61	0.49	0.58

To further assess the degree of uni-dimensionality of the dimensions and the convergent validity of the items representing the dimensions, measurement models were specified for each dimension and the CFA was carried out for the individual dimensions. This is a procedure to check how closely the designated items represent the dimensions. According to Ahire et al (1996), 'a goodness of fit index of 0.90 or higher for the model suggests that there is no evidence of lack of uni-dimensionality' (Ahire et al, 1996, p.38). Table 6 summarises the result of the CFA on the individual constructs.

Table 6: Fit indices for the E-Learning Components

Dimension	No of Items	Range of Std Regression	GFI	AGFI	CFI	TLI	Bentler Bonnet Coef Δ
Technology	4	0.574 – 0.808	0.94	0.82	0.90	0.79	0.89
Learning Strategies	6	0.468 – 0.694	0.96	0.89	0.91	0.84	0.89
Course Content	4	0.601 – 0.710	1.00	-	1.00	-	1.00
Learning Material	4	0.571 – 0.749	0.99	0.93	0.98	0.94	0.97
Teaching and Learning Environment	4	0.493 – 0.809	0.96	0.81	0.92	0.77	0.92
Support	5	0.632 – 0.860	0.93	0.80	0.91	0.82	0.90

c) Reliability

Reliability refers to the consistency of the instrument. In this paper, the Cronbach alpha was used to evaluate the consistency of the responses for each item within the instrument. An alpha value of 0.7 to 0.8 is considered satisfactory for social science researches (Nunally & Bernstein, 1994). The Alpha values for the various items of the instruments are shown in Table 7.

Table 7: The reliability index for the E-Learning Instrument

Item		
	Cronbach Alpha	Construct (Reliability index)
USM has a well maintained network system.	0.542	Technology (0.776)
Online help is available.	0.672	
Online tutorials are available.	0.772	
USM's website uses the latest technology.	0.699	
Discussions with peer is emphasised in this course.	0.641	Learning Strategies (0.763)
Learning in both formal and informal settings is encouraged.	0.699	
Different learning strategies are used in different situation.	0.658	
Learning process is stressed at least as much as learning content.	0.539	
This course promotes team work.	0.501	
In this course the students' experiences are used to facilitate learning.	0.686	
The learning material emphasises on problem solving rather that memorising content.	0.563	Learning Material (0.772)
The learning material used emphasises on critical thinking.	0.616	
The learning material is mainly task oriented.	0.620	
The learning material emphasises on learning by discovery.	0.690	
The learning material incorporates real-world situations to provide more realistic learning experience.	0.631	Teaching and Learning Environment (0.779)
Real-world situations are used to enhance students' understanding of the concepts taught.	0.702	
There is flexibility in the course content (eg. students can choose certain topics as the focus for their assignments).	0.692	
The assessment evaluates the content as well as the learning process.	0.674	
The course instructors and facilitators are always available when students' need assistance.	0.661	Support (0.835)
There are sufficient labs for students.	0.617	
Students can use the lab at their convenience.	0.630	
If students experience problems, there is always someone available to assist.	0.745	
New students are given sufficient guide at the beginning of the semester (eg. on the facilities, library, lab, etc).	0.699	
The course content emphasises critical thinking.	0.711	Course Content (0.876)
Problem solving elements are integrated in most courses.	0.754	
Most of the courses promote independent learning.	0.699	
In most courses, students' experiences are used to facilitate learning.	0.824	

Conclusion

The instrument to assess the E-Learning environment consists of six dimensions: technology, learning strategies, course content, learning material, teaching and learning environment, and support. The items representing each dimension were generated using focus group interviews. The results of the exploratory and confirmatory factor analyses provide evidence of validity while the Cronbach Alpha values shows that the items as well as the dimensions assessing the E-Learning environment are reliable for the intended population.

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