The validation of the online learning environment survey

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The increased use of computers in education, the creation of virtual learning environments based on web services, and the increased investments by educational institutions (both fiscal, physical and human) in the development of networked environments are impacting on all aspects of education. Educationalists, at all levels, are challenged to develop appropriate strategies to deal with new information and communication technology rich ways of teaching and learning. This paper will focus on the procedures used in the validation of an online learning environment perceptual measure the *Online Learning Environment Survey* (OLLES). It is envisaged the instrument, in its' final form, will inform educationalists of the efficiency and effectiveness of tactics and strategies they are employing in the online learning environments they create.

Keywords: Computers in Education, Online Learning, Learning Environment, Perceptual Measures, Evaluation

Online learning

A close examination of the term 'online learning' could lead to a simple definition, such as, 'the use by students of connected (online) computers to participate in educational activities (learning)'. While this definition is technically correct, it fails to explain the full range and use of connected computers in the classroom. To Radford (1997) the term 'online learning' was used to denote material accessible via a computer using networks or telecommunications rather than material accessed on paper or other non-networked medium. Chang & Fisher (1999) regarded a web-based learning environment as consisting of digitally formatted content resources and communication devices to allow interaction. Zhu, McKnight, & Edwards (2007) describe online instruction as any formal educational process in which the instruction occurs when the learner and the instructor are not in the same place and Internet technology is used to provide a communication link among the instructor and students. To Siragusa (2005) online learning is when students are using the Internet to interact with content, other students and their tutors. This range of definitions and interpretations of online learning is a reflection of the variety of ways educationalists, at all levels, use connected computers in learning.

However, the range of definitions and interpretations described above are all based on the assumption learners have acquired the appropriate functional knowledge of computer operations to participate in activities provided. For example, there is the assumption that students will be able to:

- know if the computer is turned on or turned off,
- use a keyboard and computer mouse,
- view information presented on a visual display unit,
- select and/or use appropriate software applications.

Therefore, a student - computer relationship common to all interpretations can be identified, described and investigated. If we focus on our understanding of the process of learning and the relationships created in this process. In each of the interpretations identified, the learners are seen to be engaged in purposeful learning activities meeting specific objectives. The objectives of the activity, the selection of tasks and the ICT tools to be used are designed, structured and facilitated by a tutor. Therefore, a tutor - student relationship can be identified, described and explored. Morihara (2001) has expanded these two relationships and has identified student - student interaction, student - media interaction (i.e. the students interaction with content knowledge presented in a variety of formats, such as audio files, video as well as text) and the outcomes of learning in the environment created as generic features of online learning. Haynes (2002) concurs and lists four features of online activity. These are,

1. student - interface relationships
2. student - tutor relationships
3. student - student relationships
4. student - content relationships.

Although these four broad categories appear to identify all aspects of online learning they do not investigate how the learner, as an individual, approaches, contributes to, reacts to, and reflects upon his/her experiences in this digital environment. The importance of creating time for and encouraging self-reflection on the learning process is well documented by constructivists (Gunstone, 1994; Hewson, 1996; Posner, Strike, Hewson, & Gertzog, 1982). It would appear to be crucial to investigate if, when and how this personal reflective activity takes place in online learning activities. If we include student reflection in the list of generic activities in online learning, we can now identify, describe and explore five broad categories of online learning.

These five broad categories are outlined below.

1. *Student - Media Interaction*: How is the student is engaged with digitally stored information and how do they relate to the information presented?
2. *Student - Student Relationships*: How, why and when do students communicate with each other and what is the nature of this communication?
3. *Student - Tutor Relationships*: How, why and when do students communicate with their tutor and what is the nature of this communication?
4. *Student - Interface Interaction*: What are the features of the interface created that enhance / inhibit student learning and navigation?
5. *Student Reflection Activities*: How are students encouraged to reflect on their learning, are they satisfied with the environment and how do they relate to the environment created?

Learning environment research

In monitoring performance or researching and evaluating the success or failure of time and resources spent in educational settings, a number of quantitative measures such as grades allocated, total number credits earned, participation rates in specified activities, graduation rates, standardized test scores, proficiency in identified subjects and other valued learning outcomes could be used (Dean, 1998; Fraser & Fisher, 1994). However, since these quantitative measures are in general focused on educational outputs they are somewhat limited. They do not adequately measure, monitor or truly evaluate the details of the educational process. Other measures can be used that are just as effective, for example, student and teacher impressions of the environment in which they operate are vital. Their reactions to, and perceptions of, this environment have a significant impact on individual and group performance (Fraser, 1998a). Indeed, research indicates student achievement is enhanced in those environments which students feel comfortable within and positive about (Waldrip & Fisher, 2003). While it is possible to employ external researchers to observe and report on these learning environments, these studies are expensive to conduct and their findings are not unproblematic (De Jong & Westerhof, 2001). Learning environment instruments appear to offer an efficient, affordable and reliable tool to investigate the learning environment created.

The essence of a learning environment is the interaction that occurs between individuals, groups and the setting within which they operate. The investigation in, and of, learning environments is based on the Lewinian formula, B=*f*(P,E) were behavior (B) is considered to be a function of (*f*) the person (P) and the environment (E). The formula recognises that 'both the environment and its interaction with personal characteristics of the individual are ‘potent determinants of human behavior’ (Fraser, 1998b, p 529). Since the learning environment is a place where learners and educators congregate for extended periods of time to participate in the activity of learning, the environment created, also referred to as climate, atmosphere, tone, ethos or ambience, during this activity is regarded as an important component in the learning process (Fraser & Wubbels, 1995).

The first school environment instruments were developed as early as 1958, however, these early environmental instruments were somewhat limited as they were awkward to use and they were not based on a clear, coherent theory (Fisher & Fraser, 1990). Over thirty years ago two researchers, Herbert Walberg and Rudolf Moos, began independent studies on educational environments. Walberg developed the *Learning Environment Inv*entory (LEI) while Moos developed social climate scales, one of which was the *Classroom Environment Scale* (CES) (Fraser & Wubbels, 1995). In essence, these instruments investigated three dimensions. Firstly, the relationships created and applied within the environment, secondly, the personal development and growth the environment either encouraged or discouraged and finally, the systems used to monitor or control the environment (Moos, 1979). Subsequent research of educational environments can be seen to have been built upon ideas first developed by Kurt Lewin and Henry Murray and their followers C. Robert Pace and George Stern (Fraser, 1998b). The association between the learning environment variables and student outcomes has provided a rationale and focus for the application and development of learning environment instruments (Dorman, Fraser, & McRobbie, 1994; Newby & Fisher, 1997). The two instruments first developed by Walberg and Moos have spawned many new lines of research and the creation and application of many new learning environment instruments spanning many countries (Fraser, 1998a; Koul & Fisher, 2005). The field of learning environment research and the development and application of economical perceptual measures is one of robustness and growth (Fisher & Fraser, 1990; Fraser, 2001; Goh & Khine, 2002; Tobin & Fraser, 1998).

Developing the online learning environment survey

The online learning environment survey (OLLES) instrument developed was designed to capture students' perceptions of their online learning environment. Apart from demographics and background information sections, there were 7 scales, each containing 5 items, in the instrument. These scales are described in table 1 below.

Table 1: OLLES: Scales and items

Scale	Description	Sample Item
Computer Competence (CC)	Extent to which the student feels comfortable and enjoys using computers in the online environment.	I have no problems using a range of computer technologies.
Material Environment (ME)	Extent to which the computer hardware and software are adequate and user friendly.	The instructions provided to use the tools within the site are clear and precise.
Student Collaboration (SC)	Extent to which students work together, know, help, support and are friendly to each other.	I communicate regularly with other students in this course.
Tutor Support (TS)	The extent to which the tutor guides students in their learning and provides sensitive, ongoing and encouraging support.	The feedback I receive from my tutor helps me identify the things I do not understand.
Active Learning (AL)	The extent to which the computer activities support students in they're learning and provide ongoing and relevant feedback.	The feedback I receive from activities / quizzes is meaningful.
Information Design and Appeal (ID)	Extent to which class materials are clear, stimulating and visually pleasing to the student.	The material presented is visually appealing.
Reflective Thinking (RT)	Extent to which reflective activities are encouraged and how students enjoyed learning and participating in this environment.	I am satisfied with my experience of using the internet and learning online.

Soliciting participation and the response

The researcher made an e-mail approach to a number of tutors within higher educational institutions who were known to employ online learning in their courses. The e-mail contact outlined the purpose of the study, the interactions to be investigated, the anticipated time-frame, anticipated participant time commitment, assurance all data collected would remain confidential and the URL link to the OLLES form. Responses to the e-mail were mixed. Firstly, although some tutors were willing to participate, institutional ethical consent was required before they could make the form available to students. As one respondent noted, the time frame for the research would have been long-closed by the time the ethical committee granted permission. Secondly, it appeared that some tutors were under pressure from their employing institutions to increase the number of research outputs. They were using their online courses to generate data in the investigation of a number of topics and did not want their groups to be "over researched", as one reply noted. Thirdly, a number of tutors did not feel their course was sufficiently dependent on web-tools; they supplemented courses with face-to-face block sessions or regularly scheduled tutorials, and were hesitant about the quality of data participants would generate. However, a core group of tutors, based in three institutions in New Zealand and one institution in Australia, agreed to participate. The specific disciplines involved were education students studying towards a graduate diploma in information technology, midwifery nurses and sports science students studying anatomy and physiology, tourism students studying various global destinations, communication students studying writing fundamentals and entry level business students studying accountancy.

In learning environment research, the numerical size of the sample used to validate the instrument is inevitably variable. For example sample size can range from a thousand or more (Dorman, 2003; Zandvliet & Fraser, 2005), between five hundred and thousand (Walker & Fraser, 2005), between two and five hundred (Fisher, Aldridge, Fraser, & Wood, 2001; Johnson & Stevens, 2001) and less than two hundred (Elen & Clarebout, 2001). In recent studies of digital learning environments a sample size of 325 was used in the validation of a measure investigating online activities (Trinidad, Aldridge, & Fraser, 2005), a sample of 334 was used in the preliminary validation of a measure investigating features of web-based learning (Chang & Fisher, 2001) and a sample of 261 was used in investigating higher education students' perceptions of their class web-site (Siragusa, 2005). Therefore, although the response to the survey was regarded as mixed by the researcher, the 284 respondents were deemed sufficient to draw attention to potential advantages / barriers of the online learning environment and to allow tentative conclusions to be drawn about the reliability and validity of the scales and individual items used in the OLLES instrument.

The sample

The data collected contained 294 rows of responses, however 10 of the rows contained limited or no response, (i.e. at least 60% of the items were not completed). These were regarded as unsolicited responses and were deleted from the final sample. Of the 284 rows of responses remaining some items had not been completed (216 non-responses to the 15,848 identified responses) and the mean of the item was used as a substitution for the non-response. There appeared to be a significant gender bias in the sample, with 184 of the respondents being female and 100 male and this could be partially attributed to the predominance of female participants undertaking the midwifery courses. The age range of the sample was reasonably spread with 86 of the respondents being aged 24 years or below, 102 respondents being between 25-40 and 96 being above 40.

The Internet skills of the sample could be considered to be excellent with a significant majority (190) accessing the Internet on a daily basis and the entire sample accessing the Internet at least once a week. Similarly, the computer skills of the sample could be considered to be excellent with a significant majority (222) using computers on a daily basis and the entire sample using a computer at least once a week.

While a significant minority (104) of the sample accessed their course on a daily basis, a similar minority (100) could be considered as infrequent users accessing their course either weekly or monthly, This could be partially attributed to some of the courses being blended offerings (i.e. a combination of face-to-face sessions with block online activities).

Statistical procedures

In learning environment research it is common for factor analysis to be undertaken to identify and describe the pattern of co-relationships between variables, (i.e. detect structure), and to investigate the reduction of the number of variables and associated data collected. Principal Components Analysis (PCA), a technique used to transform the number of correlated variables to a smaller number of uncorrelated variables called *principle components*, is a common mathematical procedure used in factor analysis (Visual Statistics, 2006). To increase the interpretability and usefulness of the factors identified, learning environment researchers often *rotate* the axes orthogonally or obliquely. Orthogonal analytic rotation methods, in which the factor axes are kept at right angles to each other (coordinates are equal to 90 degrees), could be regarded as the most common rotational method used. The most popular appears to be Varimax rotation (Majeed, Fraser, & Aldridge, 2002; Zandvliet & Fraser, 2005) although Equimax rotation has also been used (Dorman & d'Arbon, 2001). Oblique analytic rotation methods, in which the factor axes are not kept at right angles to each other (coordinates are not equal to 90 degrees), are not as common as orthogonal methods but, when used, the most popular appears to be Oblimin rotation (Trinidad et al, 2005; Walker, 2003). As well as selecting the most appropriate factor analytical rotation technique to be used, learning environment researchers also need to clarify the factor loading used in the retention of items and scales. In learning environment research the value of factor loadings used is variable. For example, factor loadings of between 0.30 and 0.35 of items on their *a priori* scale and no other scale were acceptable in some studies (Dorman & d'Arbon, 2001; Johnson & Stevens, 2001), while other studies argued factor loadings below 0.50 were unacceptable (Walker, 2003). It appeared a large number of learning environment studies have worked within these two ranges and regarded a factor loading of 0.40 for an item on their *a priori* scale and no other scale, as acceptable (Dorman, 2003; Zandvliet & Fraser, 2005). In validating if firstly, each item within the same scale is assessing a common construct, internal consistency, and secondly, each scale within a measure is assessing a separate

construct, discriminant validity, learning environment researchers follow two common procedures. The Cronbach Alpha reliability coefficient is generally used as an index of scale internal consistency and a convenient discriminant validity index (namely, the mean correlation of a scale with other scales) is used as evidence scale measures a separate dimension distinct from the other scales in this measure.
In the analysis of data for the OLLES instrument firstly, two PCA rotational techniques, orthogonal (varimax) and oblique (oblimin), using an identified factor loading of 0.40, are employed and secondly, the internal consistency and discriminant validity of the scales is reported on.

Factor analysis

Because the OLLES instrument had been designed using a 7-scale structure, during this initial data analysis a 7-factor solution was explored. This 7-factor solution appeared to be a logical fit to the data investigated. A review of the identical scree plots and eigenvalues, generated by SYSTAT 11 in varimax and oblimin rotation, confirmed this factor solution was acceptable. Factor seven had an eigenvalue of 1.34 and, using Cattell scree test, was visually above the *factorial scree* or *debris* (StatSoft, 2003). See Figure 1 below.

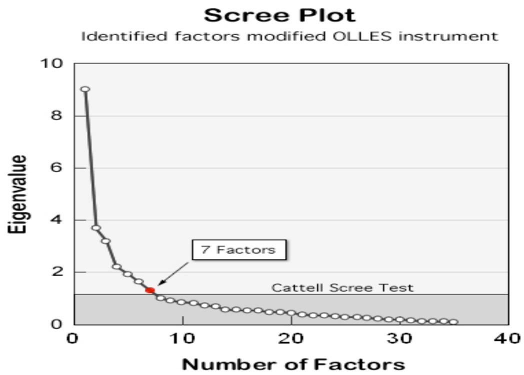

Figure 1. Scree plot for varimax and oblimin rotations of OLLES

The Principal Components Analysis undertaken confirmed, in both oblimin and varimax rotations, the 35-item OLLES instrument was structurally sound. The table below highlights only two items (M1 and TS3) in which the factor loadings show some discrepancies. M1 in the factor loadings for oblimin rotation is slightly below the threshold of 0.40 but in the varimax rotation is above this threshold. TS3 in the varimax rotation loads highly (0.46) on another factor other than its *a priori* factor, but in oblimin rotation this loading disappears (see Table 2).

The Eigenvalues and percentage of variance calculated for the instrument was, in both oblimin and varimax rotations exactly the same and these are described in the single Table 3.

The cumulative variance of all the seven scales is 65.75% and, while 34.25% of the variance remains unaccounted, this cumulative variance total is consistent with the reports of variance of other learning environment research studies (Dhindsa & Fraser, 2004; Fisher, et al, 2001; Trinidad, et al, 2005; Walker, 2003). The instrument with 35-items and 7-scales appears to provide an efficient and economical tool to measure online learning environments. However, it would be recommended further factor analysis is conducted in other studies using the OLLES instrument in order to demonstrate the findings presented here can be replicated.

Ensuring each item within the same scale is assessing a common construct and each scale within a measure is assessing a separate construct, discriminant validity and Cronbach Alpha scores are recognised measures in learning environment research. The coefficient and discriminant validity scores for the extensive field testing of the instrument are detailed in Table 4.

The alpha for the scale, Active Learning (at 0.94), could be considered to be excellent. The alpha for the scales Information Design and Appeal, Reflective Thinking, Tutor Support, Student Collaboration, Order and Organisation, and Computer Competence (all above 0.80), could be considered to be good. The remaining scale, Material Environment (alpha above 0.75), could be considered acceptable. The discriminant validity results for two of the scales, Student Collaboration and Computer Competence (all below 0.20), indicate these scales appear to be measuring distinct aspects of the learning environment. The discriminant validity results for the five remaining scales, ranging from 0.35 to 0.39, indicate the scales appear to be measuring distinct but overlapping elements of the learning environment and are considered acceptable (Koul & Fisher, 2005; Zandvliet & Fraser, 2005).

Table 2 Factor loadings (oblimin and varimax rotations) for the 35-item OLLES (N=284)

TS *Ob*	**M** **Va**	**CC** *Ob*	**Va**	**SC** *Ob*	**Va**	**AL** *Ob*	**Va**	**RT** *Ob*	**Va**	**ID** *Ob*	**Va**	**M** *Ob*	**TS** **Va**	
Ob= Oblimin Rotation				0.75	0.75					Varimax Rotation= **Va**				*SC1*
				0.70	0.71									*SC2*
				0.83	0.82	Student Collaboration (SC)								*SC3*
				0.68	0.69									*SC4*
				0.85	0.84									*SC5*
		0.83	0.83											*CC1*
		0.82	0.83											*CC2*
		0.78	0.78	Computer Competence (CC)										*CC3*
		0.72	0.74											*CC4*
		0.73	0.73											*CC5*
						0.78	0.77							*AL1*
		Active Learning (AL)				0.89	0.87							*AL2*
						0.84	0.81							*AL3*
						0.68	0.69							*AL4*
						0.85	0.83							*AL5*
0.65													0.67	*TS1*
0.73									Tutor Support (TS)				0.75	*TS2*
0.50	Tutor Support (TS)												0.55	*TS3*
0.70													0.70	*TS4*
0.72													0.71	*TS5*
	0.45			Information Design and Appeal (ID)						0.53	0.54			***ID1***
										0.71	0.71			*ID2*
										0.72	0.72			*ID3*
										0.76	0.75			*ID4*
										0.85	0.84			*ID5*
	0.43											0.37		*M1*
	0.76							Material Environment (M)				0.75		*M2*
	0.49	Material Environment (M)										0.43	**0.41**	***M3***
	0.63											0.62		*M4*
	0.75											0.74		*M5*
								0.60	0.62					*RT1*
								0.73	0.74					*RT2*
			Reflective Thinking (RT)					0.64	0.66					*RT3*
								0.82	0.80					*RT4*
								0.79	0.77					*RT5*

Ob = Oblimin Rotation **Va**= Varimax Rotation
TS=Tutor Support **CC**=Computer Competence **SC**=Student Collaboration **AL**=Active Learning **RT**=Reflective thinking
ID=Information Design and Appeal **ME**=Material Environment

Table 3: Varimax and oblimin rotation Eigenvalues and percentage of variance accounted by each factor in the modified OLLES

Factor	**Cumulative EV**	**Eigenvalue**	**% of Variance**	**Cumulative %**
1	12.92	9.01	25.75	25.75
2	17.60	3.69	10.55	36.30
3	21.84	3.18	9.09	45.39
4	24.64	2.19	6.27	51.66
5	27.05	1.94	5.55	57.20
6	29.17	1.65	4.72	61.93
7	30.85	1.34	3.82	65.75

Table 4 Internal consistency and discriminant validity scores for the OLLES

Scale	Items	Discriminant Validity	Alpha Reliability
Computer Competence	7	0.18	0.88
Material Environment	7	0.38	0.79
Student Collaboration	7	0.10	0.87
Tutor Support	7	0.39	0.89
Active Learning	7	0.37	0.94
Information Design and Appeal	7	0.35	0.89
Reflective Thinking	7	0.38	0.88

(N= 284)

Constraints and limitations

In presenting the validation and reliability results for the OLLES instrument it must be acknowledged, as (Walker, 2003) has done, the procedures explained do not exactly match those followed in previous learning environment instrument developments and validations. This is caused in part by the initial collection of data where individual's responses, but not the individuals' responses as part of an identified class group, were captured. In essence, the sample was web-based and, since responses were solicited from a potentially unlimited group, the sample was not as well-defined as with conventional samples drawn from identified class groups. In previous research, class data has been used to enrich the findings investigating the degrees of similarity and difference between two units of statistical analysis, that of the individual student and that of the class mean. Such analysis was not undertaken in this research. It must also be noted the responses were from self-selected participants with a potential affinity towards web-based/online learning environments. Those students who might not have the same affinity to web-based/online learning may have chosen not to respond. Therefore the results of the study should be treated with particular care.

However, the analysis conducted thus far is sufficient to draw tentative conclusions about the reliability and validity of the scales and individual items used in the OLLES instrument and the method of instrument administration and data collection. It would appear from preliminary analysis, the refined 7-scale, 49-item OLLES instrument will allow conclusions to be drawn about student perceptions of the interactions occurring in their online environments, in an economical and efficient manner.

Concluding comments

In the not too distant future, educational activity will no longer be constricted to or confined by text, print based materials, time or space. Educationalists will be challenged to develop appropriate strategies to deal with new information and communication technology-rich ways of teaching and learning. It appears evident those features explored in learning environment research, the perceptions of students and teachers of the environment, the social and psychological factors, will be as equally important to research in digital environments. The development, validation and refinement of a perceptual measure investigating the online learning environment is timely and can make a significant contribution to teaching, learning and research.

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