Papercode: cha01098

The Validation and Application of a New Learning Environment Instrument to Evaluate Online Learning in Higher Education

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Abstract

More and more academics are accepting the challenge of using the web-based or on-line learning in higher education to deliver coursework. Many web sites indicate that opportunities for students to receive coursework via the web is routine at most universities. The Internet/Web has become an important change agent in higher education and universities are reviewing their strategic plans to incorporate on-line learning. As a result of the increase in on-line courses, it is timely for learning environment research to focus on the Web. However, to date, no comprehensive instruments have been developed to assess on-line learning environments for higher education. A new web-based learning environment instrument is described in this paper. The Web-based Learning Environment Instrument (WEBLEI) contains four main scales. Three scales (emancipatory, co-participatory, and qualia) are built upon the work of Tobin (1998). The other scale focuses on information structure and the design of on-line material. The rationale behind, and development of, the WEBLEI are described in the paper. Statistical analyses, Cronbach alpha reliability coefficient, factor analysis, and discriminant validity, indicated that the WEBLEI is a reliable and valid instrument. The paper also reports on findings involving the perceptions of undergraduate and graduate students utilising this new instrument.

Introduction

The rise in computer literacy of users and the trend of Internet access have presented enormous challenges for universities world wide to improve outcomes and extend access to a broad range of students. Higher education now draws students from all backgrounds from all over the world and all age groups. The web represent a paradigm shift in education and it signifies an evolving change in learning style where information is shared with a wider community (Brodsky, 1998).

Given the fact that the Web is being used in an increasing number of courses and in most universities, it is desirable to conduct research into the social and psychological aspects of online learning environment and to draw from it the students' perception of online learning environment. The study described here concentrates on online learning in higher education and the effectiveness of online learning as a learning environment. This is achieved by investigating students' perceptions of this learning environment.

Learning Environments

The concept of learning environment has existed since the 1930s (Fraser, 1994, 1998; Goh & Fraser, 1998). During the last 25 years, learning environment research has been firmly established in the traditional or classroom environment particularly in the field of science education (McRobbie et al, 1998, Tobin & Fraser, 1998) and these research has recognised that students' perceptions are important social and psychological factors in classrooms (Fraser, 1994; Fraser, 1998). Fraser (1998) collated and explained a list of nine learning environment instruments developed over the last two decades. These instruments were mainly used in the assessment and investigation of classroom environments in primary and secondary schools (Fraser, 1998).

In recent times, there have been research studies into distance education environments for higher education levels. Jegede, Fraser, and Fisher (1998) developed the Distance and Open Learning Environment Scale (DOLES) for university students studying in distance education. Lately, research on learning environment has focused on the Web (Tobin, 1998). Tobin describes a framework which can be used for evaluation of learning environments in interactive environments. However, no comprehensive instruments have been developed to assess online learning environments for higher education.

Thus, it was decided to develop a new web-based learning environment instrument building on the work of Tobin (1998). This study is significant in that there is now a focus on the Web as a learning environment but although interest in this environment has increased in recent time (Laurillard, 1993; Reeves and Reeves, 1997; Khan, 1997; Palloff and Pratt, 1998; Tobin, 1998), there is little research and almost none at the tertiary level in the psychosocial aspects of online learning environments.

Paradigm Shift in Learning Environment

Many students see web-based learning as an opportunity for them to gain higher education without having to physically attend classes. Academics worldwide realised the attractiveness and the extent of this new learning mode. The change in the teaching and learning mode from the traditional environment to on-line environment presents a new way of teaching and learning for both the teachers and students. Most academics are comfortable with the traditional way of teaching, and students, on the other hand, understand the traditional way of learning. It is important that both academics and students understand the shift in teaching and learning if they are to change to the on-line learning environment. It is important that an analysis of the two teaching approaches be compared in order for academics to understand changes that need to be made in their methods of teaching and for students, in their way of learning.

Traditional Learning Environment

This traditional environment usually involves teaching and learning in a face-to-face classroom where knowledge is imparted by the knowledge expert, in this case, the teacher, and students are the recipient of this knowledge. Students move through the traditional education system following a set of pre-determined course material. In this environment, students are normally taught the same thing at the same time, and then assessed on how much was learned. Mandl and Reinmann-Rothmeier (1995) classified the traditional approach as a "system-mediated learning environment" which imply that the learning is primarily a passive and receptive process. Hofstetter (1997) believes that much of what happens in the traditional classroom approach was influenced by Skinner's behavioural theory. The behavioural theory according to Skinner (1968) views that learning is measured as change in an individual's behaviour. This theory focuses on modifying the learner's behaviour when knowledge is generated and the knowledge adds values to the learner's overall learning experience. According to Greeno, et al, (1996:28) "behavioural learning approach is the basis of traditional learning environments that are geared for efficiently transmitting information and basic skills to students in a well-organised manner." Arguably, the instructional basis of traditional styles of teaching relies on realist and objectivist views of knowledge (Gruba & Lynch, 1997).

Skinner (1968) believed that in order for learners to learn correctly, the learner must experience a behaviour change and this is accomplished when the learner undergoes the behavioural learning cycle. The following steps are included in this learning cycle:

1. Information is gathered and presented to the learner.
2. In order to learn, questions are asked to elicit responses from the learner.
3. Feedback is given to the learner based on the responses.
4. Positive or negative reinforcement is given for a correct or incorrect answer.

Skinner (1968) believed that for the behaviour to be effective, positive reinforcement should be given soon after step 4. To encourage learning and to give learners confidence, he prefers to avoid negative reinforcement but to repeat the learning cycle and receives positive reinforcement. According to Skinner (1968) this positive reinforcement is a source of motivation for the learner.

To learn in a higher education environment, Barnett (1990) believes that graduates should acquire declarative and procedural knowledge in their area of study. Declarative knowledge is regarded as stable and factual knowledge, whereas procedural knowledge is regarded as dynamic and it is the act of applying declarative knowledge. This procedural knowledge may include solving problems by understanding the problems at hand, critically reflecting on the problems, and making decisions based on the critical analysis of the problems. According to Norris (1989), in order to make a decision, it is necessary for a higher education student to have not only the requisite declarative, procedural, knowledge but also to incorporate Biggs' (1992) description of conditional, theoretical, and meta-theoretical knowledge.

Conditional knowledge is deemed as knowing when to exercise certain procedures and use appropriate content in the decision making process. Biggs described theoretical and meta-theoretical knowledge as a higher level of abstraction than declarative knowledge. Biggs asserted that in higher education, teachers have traditionally aimed at teaching theoretical and meta-theoretical knowledge and have found difficulty in teaching procedural and conditional knowledge effectively. One of the most widely reported studies is that of Saljo (1979) who viewed learning as acquiring information and showing a quantitative increase in knowledge. This view supports the theoretical and meta-theoretical knowledge of Biggs (1992) or Barnett's (1990) declarative knowledge.

Marton, et al (1993) consider this quantitative conception of learning as increasing one's knowledge, memorising, reproducing, and applying. However, the "applying" view of Marton et al, has the connotation of qualitative conception which involves critical thinking. According to Marton and Saljo (1976), critical thinking engages deep learning approach rather than surface learning; and this deep approach to learning lies with students' interests, their intentions to understand the material, and also to use existing knowledge to apply it in a real world situation. Ramsden (1988), however, reasons this with evidence that most graduates from universities possess little but surface declarative knowledge of their disciplines and that they do not think like experts in their fields of study. Ramsden also believes that students learning in a traditional environment acquire information from lectures and textbooks; students may be able to apply the information routinely, but do not necessarily understand it or become critical thinkers.

The ideal learning outcomes for higher education graduates should be that they are able to understand, integrate, and apply the knowledge they have learned in their discipline in the real world (Barnett, 1990). There underlies a common traditional conception of learning where declarative knowledge (knowing that) and procedural (knowing how) (Marzano, et al, 1988) is transferred into the learner's mind. Iran-Nejad (1990) mentions that these learners are assumed to be passive receptors of knowledge and the teachers are assumed to be the transmitter and presenter of knowledge to learners. However, as recognised and identified by Shuell, 1993; Dart & Clarke, 1991; Laurillard, 1993; Ramsden, 1992; Wilson, 1997, and many others, recent conceptions of learning emphasised that learners instead of being passive learners, should actively construct knowledge for themselves by selecting relevant material, reflecting and interpreting the chosen material and the constructed knowledge, and finally be able to understand and comprehend the result of the active search.

For learning to be effective, learners should take on an active role and applies the third concept of Bigg's conditional knowledge (according to Marzano, et al (1988) knowing when and why). Learners should be able to seek meaning and understand the material being studied through engaging in ways that elaborate and transform deep learning approach. Biggs (1993) identifies this as a qualitative outlook on learning. As a matter of fact, all these learning conceptions where learners ought to be active, learners ought to take an interactive role, and teachers ought to employ different teaching methods, for example, facilitate and have a student-centred approach as opposed to teacher-centred, have been the focus of on-line learning environment.

The view of the on-line learning approach, which is discussed in the next section, is one that carries all of the teaching and learning notions of a traditional environment with emphases on constructivist and cognitive perspectives.

On-Line Learning Environment

The styles of teaching and learning in an on-line environment can be characterised in a quite different manner to the traditional teaching and learning environment. On-line learning is defined as a system and process that connects learners with distributed and on-line learning materials. The learning in this environment is characterised by separation of place and time between the teacher and learner, between learners, and between learners and learning resources. In order for this on-line environment to be utilised effectively, the teaching and learning activities in this environment can be characterised as having a three way interaction: 1) one-to-one; 2) one-to-many; and 3) many to many (McDonald & Postle, 1999).

A one-to-one communication can be characterised as activities that were carried out by answering students' queries via electronic mail. Also included in this would be students seeking advice regarding their course or other matters from their teacher. A one-to-many communication can be described as activities carried out when the facilitator is guiding and facilitating students' progress through study materials, readings, and other postings. The final interaction type of many-to-many can be deemed as activities where on-going discussion are established amongst learners and the facilitator. This is shown where discussion of a particular topic takes place with the group sharing, collaborating, and cooperating with one another. This environment is seen as promoting an effective and a rich learning environment.

Many authors such as Laurillard, 1993; Bannan and Milheim, 1997; Jonassen, 1994; Dowling, 1997, have indicated that the on-line learning environment utilises the model of an integrated behaviorist or objectivist and constructivist model. It is claimed that this model offers a structured approach for basic skills or the content of the lesson (behavourist or objectivist approach) whilst the constructivist design of the course includes motivating and empowering the learner in their course of study. In order to benefit from this on-line learning environment, learners must collaborate and interact with other students and at the same time, be able to analyse, reflect, synthesise, organise, and restructure information as well as create and contribute their own ideas (Bannan & Milheim, 1997). In contrast to the behaviourist and objectivist views of traditional learning environment, the constructivist believes that the student ought to build an internal and personal interpretation and be able to construct new knowledge based on their prior knowledge and understanding of the present knowledge (Bannan & Milheim, 1997).

Another consideration of this constructivist environment involves the control of learning activities. According to Hooper and Hannafin (1991), this control of learning activities is demonstrated by students selecting and sequencing their learning activities as well as creating their own learning opportunities and satisfying their own learning needs. This approach is view as students taking control of their own learning, students being more responsible for their own learning, and thus, creating a student-centred learning environment.

As on-line learning becomes more collaborative and interactive, it is important to consider the changing roles of the teacher. A study conducted by Hiltz (1994) confirmed teachers should consider their new role in an on-line teaching environment. In an on-line environment, teachers ought to foster a sense of community among learners. This may mean that teachers need to pursue the role of a facilitator or a guide, rather than being an instructor where stringent instructions were usually given to students in a face-to-face setting. Hiltz (1994) found that there are three basic principles that a teacher must consider in order to establish and maintain a learning community, the principles are to: 1) be responsive; 2) be competent; and 3) be organised in their facilitation of student interaction. In addition, teachers were exhorted to provide frequent feedback, to encourage students to contribute, to acknowledge comments, and to periodically update and summarise reviews of discussion.

Purpose of study

The use of the Internet has created opportunities to expand learning experience beyond the traditional classroom and the Internet has become an important agent to strategic change in higher education. Whilst on-line learning is becoming more and more popular, it is the purpose of this study to investigate the effectiveness of web-based learning as a learning environment in a university setting.

This investigation will be conducted by examining students' perceptions of this learning environment. A new instrument called the Web-Based Learning Environment Instrument (WEBLEI) was developed and used to assess students' perceptions of online learning. This instrument incorporates students' usage pattern (for example, students' access, convenience of materials), students' learning attitudes (for example, students' participation and enjoyment), students' learning process (for example, level of activity and interactivity between student to student and student to lecturer) and academic factors (for example, scope, layout, presentation, and links of the web-based learning materials).

Development of the Web-Based Learning Environment Inventory (WEBLEI)

This instrument was designed to capture students' perceptions of web-based learning environments. Apart from demographics and background information sections, there are four scales in the instrument. The first three scales are adapted from Tobin's (1998) work on Connecting Communities Learning (CCL) and the final scale focuses on information structure and the design aspect of the web-based material. Each of these aspects is explained in the following section.

WEBLEI Scale I: Emancipatory Activities

Tobin (1998) listed three main categories of convenience, efficiency and autonomy for emancipatory activities.

- Convenience is achieved when students can access the learning activities at convenient times.
- Efficiency is described as not having to attend on campus classes and therefore allowed for efficient use of time.
- Autonomy is described as allowing students to decide when and how to access the curriculum. (Tobin, 1998:151)

Examples of items which are included in evaluating Emancipatory Activities are:

1. I can access the learning activities at times convenient to me.

2. I am allowed to work at my own pace to achieve learning objectives.

3. I decide when I want to learn.

WEBLEI Scale II: Co-Participatory Activities

According to Tobin (1998), *"co-participation implies the presence of a shared language which can be accessed by all participants to engage the activities of the community, with a goal of facilitating learning."* Included under the co-participatory activities are six categories of flexibility, reflection, quality, interaction, feedback and collaboration.

- Flexibility is described as allowing students to meet their goals.

- Reflection is noted as asynchronous interactions which encouraged reflective interactions.
- Quality is linked to the learning reflected in the level of activity undertaken by the students.
- Interaction is described as enabling students to interact with each other asynchronously.
- Feedback is described as the availability of feedback from students and the teacher.
- Collaboration enabled students to collaborate in a variety of activities. (Tobin, 1998:152)

The focus of this aspect is on the learning activities that the students will participate in. This includes structuring of activities in which students use their existing

knowledge to apply to the present subject and build new understandings from the present subject. This co-participatory aspect is aligned with Laurillard's (1993)

analysis of how learners 'come to know' through (1) active learning, (2) feedback, and (3) reflection.

Examples of items which are included in evaluating Co-Participatory Activities are:

1. This mode of learning enables me to interact with other students and the tutor asynchronously.

2. I communicate with other students in this subject electronically (email, bulletin boards, chat line).

3. In this learning environment, I have to be self-disciplined in order to learn.

WEBLEI Scale III: Qualia

Tobin (1998) explained qualia by describing knowledge which is considered *"as embodied in neural networks as vectors of electric charge that reflect life experiences of individuals."* According to Churchlands (1989) and Churchlands (1996) *"neural network theory conceptualises knowing in terms of electronic loadings on a matrix of neurons that tightly couples qualia and cognitive ways of knowing."*

Tobin (1998) described six categories of qualia. They are enjoyment, confidence, accomplishments, success, frustration and tedium.

- Enjoyment is associated with academic success and mastery of technology.
- Confidence is associated with successful learning and support for learning.
- Accomplishments are described as allowing student to display their course accomplishments regularly and publicly.
- Success has two dimensions - use of technology and conceptual aspects of the program.
- Frustration is associated with the use of technology and the conceptual aspects of the program.
- Tedium is associated with posting and responding to reviews on a regular basis. Tobin (1998:155)

Examples of items which are included in evaluating Qualia are:

> 1. I felt a sense of satisfaction and achievement about this learning environment.
>
> 2. I enjoy learning in this environment.
>
> 3. I could learn more in this environment.
>
> 4. I felt a sense of boredom towards the end of my course of study.

WEBLEI Scale IV: Information Structure and Design Activities

Information structure and design deals with how the web based learning materials is structured and organised, and whether the materials presented follow accepted instructional design standards, such as stating its purpose, describing its scope, incorporating interactivity, and providing a variety of formats to meet different learning styles. Included in this section are relevance and scope of content, validity of content, accuracy and balance of content, navigation, and aesthetic and affective aspects.

Examples of items which are included in evaluating information structure and design activities are:

> 1. The scope or learning objectives are clearly stated in each lesson.
>
> 2. The organisation of each lesson is easy to follow.
>
> 3. Activities are carefully planned.
>
> 4. The subject content is appropriate for delivery on the Web.
>
> 5. The material shows evidence of originality and creativity in the visual design and layout.
>
> 6. The links provided in the material are clearly visible and logical.

Rationale for WEBLEI

The rationale for selecting these four scales is represented in Diagram 1. In order to study online, it is necessary to have access (Scale I: Emancipatory) to some web-based learning material or a virtual subject. This scale is necessary to ascertain the convenience of accessing the learning activities, the efficiency in terms of accessing the learning materials at a location suitable to the student and the autonomy of accessing the learning materials at a time convenient to the student.

Once access (Scale 1) to the learning materials is established, it is vital that students would interact with one another to achieve the learning outcomes set out in the learning materials. In Scale II of co-participatory activities, students are required to participate actively, to work in a collaborative and cooperative manners with other students in order to achieve the learning outcomes.

Once students have access (Scale I) to the learning materials and that they are actively participating (Scale II) in the learning activities, students should have a good indication of how they feel (Scale III: Qualia) in using this type of learning environment. Students will be able to respond by indicating their perception of this learning environment and whether they have accomplished any learning objectives through this learning environment.

Having gone through all the learning activities, from access (Scale I) to interaction (Scale II) to response (Scale III), students should be able to determine whether they have gained (Scale IV: Results) from learning in this environment.
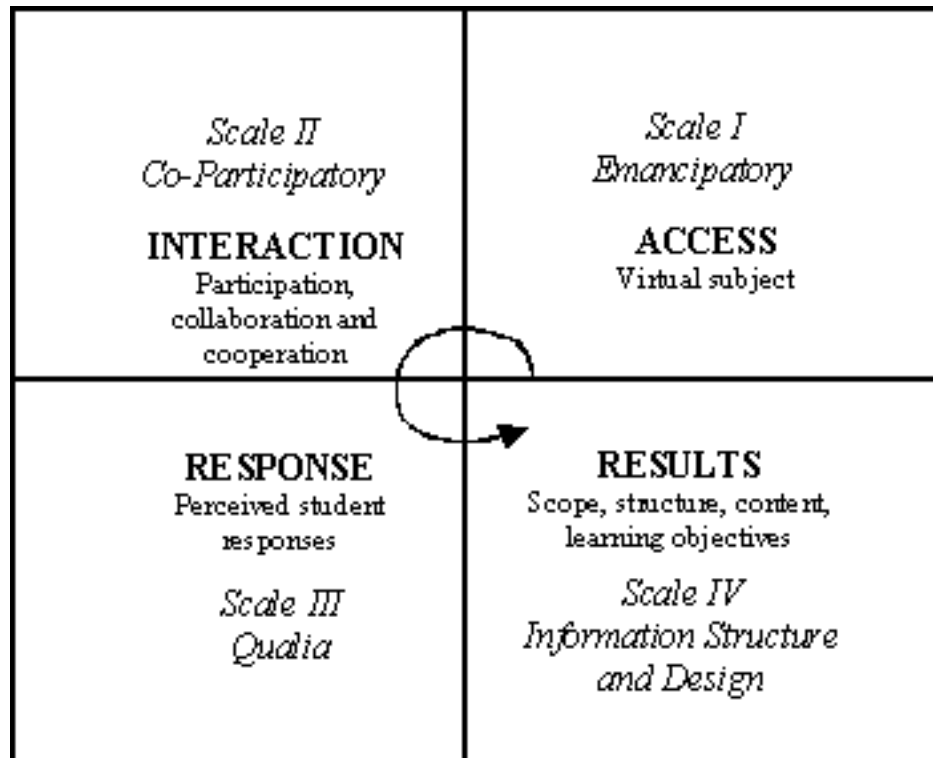
Diagram 1: Weblei scales

The Study

The WEBLEI was administered to 13 groups of undergraduate and graduate students. Six of the 13 units groups are undergraduate units and the remaining seven units are graduate units. Two of the 13 groups were administered in a Pilot study. All students were enrolled in an Electronic Commerce course that can be studied as a fully on-line unit, a face-to-face unit, or a combination of the two modes of learning. Students are required to study the unit's materials on-line during the semester and assignments are handed in electronically. This paper will report on the analysis of two units, an undergraduate and a graduate unit, starting with a general discussion on the demographic profile of the participants and followed by the result of the Weblei survey.

Demographic Profile

The demographic section of the survey involves capturing the general information of each student. Apart from this, information such as whether the students have had exposure to on-line learning before and their mode or preference of learning in an on-line environment are also obtained in this section.

From the two units, a total of 334 undergraduate and graduate students participated in the study. Of the 334 students, 255 are undergraduate, 75 are graduate students, and 4 students did not indicate whether they are undergraduate or graduate students. Table 1 shows the number of participants according to age and gender. One student did not indicate his or her age and gender. About 81.0% of the students concerned were aged less than 26.

Age / Gender	Female	Male
Less than 21	31	43
21 – 25	88	109
26 – 30	14	27
31 – 35	3	8
Greater than 35	2	6
TOTAL	138	193

Table 1: Number of students participated in the study.

Table 2 shows the number of students who were enrolled in an on-line unit for the first time. The figures in Table 2 show that majority of students (95.3%) are new to the concept of studying a unit in an on-line mode. About 73.3% of students studied in a fully on-line mode.

First On-Line Unit	Female	Male	**TOTAL**
Yes	105	150	255
No	30	41	71
Did not indicate	4	3	7

Table 2: Number of students studying on-line for the first time.

Table 3 shows the use of different access methods in studying the unit. It is obvious that the use of electronic mail (mean score of 4.14, towards *Always*) was a popular method of interacting with other students and tutors. The use of the on-line study materials with a mean of 3.69 shows an indication that the unit materials were accessed and used by most students. The use of bulletin board and remote library access was also an indication that

assistance was sought on-line. Table 3 also shows that both male and female students made similar accesses.

Gender	Cases		E-mail	Phone	Bulletin Board	Chat Line	On-line Study Materials	Remote Library
Male	193	Mean	4.10	2.85	3.21	2.73	3.75	2.82
		Std Dev	0.84	1.16	0.99	1.16	1.08	1.09
Female	139	Mean	4.19	2.75	3.18	2.62	3.60	2.90
		Std Dev	0.86	1.20	1.00	1.21	1.10	1.27
TOTAL	332	Mean	4.14	2.81	3.20	2.68	3.69	2.85
		Std Dev	0.85	1.17	0.99	1.18	1.09	1.17

Table 3: Mean and Standard Deviation of Student Access.

Table 4 shows that students spent most of their time studying at home (towards Often). This is consistent with the concept of on-line learning where students are encouraged to telecommute or to study in a virtual environment. All the other options were in the Never, Seldom and Sometimes categories. Male and female students show very similar mean scores in the place they spent time studying.

Gender	Cases		Home	Campus	Work	Library	Other
Male	193	Mean	4.07	3.09	1.53	2.88	2.17
		Std Dev	0.86	0.93	0.92	0.88	0.992
Female	138	Mean	4.16	3.15	1.247	2.70	1.97
		Std Dev	0.85	1.10	0.54	0.99	1.01
TOTAL	331	Mean	4.11	3.11	1.41	2.80	2.09
		Std Dev	0.86	1.00	0.79	0.93	1.00

Table 4: Mean and Standard Deviation of Time Spent in On-Line Unit.

Weblei Result Discussion

A factor analysis confirmed that there were indeed four scales in the WEBLEI. Table 5 provides some information about the internal consistency, using Cronbach alpha reliability coefficient, and the discriminant validity, using the mean correlation of a scale with the other scales as a convenient index, of the WEBLEI for this particular sample. The Cronbach alpha reliability coefficients presented in the table show that the figures ranged from 0.65 to 0.88. According to Nunnally (1967), a reliability coefficient of 0.60 or greater is acceptable. Therefore, the figures indicate that they are satisfactory in terms of their internal consistency. The discriminant validity shows that the mean correlations ranged from 0.38 to 0.52 indicating that the scales of the WEBLEI measure distinct although somewhat overlapping aspects of the on-line learning environment.

Aspects	Items	Cases	Validation Statistics		Descriptive Statistics	
			Alpha Reliability	Discriminant Validity	Mean	Std Dev
Scale I: Emancipatory	9	310	0.80	0.51	3.90	0.53
Scale II: Co-Participatory	8	318	0.67	0.38	3.52	0.51
Scale III: Qualia	7	318	0.65	0.48	3.38	0.53
Scale IV: Information Structure and Design	13	312	0.88	0.52	3.75	0.57

Table 5: Cronbach Alpha Reliability and Discriminant Validity (Validation Statistics) and Descriptive Statistics of the WEBLEI Questionnaire

The mean scores (as shown in Table 5) of 3.90, 3.52, 3.38, and 3.75 for these four scales respectively, indicate that on average students gave a response of 'Sometimes' to 'Often' on the items in these scales. These are a relatively high means (3.64) for the scales.

The mean score of Scale 1 of emancipatory activities of 3.90 shows that students generally agree that on-line learning environment is a convenient and efficient way of accessing the learning activities. And as such this learning environment provides them the autonomy of when and how they intend to access the learning materials.

The mean score of Scale II of co-participatory activities of 3.52 confirms not only that students must be responsible in their learning activities but other students and tutors or lecturers must also be responsible in participating and providing timely feedback. With the mean score of 3.52 which range from 'Sometimes' to 'Often', students realise that they must be self-disciplined when engaged in learning in an on-line learning environment and they must also participate and interact regularly in order to be a successful and effective learner in this environment.

Scale III of qualia has a mean score of 3.38 also shows that one must enjoy the mode of learning in order to be satisfied in the on-line environment. The result of this scale indicates that students want to feel a sense of achievement and satisfaction once they have

completed the on-line learning unit. This result confirms that the course developer must also incorporate different learning activities in order to maintain students' interest in the course of study and to ensure that students do not feel bored towards the end of the course.

The last scale, Scale IV of information structure and design activities has a mean score of 3.75 indicates that students agree that the learning objectives and organisation of the on-line materials are important in guiding them in their studies. It is imperative for course developers to know that having the unit activities planned carefully for students will assist the students in their course of study.

Conclusion

This paper has described a new instrument which assesses student perceptions of four core aspects of the Web-based learning environment, namely, emancipatory, co-participatory, qualia, and information structure and design. The study of the 37-item instrument with 334 students indicates that the concept of on-line learning is well received by these students. This is shown in the result of the alpha reliability coefficient and the overall mean of the four core aspects. The research presented here is the first part of a more extensive study. An extensive analysis involving the rest of the sample size will be reported in a doctorate thesis. The availability of this instrument will allow researchers and developers to evaluate the use of the Web as a learning environment.

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