The application of the results of learning environments research to an innovative teacher-designed website

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Abstract

For more than 30 years, proven qualitative and quantitative research methods associated with learning environments research have yielded productive results for educators. A variety of learning environment instruments has been developed over the years to gather quantitative data. The *Web-based Learning Environment Instrument* (WEBLEI) (Chang & Fisher, 2003) was developed to evaluate online learning in higher education. In this research, a modified version of the WEBLEI was used for the first time to evaluate students' perceptions of their blended web-based learning environment in a high school setting. The feedback generated through the WEBLEI was used in the development of *Getsmart* – a teacher-designed website for students studying junior science and physics at a Queensland Secondary School. Qualitative data was also gathered through written surveys and emails. The research involved more than four hundred students over a two year period. This paper presents the perceptions of these students of their learning environment and how it influenced the development of the website. The paper also presents the changes in the perceptions of a group of physics students during the course of the research. It also highlights the effectiveness of the modified version of the WEBLEI in a high school environment.

Introduction

In classrooms throughout the world, teachers design, develop and implement innovative teaching methods in order to capture students' interests and optimise their learning outcomes. Sometimes these initiatives are also undertaken to address subject related issues. But what do students think of such initiatives? In this research, web-based learning was implemented in junior science and senior physics lessons. Students' perceptions of such an environment were measured using techniques developed in the field of learning environments. These results gave an indication of the effectiveness of such an approach.

Science Education

The inability of the schooling system to meet the needs of the ever-changing human population has probably led to serious problems in school subjects such as science. According to Lowe (*Science Initial in-service materials*, 1999), science education is still based on the "Moses model", where the knowledge is conveyed by the teacher "usually male" and students are expected to memorise and regurgitate the contents. Consequently, many students view science as boring and irrelevant and have a "where will I use this" attitude. Goodrum, Hackling, and Rennie (2001) produced a comprehensive report titled *The Status and Quality of Teaching and Learning of Science in Australian Schools* on issues that related to science education. The authors of this report pointed out that on average, the actual picture of science was "disappointing" and the quality of teaching ranged from "brilliant to appalling" (p. 85). Their finding also noted that chalk and talk teaching, copying notes off the board, and cookbook type practical lessons dominated science lessons. As a result of this grim picture, enrolments in science have probably diminished significantly and according to Harrison (as cited in Roberts, 2002, p. 13); science "was in danger of becoming an optional snack in a smorgasbord of subjects". Findings such as these suggest that in order to reinvigorate student interest, science teachers need to re-think their teaching pedagogies. In this study, web-based learning was blended into junior science and physics classes in order to add variety and minimise chalk and talk teaching, copying notes off the board, and cookbook type practical lessons. Students' perceptions are important as this gives an indication of what they think of the teaching approach. In the field of learning environments, several quantitative instruments and qualitative techniques have been developed in order to effectively establish these perceptions. This research draws on some of these methods.

Learning environments

Research has shown that the learning environment is an alterable educational variable which can directly influence cognitive and affective outcomes (Wang, Haertel, & Walberg, 1993; Waxman & Huang, 1998). It is not the only variable which affects learning outcomes; nonetheless, it is a very important one. By using various reliable learning environment instruments and a variety of qualitative methods, researchers have been able to assess the perceptions of educators and learners of their learning environments. This has enabled them to "theorise teaching and learning from different vantage points" (Tobin, 1998, p. 223).

The foundations for this now flourishing field of learning environments was initially laid by two psychologists who were working independently of each other. The work of Walberg (1976) and Moos (1974) led to the development of a variety of learning environment instruments. Despite the development of several learning environment instruments over the years, the design philosophy is essentially the same. Learning environment instruments have scales and within each scale is a series of items, which help formulate student perceptions for that scale. The construct validity of each scale is determined by gathering qualitative data from the respondents.

The Web-based Learning Environment Instrument (WEBLEI)

In the past decade, computers and the Internet have become significant educational tools within the learning environment of learners. They have become important in shaping the classroom and home learning environments. Consequently the perceptions of the learners of this new variable within their learning environment are important. Research has shown that not all technology-driven interventions in learning lead to positive perceptions. For instance, Elen and Clarebout's (2001) research on an ill-structured innovation on students' instructional and epistemological beliefs suggested that not all authentic tasks in a technologically-rich learning environment generated positive perceptions amongst the participants.

The *Web-based Learning Environment Instrument* (WEBLEI) (Chang & Fisher, 1998, 2003) was used to gather data quantitatively on students' perceptions of their web-based learning environment in a tertiary environment. In the design of the WEBLEI, Chang and Fisher (1998) created four scales and the first three were adapted from Tobin's (1998) work on *Connecting Communities of Learning* (CCL). The CCL was developed by Tobin to study the perceptions of maths and science education students enrolled in an asynchronous mode.

The WEBLEI measures students' perceptions across four scales – Access, Interaction, Response, and Results. According to Chang and Fisher (1998), the first step in successfully using a web-based learning environment requires learners to effectively access the Internet. Consequently, the Access scale establishes the extent to which the variables associated with accessing this medium met student' expectations. Once the students have logged in successfully, they should be able to interact productively with their peers and their teachers. Hence, the Interaction scale explores the extent to which this is achieved from students' point of view. The Response scale gives an indication of how they felt about using a web-based medium and the Results scale gives an idea of whether they accomplished any of the learning objectives by using the learning resources accessed through this medium.

The WEBLEI was designed with a unique rationale. When Chang and Fisher (1998) developed the WEBLEI, they pointed out that scales one to four were related to each other in this sequential order. The responses to the items in the Results scale depended to a large extent on how students related to the items in scales one to three. For this reason, the Results scale of the WEBLEI is probably the most significant because it reflects students' perceptions of what they had gained through the web-based learning experience. The rationale of the design of the WEBLEI also suggested that if students did not have positive perceptions of the Access, Interaction, and Response scales, then this was most likely to effect the Results scale.

In this study, *Getsmart* – a teacher designed website was blended into physics and science lessons. Students accessed this website for notes, examples, quizzes - both in school and from their homes. These learning activities were designed for specific units of work. Once these tasks were completed, the WEBLEI was administered to the students. Qualitative data were also gathered through written surveys and emails to support the findings generated through the WEBLEI. This data was analysed and used in further development of *Getsmart.*

Method

a) The modified version of the WEBLEI

In this study, the WEBLEI was modified and used for quantitative measurements. The initial version of the WEBLEI was designed by Chang and Fisher (1998, 2003) to quantify students' perceptions of their learning environment in a higher-learning institution where the entire course was offered online. In this research, the course was offered in a blended environment to students in a high school. While in a university environment, courses were delivered through sophisticated software (e.g., *WebCT*), in a high school environment, the course was delivered by *Getsmart*- a teacher developed website. In order to address this difference in the learning environment, most of the items of the WEBLEI were either amended or changed to suit high school students. The modified version had a total of 32 items with eight items in each scale (Chandra, 2004). The total number of items and the number of items per scale were similar to those in the original version of the WEBLEI.

b) Design and development of *Getsmart*

The design of *Getsmart* paralleled the electronic cognitive apprenticeship teaching model (Collins**,** Brown, & Newman, 1989; Wang & Bonk, 2001). Within this framework a variety of learning opportunities such as modelling, coaching, scaffolding, articulation, reflection, exploration, and questioning were created through web-based lessons, tests, online chats, and interactive activities (Chandra, 2004; Chandra & Fisher, 2003).

Brooks, Nolan, and Gallagher (2001) proposed numerous features that websites should have in order to improve learning outcomes. A high degree of interaction was one of their suggestions. Features which promoted interaction included provisions for asynchronous discussion (emails and bulletin boards) and synchronous discussion (chat rooms). They suggested that websites should use:

- hypertext links to enable readers to make decisions about their reading.
- web-based assessment tools such as quizzes and tests.
- visual media such as still images and images in motion.
- a "neat" domain address to identify the website.

Janicki and Liegle (2001) developed WebTAS (*Web-Based Tutoring Authoring System*) which blended parts of instructional design theories and ideas proposed by web researchers. WebTAS incorporated features such as multiple examples and exercises, consistent design, feedback management, and tracking process capability.

The educational value of the website has to blend in with good web design principles. Issues such as the process, interface and site designs, page design, typography, editorial style, graphics, and multimedia were recognized as essential ingredients of a good website (www.webstyleguide.com). While all these ideas were acknowledged in the design of *Getsmart,* one of the key aspects which steered its development was the results gathered from the WEBLEI and qualitative data gathered through emails and written surveys.

The website was initially piloted with a group of physics students. In this interim stage, the website had fewer than 10 lessons. Notes, examples, and exercises were the only features of each page. The pilot stage was followed by Phase I and Phase II. In Phase 1, the number of features in lessons increased to five and by Phase II, the website had 14 features and 74 lessons in science and physics (Table 1).

Table 1

Features of Getsmart.

Features of *Getsmart*
Pilot Phase ➢ Lesson pages
Phase I ➢ Lesson pages with graphics ➢ Multiple choice tests ➢ Email option ➢ Links to other sites ➢ Web-based chat facility
Phase II ➢ Lesson pages with graphics ➢ Revision page(s) per unit or topic ➢ Key words list per page ➢ Some lessons had downloadable worksheets ➢ *Html* pages replaced by pages written in *asp* ➢ Multiple choice and short answers tests ➢ Email option ➢ Links to other sites ➢ Own domain name ➢ Web-based simulations, movies & experiments ➢ Password login ➢ User feedback capability ➢ Tracking login frequency and test results via a database

c) Target Audience

The website was aimed at students in years 10, 11, and 12. For this reason, the ease of use was central to its development. The lessons were designed so that they would keep students on task and could be completed within a normal school period. Each school period lasted for a maximum of 31 minutes (it generally required 3-5 minutes for students to login into the school computers). Students could also access the website outside class times including their homes.

Phase I of the study involved 261 year 10 science and 41 physics students in years 11 and 12 (Table 2). Phase II involved 54 advanced science and 50 year 12 physics students. Work in phase III is currently underway.

Table 2

Statistics on the Participants in the Research.

Year	**Group**	**Number of classes**	**Number of participants**
Phase I	Year 10 Science	9	261
	Year 11 Physics	1	25
	Year 12 Physics	1	16
Phase II	Year 10 Advanced Science	2	54
	Year 12 Physics	2	50
Total		15	406

d) Data Collection and Analysis

Once students had completed their unit of work in the blended environment, the WEBLEI and a written survey were administered. Emails were received throughout the course. All quantitative data were analysed using the *Statistical Package for the Social Sciences Version 11.0 for Windows* (SPSS) and *Microsoft Excel*. Data from the WEBLEI survey were coded and entered as 1 (*Strongly Disagree*), 2 (*Disagree*), 3 (*Neither Agree nor Disagree*), 4 (*Agree*), and 5 (*Strongly Agree*). Responses that were illegible or ignored were eliminated pair wise from the survey. Statistical measurements such as mean, median, standard deviation, Alpha Reliability, and Discriminant Validity were determined using the SPSS software. All emails and answers to written questions were read and the key points were identified in each instance. For analysis purposes, this information was then recorded on a *Microsoft Access* database. The qualitative data was then analysed by grouping the responses into categories which reflected the student responses. Web-based chat discussions were interpreted individually.

Results & Discussion

a) WEBLEI Results Phase I

The reliability analysis gives an idea of the extent to which items in the same scale of a learning environment instrument are related to each other. The Cronbach alpha reliability coefficient measures the internal consistency and is based on the average inter-item correlation. All values above 0.60 obtained through this calculation are considered to be acceptable (Nunnally, 1967). In this study, the alpha reliability coefficient for the four scales survey ranged from 0.78 to 0.86 (Chandra, 2004). The discriminant validity determines the extent to which a scale measures a unique dimension not covered by other scales in the instrument. In this study, the discriminant validity of the modified version of WEBLEI obtained ranged from 0.52 to 0.59 for the four scales (Chandra, 2004). On the basis of these results, the modified version of the WEBLEI was a valid and reliable instrument for this study.

When the WEBLEI was administered to this sample, the mean for each scale was very close to four for all scales (except for the Interaction scale where it was 3.53). All these means were slightly higher than those reported by Chang and Fisher (2003). They reported means of 3.96 for the Access scale, 3.55 for the Interaction scale, 3.37 for the Response scale and 3.72 for Results scale. In this research, means of 3.99, 3.58, 3.80, and 3.94 were obtained for the Access, Interaction, Response, and Results scales respectively (Table 3).

Table 3

Mean and Standard Deviations for the Four scales of the WEBLEI in Phase I.

WEBLEI Scales	Descriptive Statistics		
	Mean	Standard Deviation	Valid Cases
Access	3.99	0.61	208
Interaction	3.58	0.71	206
Response	3.80	0.68	209
Results	3.94	0.60	206

A mean of 3.99 (*SD* = 0.61) (Table 3) for the Access scale suggested that students agreed that their learning environment was easily accessible at locations suitable to them. It was also convenient and it enabled them to work at their own pace. A web-based environment also gave them greater autonomy in achieving their learning objectives.

The Interaction scale produced a mean of 3.58 (*SD* = 0.71), the lowest of all the scales (see Table 3). An average of three implied that students neither agreed nor disagreed with all the items in the scale. A mean of four suggested that they agreed with the statements. A mean of 3.58 suggests that there was agreement to a certain degree to the items of the Interaction scale. The responses to each item of this scale were analysed. The means and standard deviation for each item is shown in brackets.

9. I communicate with my teacher in this subject electronically via email. (*M* = 3.41, *SD* = 1.29)
10. In this learning environment, I have to be self-disciplined in order to learn. (*M* = 3.40, *SD* = 1.20)
11. I have the option to ask my teacher what I do not understand by sending an email. (*M* = 3.61, *SD* = 1.27)
12. I feel comfortable asking my teacher questions via an email. (*M* = 3.31, *SD* = 1.34)
13. The teacher responds to my emails. (*M* = 3.10, *SD* = 1.23)
14. I can ask other students what I do not understand during computer lessons. (*M* = 3.98, *SD* = 1.08)
15. Other students respond positively to questions in relation to Internet lessons. (*M* = 3.76, *SD* = 0.93)
16. I was encouraged by the positive attitude of my friends towards the Internet lessons. (*M* = 3.55, *SD* = 0.98)

From the means above, it is obvious that the items generally in relation to emails were the ones in which the students expressed the greatest uncertainty ($M \approx 3$). A mean score of 3.80 (*SD* = 0.68) was obtained for the Response scale (see Table 3) which implied that students generally agreed web-based learning was satisfying and it enabled them to interact with other students and their teachers. They also enjoyed learning in this environment and they believed that this approach held their interest in the subject for the whole term.

In the Results scale, individual items had means that ranged from 3.62 to 4.12. It was interesting to note that items 25, 26, 30, 31, and 32 had means greater than 3.80.

25. I can work out exactly what each lesson on the Internet is about. (*M* = 3.88, *SD* = 0.92)
26. The organisation of each lesson on the Internet is easy to follow. (*M* = 4.13, *SD* = 0.83)
30. The subject content is appropriate for delivery on the Internet. (*M* = 3.90, *SD* = 0.91)
31. The presentation of the subject content is clear. (*M* = 4.01, *SD* = 0.84)

32. The multiple choice test at the end of each lesson on the Internet improves my learning in this subject. (*M* = 4.01, *SD* = 1.04)

For the Results scale, Chang and Fisher (1998) reported a mean of 3.75. In this research, the mean score of 3.94 (*SD* = 0.60) suggested that students agreed they could establish the purpose of web-based lessons (see Table 3). It was also easy to follow, well sequenced, and clear. The structure kept them focussed and it helped them learn better the work that was done in class. The content was presented well and it was appropriate for delivery in a web-based learning environment. The tests at the end of the lessons, improved their understanding in the subject.

The data generated through the WEBLEI suggested that students had positive perceptions of their web-based learning environment. This was also confirmed by qualitative data gathered through student surveys and emails (Chandra, 2004).

b) WEBLEI Results Phase II

On the basis of the feedback received from students in Phase I, further improvements were carried out to the website. The aesthetics of *Getsmart* was enhanced. Other features were added. These were listed in Table 1. The WEBLEI was once again administered to students. The majority of these students had not experienced web-based learning previously. The results obtained in Phases I and II are tabulated in Table 4.

Table 4

Mean and Standard Deviation of the WEBLEI Scales for the Samples in Phases I and II.

WEBLEI Scales	Descriptive Statistics					
	Means		Standard Deviations		Valid Cases	
	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II
Access	3.99	4.11	0.61	0.48	208	75
Interaction	3.58	3.52	0.71	0.48	206	80
Response	3.80	3.65	0.68	0.66	209	74
Results	3.94	4.07	0.60	0.52	206	74

The table above (Table 4) shows that over the two years, the results obtained were comparable. For the Access scale, means of 3.99 (*SD* = 0.61) and 4.11 (*SD* = 0.48) were obtained for Phase I and Phase II respectively. For the Interaction scale, a mean of 3.58 (*SD* = 0.71) was achieved in Phase I - this fell marginally to 3.52 (*SD* = 0.48) in Phase II. Similarly, for the Response scale the mean fell from 3.80 (*SD* = 0.68) in Phase I to 3.65 (*SD* = 0.66) in Phase II. For the Results scale, the mean rose slightly in Phase II to 4.07 (*SD* = 0.52) from 3.94 (*SD* = 0.60) in Phase I. While there were some differences, none of these variations were statistically significant ($p<0.05$).

c) WEBLEI responses of the physics group

In this study, one group of physics students experienced web-based learning in both years 11 and 12. This class also had the same teacher. The WEBLEI results obtained over two years from this class are listed in Table 5.

Table 5

Descriptive Statistics of the WEBLEI Scales based on the Physics Class that Participated in Web-based Learning in Phase I and Phase II (In both years, this class had the same teacher).

WEBLEI Scales	Descriptive Statistics						
	Mean			Standard Deviation		Valid Cases	
	Phase I (1)	Phase II (2)	Difference (1) – (2)	Phase I	Phase II	Phase I	Phase II
Access	4.23	4.19	0.04	0.43	0.39	15	16
Interaction	4.09	3.61	0.48**	0.40	0.44	15	16
Response	3.96	3.73	0.23	0.39	0.43	15	16
Results	4.27	4.15	0.12	0.36	0.31	15	16

** $p<0.05$.

As shown in the table above, there was a difference in the means for each scale. However, with the exception of the Interaction scale, none of the differences were statistically significant (p<0.05). A further investigation of the items in the Interaction scale was carried out. The differences in the means of only two of these items (9 and 15) were statistically significant.

9. I communicate with my teacher in this subject electronically via email.

   ($t(29) = -4.93$, $p<0.01$)

15. Other students respond positively to questions in relation to Internet lessons.

   ($t(29) = -2.70$, $p<0.05$)

The mean for Item 12, which is related to Item 9, was also revealing. The mean for this item (“I feel comfortable asking my teacher questions via an email”) decreased from 4.13 (*SD* = 0.92) in Phase I to 3.69 (*SD* = 0.70) in Phase II. Even though this change was not statistically significant ($p<0.05$), it does make it seem that in Phase I there was a higher proportion of students who felt comfortable asking questions via email than in Phase II. While it would be assumed that as students matured, their willingness to participate in discussions electronically with their teachers would be more spontaneous, this was not the case with this group.

Qualitative data gathered from this group provided some evidence on students’ perceptions towards using emails as a communication tool with teachers. They explained their reasons as follows:

I agree that I can communicate via email but prefer to have my questions answered face to face.

I didn't communicate via email because there might be a pause of one day before a response, in which case I would have already forgotten my problem.

I don't like the email all that much and if I don't understand something, I'd rather talk to someone face to face.

Conclusion

In this study, the WEBLEI (Chang & Fisher, 1998, 2003) was found to be a valuable tool in the development of *Getsmart.* It showed that the website enabled them to undertake learning activities at their own pace and convenience. It also facilitated interaction with their teachers electronically. The results also suggested that such an approach was satisfying and enjoyable. More importantly the learning activities on the website were well sequenced, easy to follow, clear, and it helped them achieve their learning objectives. This study has shown that a suitably designed website such as *Getsmart* can be blended into science and physics lessons. Such an approach adds variety and minimises chalk and talk teaching, copying notes off the board, and cookbook type practical lessons

This study has also shed light on the effectiveness of emails in blended learning environments. As discussed previously, the WEBLEI was initially designed for students at universities in off- campus environments where the interaction between learners and educators via the Internet was essential. In a blended learning, high school environment, learners are probably looking for an interactive learning environment with technology. They are looking for an opportunity to be away from the classroom momentarily and from human beings. While emails are productive for the ideal student who reviews his or her work on a daily basis, identifies problems, and forwards queries electronically to his or her teacher, very few students probably fall in this category. High schools are probably still a few years away from producing a learning culture where learners have the confidence to conduct their learning in this manner. For many, asking the teacher questions face to face in class is probably viewed as a more feasible and preferred option. Emails are obviously not the preferred method of communication as far as students are concerned in a blended learning environment. When used in a blended environment, the items of the Interaction Scale of the WEBLEI should perhaps be reworded to establish students' perceptions other types of interactions that occur in such situations.

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