Impact of Web Based Flexible Learning on Academic Performance in Information Systems

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ABSTRACT

Flexible learning environments are becoming increasingly important for the planning and delivery of information systems curricula. Despite the significance and importance of these new learning environments, little has been done to empirically assess their impact on student learning outcomes. In this paper we investigate the effectiveness of using a technology-centric flexible learning environment to teach a tertiary level introductory information systems course. The subjects for the study were students who were enrolled in two similar courses: (1) a group using traditional teaching and learning methods only, and (2) a group using a flexible learning approach incorporating extensive use of web technology. The course content, lecturer, textbook and assessment were the same for each group. The results show that the technology-centric flexible learning course provided an effective learning environment for students. However significant differences in academic performance within individual assessment items indicate that particular assessment strategies are more suited to a flexible learning context than others. Student tertiary entrance scores and computer playfulness were identified as important overall predictors of academic performance.

Keywords: IS education, flexible learning, hypermedia, computer playfulness

1. INTRODUCTION

Universities are under increasing pressure to provide responsive and relevant business education systems that produce self-reliant individuals with the ability to apply advanced problem-solving skills. These demands along with competitive pressures and reductions in educational funding are forcing many business educators to rethink delivery. Many Universities are adopting strategies centered on flexible learning and computer-based technologies. Much of the research into the use of flexible learning approaches revolves around the question of whether or not they provide a pedagogically sound foundation on which to provide educational programs. That is, do flexible learning approaches, particularly those employing the use of Internet technologies result in learning outcomes equivalent to that of traditional education. Further, do web-based flexible learning environments provide adequate reward for the extra development effort required? This paper focuses on flexible learning as an alternative to traditional teaching methods.

2. LITERATURE REVIEW

2.1 Flexible Learning

When considering flexibility, each course planner needs to identify the aspects of the program or course that will become flexible. Flexibility is generally understood to mean offering choices in the learning environment so that a course of study better meets the individual needs of students. Several aspects of the learning environment can offer flexibility including class times, course content, instructional approach, learning resources, location, technology use, entry/completion dates and communication medium (Collis *et al.* 1997). From a student's perspective, Collis (1998) identified several forms of flexibility that were of particular importance; these included location, class times, assignment completion times, course content, amount of communication required and assignments relevant to their workplace. However, in offering flexibility, educators must recognize and understand who their students are and where their experience and interests lie (Gaies 1989). Educators must also balance this autonomy with the need to provide opportunities for

stimulating learning and fostering interaction and collaboration between the students themselves and the teacher.

Flexible learning is an educational approach that uses a range of student-centered teaching and learning methods and resources (GIHE 2000). This educational approach is responsive to the needs of a diverse student population. That is, students are personally and socially motivated to achieve and learn (Taylor and Joughlin 1997). Further, the introduction of flexibility encourages greater self-reliance and the development of lifelong learning skills (Harasim *et al*. 1995). Although the use of information and telecommunications technology is not a requirement for flexible learning, it is generally seen as an important element in supporting student-centered learning and improving the quality of education (Hobbs and Judge 1992; McComb 1994; Santoro 1995). Internet technologies can be used to enhance student independence and control over access to course content and other resources. These technologies can significantly reduce the required amount of formal face-to-face contact and allow students to progress through key course milestones at different rates.

Several researchers have undertaken reviews of the surfeit of research that exists on the use of web-based technologies in teaching and learning settings. Landauer (1995) reported that many studies did not have any scientific rigor and provided little support for the claims made while Chen and Rada (1996) found only 18 experimental studies of note. Analyses conducted in both studies revealed little advantage for web technologies over other media in general information tasks. A more recent analysis conducted by Dillon and Gabbard (1998) extended Landauer's work into the learning domain and attempted to provide a baseline review of experimental findings on the quantitative effects of hypertext/hypermedia on learning outcomes. Dillon and Gabbard found that the use of hypermedia did not lead directly to significant gains in comprehension, nor do media characteristics or interface features impact gains.

One interesting point revealed in the literature is that low-ability learners benefit from the use of hypermedia and that the high-ability learners are seemingly indifferent. This suggests that hypermedia learning environments should be designed with low-ability students in mind. While the research tends to support the contention that web-based technologies have potential for supporting an effective teaching and learning environment, its use must be carefully balanced against the desired learning outcomes. Further, much of the reviewed research has focused on gains and performance improvement through the use of hypermedia, but little attention has been focused on the use of this technology for specific learning areas such as information systems. In an attempt to address this issue, this study explores the effectiveness of using web-based technology for teaching an introductory information systems course to students undertaking a business degree.

2.2 The Use of Technology in Flexible Learning

Newman (1990) proposed a framework for implementing and using technology in education. The framework consists of four steps, which are preceded by the establishment of the goals for the educational unit. Newman's framework consists of:

1) The identification of strategies that create effective teaching and learning environment;
2) Analysis of how technology can support the strategies;
3) Exploring new technologies to improve teaching and learning environments; and
4) Proposing areas for research.

The objective of any learning environment should be to ensure there are prospects for learners to develop competencies in the material being taught. Subsequent improvements must also support this goal. Strategies for creating an efficient and effective learning environment must be established to identify how computers can best support learning before the technological infrastructure required to support them can be devised. Egbert (1993) identified several strategies that can be applied to almost any classroom situation to create an effective learning environment. Egbert's strategies are:

1) Providing occasions for learners to interact;
2) Providing an authentic audience and opportunities to negotiate meaning;
3) Creating and using real tasks;
4) Promoting exposure to and production of rich language;
5) Providing learners opportunities to formulate ideas and thoughts;
6) Promoting intentional cognition;
7) Creating an atmosphere with optimal stress and anxiety; and
8) Creating a learner-centered classroom.

However, Egbert (1993) identified several benefits and limitations of these strategies when she applied them to teaching English as second language students. While Egbert focused specifically on the use of group support system software, this study employed Internet technologies, such as hypermedia, chat rooms and bulletin boards. These technologies can provide beneficial learning and teaching environments (Carter 2002; Stout, Villegas and Kim 2001; Machart and Silverthorn 2000). Hypermedia can provide opportunities for interaction and negotiation amongst learners by supporting real-time interaction (Strategies 1 and 2). Further, the technology can also support task-processes so that the users can create and use tasks that have practical applications, thus increasing knowledge (Strategies 3 and 6). Hypermedia can expose learners to a rich and varied language via a range of real-life tasks

and information from other applications (Strategy 4). Time spent on tasks is enhanced as learners can view and reply to ideas input by other students during chat sessions (Strategy 5). Hypermedia permits students to work at their own pace and in their preferred manner thereby increasing participant comfort levels and reducing stress and anxiety to an acceptable level for each student (Strategy 7). Control of the hypermedia learning environment is given to the learners (Strategy 8).

However, several potential disadvantages can also occur. Constrained social interactions may limit outcomes and the attainment of lesson goals (Strategy 1) and reduce participation (Strategies 2 and 7). Applications of real tasks may be discarded due to a student's lack of creativity or failure to perceive the relevance to external environments such as the workplace (Strategy 3). Increased comfort may promote the use of informal or common language (Strategies 4 and 7). Learners may not fully comprehend comments due to time constraints or they may be unable to obtain adequate feedback (Strategies 5 and 6). Learners who are hesitant in taking control may resort to more traditional delivery methods (Strategy 8).

3. THE STUDY

3.1 Research Model

The research question in this study is:
W*hat impact does a web-based flexible learning mode of delivery have on the academic performance of students studying information systems?*

In technology-centric flexible learning environments, a student's ability and disposition to using microcomputers should be strongly associated with academic performance. Therefore, student preferences relating to these factors must be taken into consideration when assessing flexible teaching and learning environments that are highly reliant on technology. Although learning style has been the focus of a large body of research, there does not seem to be any consensus on which measure is most appropriate (Pillay 1998). Learning styles reflect the learner's position on a continuum of traits such as holistic and analytic, verbal and spatial, reflective and impulsive or exploratory or passive. The difficulty that researchers face is that learning style cannot be isolated from personal characteristics of the learner and other influences such as prior knowledge, prior experience with higher learning environments and other aspects of learning (Biggs 1991). Several measures of learning style have been proposed including field independence/field dependence construct (Witkin *et al*. 1971), passive versus active learners (Entwistle 1981), and deep versus shallow processors (Marton and Säljö 1976). However, each measure focuses on a different aspect of the learning dimension, thus no single measure has been accepted as definitive. In contrast, the microcomputer playfulness measure is designed to incorporate a mixture of attitude, anxiety, competence and efficacy (Webster and Martocchio 1992) and is, as a consequence, a more appropriate measure than learning style. Hackbarth *et al*. (2002) studied computer playfulness and computer anxiety separately but still concluded that both constructs were significant mediators of computer experience and perceived ease of use.

3.2 Flexible Teaching and Learning Environment

Business Information Systems (BIS-F) is a first-year core course within an undergraduate business degree program and is designed to run in a flexible mode to allow students greater choice of access, presentation format, and communication methods (Campbell 2000). The course provides a teaching/learning approach that reduces the complexity of an introductory course in information systems by using a conceptual framework that organizes the knowledge needed by managers into five key modules. The material in each of the five modules (see Table 1) was covered over a period of two or more weeks.

Table 1. Five content modules used in the Business Information Systems course

Module Title	Module Description
Foundations of Information Systems	Basic information systems theories and concepts describing the operational, decision-making, and strategic roles of information systems.
Solving Business Problems with Information Systems	The systems approach in business problem solving and other techniques used to develop information systems.
Information Technology	Important concepts and managerial implications in computer hardware, software, telecommunications technologies, and database management.
Applications in Business and Management	How information systems are used to support business operations, managerial decision making and strategic advantage.
Managing Information Technology	The challenges and methods of managing information systems technologies, activities and resources.

A range of teaching methods was used to deliver core concepts in flexible mode. Teaching materials included the use of texts, workbooks, videos, computer-based interactive multimedia software, and a comprehensive course Web site. Teaching and learning activities were structured around three types of formal class: plenary or keynote presentations (large group), tutorials (small groups) and computer-laboratories (small groups). Each module was introduced by a two-hour plenary session that provided an overview of the module and an outline

of the key concepts. These sessions were also used to expand upon points covered in readings and to provide a group focal point for providing information about course administration and assessment items.

Face to face contact occurred in tutorials and computer-labs that were scheduled on alternate weeks with the students attending a two-hour tutorial in one week and a two-hour computer-lab the next. The tutorial sessions involved an hour of discussion and activities relating to the key concepts and one hour of student group discussions. The computer workshops involved hands-on computer-based activities using Microsoft Excel and Access. Students had the option of attending the computer-labs depending on their level of experience with the software applications.

The web site for BIS-F was established to support the student-centered learning approach. The web site contained information normally provided to students together with a range of learning activities and relevant support material including:

- General course information including information about the teaching team, contact information and key dates
- A course outline including aims and objectives, links to other courses within the degree, organization of the course (eg, mode of delivery), and a framework for the course
- A study chart that provided a week by week breakdown of the course content, learning activities and assessment
- Course content (the main teaching component) which provides content, learning and assessment activities
- An overview of assessment activities including topics, due dates, criteria and models
- Resources including material located on this web site, links/references to other relevant web sites, bibliographies, and information on accessing resources from the library
- Self assessment tests for each topic areas within each Module
- Frequently Asked Questions (FAQ) facility where the answers to common questions asked by the students were provided;
- Forum or chat facility through which students could interact with each other, and the teaching staff, to exchange ideas and seek help on any problems they may have encountered; and
- Noticeboard on which the lecturer could announce events of interest, the availability of assessment material, and provide feedback on assessment items.

The web page for BIS-F was divided into two distinct sections. The left–hand side of the screen provided an index of the site's contents. The index is standard across all courses taught on the campus, although the options may differ according to the requirements of each course. The right-hand side provided access to the modules and the various topics as well as the learning resources and other relevant information about the course. On entering a module, any of its topics could be opened. Learning materials were organized in a hierarchical structure with the same layout and format used for each topic. Students were able to access the site from outside the university so they could undertake learning activities at their own convenience.

Students were provided with a printed version of some of the study material available on the web site. The provision of a hard copy of this material ensured those students, who preferred not to use the technology extensively were not disadvantaged. This material included a study guide containing a course overview, general assessment details, keynote presentation schedule, workshop schedule and outline, as well as the learning activities for the semester. In order to facilitate informal interaction and enhance their learning, students were encouraged to form small study groups of up to four to five of their peers.

While the course web site provided a degree of independence and control for the students, they were also able to discuss and analyze study materials and assessment items during workshops. The workshops were run on a regular basis and, although attendance was optional, they facilitated the interaction of students with the teaching staff in a small group context. Students were set exercises that could be completed in their own time and, if problems or questions were encountered, these were then handled most effectively during the tutorial or computer-laboratory sessions. The tutorial exercises were structured to ensure appropriate coverage of the theoretical aspects of each topic in the first instance, and then the application of the theory to case examples in the second.

Students had access to teaching staff outside formal class times at regular set consultation times and at other times by appointment. E-mail access could be gained at any time with staff usually responding within a 24-hour period. Students were provided with a forum or chat facility through which they could exchange ideas and provoke creative thought although they generally preferred to use informal face-to-face study groups. The electronic noticeboard was used as a means of communication, motivation and providing feedback on assessment items.

Since students were able to download topic summaries from the web site, the focus of the lectures was in providing appropriate examples of how the theory was applied in a business environment rather than as a means of disseminating information. The students also had access to self-assessment quizzes to test and verify their understanding of each topic in the course. The only element in the course that was outside the student's control was the assessment items and the dates on which they were due. Three types of assessment were

employed to test the level of learning by students. These were Concept tests, a Group Project and an Activity Folio. Additional details on each assessment item are provided in Section 3.4.

3.3 Traditional Teaching and Learning Environment
While BIS-F was undertaken using a flexible learning approach supported by web-based technologies, its companion course, BIS-NF, was offered on another campus and used a traditional lecture and tutorial approach. Two-hour lectures were held every week during the semester. The material was covered in the same order as the chapters in the textbook. This approach was adopted to allow students to follow the textbook in a traditional, linear fashion. All lectures were independent of each other and their order of presentation was unimportant, as the information contained in each lecture did not depend on knowledge from a previous one. While the teaching and learning activities in BIS-NF were similar to those in BIS-F, the material was covered in one-hour tutorials and one-hour computer-labs each week. Due to this timing limitation, case studies were limited in size and discussion was not as in depth. Students were required to attend both a tutorial and a computer-lab each week.

Students enrolled in BIS-NF were presented with a hardcopy of the same material as the BIS-F students. Although a Web site was not provided within the BIS-NF course, students could download lecture material from a common web site provided for this purpose by the library. Neither the FAQ nor Noticeboard were available to the BIS-NF students, however they could contact the teaching staff either directly or via e-mail. The assessment for BIS-NF was the same as BIS-F.

3.4 Comparison of the Two Courses
Table 2 shows the differences and similarities between each module of BIS-F and BIS-NF. The content in BIS-F was taught using a modular format while a traditional linear approach was used for BIS-NF. Further, the two-hour workshops and computer labs for BIS-F were alternated weekly whereas in BIS-NF they were held each week but each was only for one hour. Both versions of the course were taught by the same lecturer and within the same semester. Further, the same textbooks were used in both courses.

The assessment strategies used for BIS-F were also used for BIS-NF. Concept Tests, a Group Project and an Activity Folio assessed student learning in three ways. Two Concept Tests consisting of multiple-choice, true-false and fill-in-the-blank type questions were scheduled during the semester. The tests were offered in Weeks 7 and 13. The group project consisted of a business case for which the students had to analyze, design and implement an information system. The project was submitted in two parts. The first part was a case analysis which was due in Week 8, while the second part was due in Week 12 and followed on from the case analysis and required the use of Microsoft Excel and Microsoft Access to create an information system solution. The activity folio was designed to encourage student participation in the learning activities of the course. The folio was a record of a student's learning activities and could contain preparation for tutorials, notes taken during plenary/keynote sessions, evidence of completed computer-laboratory exercises, and additional research notes. The activity folio was submitted in two parts. The first submission covered Modules 1 and 2 and was due in Week 7, while the second submission covered the remaining three modules and was due in Week 13.

3.5 Measurement
The effectiveness of the educational approaches was evaluated by comparing the performance of students enrolled in BIS-F with that of students enrolled in BIS-NF. BIS-F was offered using a flexible learning approach that was supported by web-based technologies, while BIS-NF was offered using a traditional approach to teaching and learning. A sample of 119 and 203 students studying BIS-F and BIS-NF respectively participated in the study. Demographic details for the students are provided in Table 3. Participation in the study was entirely voluntary on the part of the student. All students were in their first year of study in an undergraduate business degree.

Student predisposition to interacting with microcomputers was measured using the Computer playfulness instrument which describes "*an individual's tendency to interact spontaneously, inventively and imaginatively*" with a computer (Webster and Martocchio 1992, p. 201). Microcomputer playfulness has been shown to be associated with positive outcomes in technology-centric learning environments and has been extensively tested and validated (Webster and Martocchio 1992, 1995). This instrument was selected as an alternative to learning style in an attempt to circumvent the current debate on learning styles. Students in both BIS-F and BIS-NF completed the computer playfulness instrument in the first week of the semester.

Tertiary Entrance (TE) Scores[1] were used as an indicator for a student's overall academic ability. Although TE scores represent composite measures of historical student performance across a range of areas, they provide a satisfactory rank-order indication of academic ability. Academic performance was measured

[1] The Tertiary Entrance Score is a graduated score calculated for each student after his or her secondary school studies and is used to determine suitability for University entrance. In Queensland, Australia where this study was undertaken, it is referred to as the Overall Position or OP score. The score value can range between 1 and 25 with lower score values indicating higher overall achievement in high school studies.

Table 2. Similarities and differences between the two teaching methods

Week	*BIS-F (flexible learning version) Topics and teaching format*	**BIS-NF (traditional lecture and tutorial format) Topics and teaching format**
1	Introductory Sessions: Introduction and solving problems *Two hour lecture, no computer lab no tutorial* Pages 78-90, Appendix A, A1-A2 of the textbook	Introduction to information systems in business *Two hour lecture, no computer lab and no tutorial* Chapter 1 of the textbook
2	Introductory Sessions cont. *Two hour lecture, one-hour computer lab and one-hour tutorial* Pages 78-90, Appendix A, A1-A2 of the textbook Introduction to Microsoft Excel	Fundamentals of information systems *Two hour lecture, one hour computer lab and one hour tutorial* Chapters 2 and 3 of the textbook Basic Exercises in Microsoft Excel
3	Module 1: Foundations of information systems *Two hour lecture, no computer lab and two hour tutorial* Chapters 1 and 2 of the textbook	Computer hardware *Two hour lecture, one hour computer lab and one hour tutorial* Chapter 4 of the textbook Intermediate Excel Exercises
4	Module 1 cont. *No lecture, two hour computer lab and no tutorial* Intermediate and Advanced Excel	Computer software *Two hour lecture, one hour computer lab and one hour tutorial* Chapter 5 of the textbook Advanced Excel Exercises
5	Module 2: Solving business problems with information systems *Two hour lecture, no computer lab and two hour tutorial* Chapter 3 and Appendix B of the textbook	Telecommunications *Two hour lecture, one hour computer lab and one hour tutorial* Chapter 6 of the textbook Microsoft Access Workbook – Chapters 2 & 3
6	Module 2 cont. *No lecture, two hour computer lab and no tutorial* Microsoft Access Workbook – Chapters 1, 2 & 4	Database management – *Two hour lecture, one hour computer lab and one hour tutorial* Chapter 7 of the textbook Microsoft Access Workbook – Chapter 4
7	Module 3: Information technology Concept Test conducted during lecture; *One hour lecture, no computer lab and two hour tutorial* Chapters 4, 5, 6 and 7 of the textbook	Business systems review Concept Test conducted during lecture *One hour lecture, one hour computer lab and one hour tutorial* Chapters 1-7 of the textbook Microsoft Access Workbook – Chapter 3
8	Module 3 cont. *No lecture, two hour computer lab and no tutorial* Microsoft Access Workbook – Chapters 2, 3 & 4	The Internet and e-commerce and enterprise collaboration *Two hour lecture, one hour computer lab and one hour tutorial* Chapters 8 and 9 of the textbook Microsoft Access Workbook – Chapter 5
9	Module 4: Applications in business and management *Two hour lecture, no computer lab and two hour tutorial* Chapters 8, 9, 10, 11 and 12 of the textbook	Information systems for business operations *Two hour lecture, one hour computer lab and one hour tutorial* Chapter 10 of the textbook Microsoft Access Workbook – Chapter 6
10	Module 4 cont. *No lecture, two hour computer lab and no tutorial* Microsoft Access Workbook – Chapters 3, 5 & 6	Information systems for managerial support *Two hour lecture, one hour computer lab and one hour tutorial* Chapter 11 of the textbook Microsoft Access Workbook – Chapter 6
11	Module 5: Managing information technology *Two hour lecture, no computer lab and two hour tutorial* Chapters 13, 14 and 15 of the textbook	Information systems for strategic advantage and enterprise and global management *Two hour lecture, one hour computer lab and one hour tutorial* Chapters 12 and 13 of the textbook Microsoft Access Workbook – Chapter 6
12	Module 5 cont. *Two hour computer lab and no tutorial* Microsoft Access Workbook – Chapter 6	Managing IT - Planning and implementing change and security and ethical challenges *Two hour lecture, one hour computer lab and one hour tutorial* Chapters 14 and 15 of the textbook Microsoft Access Workbook – Chapter 6
13	Course Review Concept Test conducted during lecture *One hour lecture, no computer lab and no tutorial* All Chapters of the textbook	Course Review Concept Test conducted during lecture *Two hour lecture, one hour computer lab and one hour tutorial* All Chapters of the textbook Microsoft Access Workbook – Chapter 6

Textbook: O'Brien, J.A., [1999], Management Information Systems: Managing Information Technology in the Internetworked Enterprise. 4th edition, Irwin/McGraw-Hill, Boston MA.

Workbook: Grauer, R.T. and M. Barber [1998], Exploring Microsoft Access 97. Prentice-Hall, Upper Saddle River, NJ.

by reference to the raw marks awarded to students for each assessment item. The assessment items were identical for both groups with the exception of the concept tests. While the same questions were used to test the same course material, they may not have been included in the same Concept Test, because the order in which the material was presented was different in both courses. MANCOVA was used to assess the specific relationship between the teaching and learning approach and academic performance. Computer playfulness and student TE scores were used as covariates to remove the effect of student ability and technology predisposition on performance.

Table 3. Student Demographics in Flexible and Traditional Learning Environments

Variable	Category	Traditional T&L Approach	Flexible T&L Approach
Gender	Female	100 (49.26%)	57 (47.90%)
	Male	103 (50.74%)	62 (52.10%)
Age	Average	20.6	21.1
	SD	6.0	6.4
	Range	17 - 55	17 - 49
TE Score	Average	10.0	11.6
	SD	3.0	2.9
	Range	2 - 15	3 - 20
Computer Playfulness	Average	31.2	33.4
	SD	6.9	6.8
	Range	17 - 49	10 - 48
Participants	Total (N=322)	203 (63.04%)	119 (36.96%)

4. RESULTS

Because the assessment items in both courses carried the same weights, percentages of item totals have been used in the analysis instead of raw marks. The first set of performance indicators compares the mean scores for the Concept Tests, Group Project and the Activity Folio by delivery method. The second set of indicators focuses only on the assigned grades. The means, standard deviation and range of scores for each assessment item by teaching method are shown in Table 4a whereas the distribution of grades is presented in Table 4b.

The simple comparison of the differences between the group means (Table 4a) indicate that the flexible learning student cohort did better on average in the concept test, but worse in the group project and activity folio. This view was further confirmed by multivariate analysis of covariance (see Table 5). The distribution of scores was marginally tighter for the BIS-F in the Concept Test and Activity Folio. The range of scores varied across each assessment item, with neither delivery mode outperforming the other in all instances. The distribution of grades (Table 4b) for BIS-F is tighter than in BIS-NF with clustering occurring at the Credit level. More students were awarded Distinctions and High Distinctions in BIS-NF, and there was also less Fail grades awarded.

Table 5 displays the MANCOVA output for student performance with computer playfulness and TE score treated as covariates. Of all the study variables, the TE score was the most reliable indicator of academic performance across all three types of assessment items ($p < 0.01$). The second covariate, computer playfulness, was significant in only one of the assessment items – Concept Tests ($p < 0.01$). The flexible learning and teaching method proved to be a significant factor in two of the three assessment items – Concept Tests ($p < 0.01$) and the Group Project ($p=0.57$).

5. DISCUSSION

The findings of this study provide support for the argument that web-based flexible learning can provide an effective learning environment for students. The results that are reported in Table 4 highlight some interesting issues. The Concept Tests provided ongoing evaluation of students' understanding of the concepts covered in the course. It would appear that the summary notes, self-assessment quizzes and other material contained on the Web site was beneficial for the BIS-F students and contributed to the significant result. However, the flexible approach of BIS-F was not beneficial with respect to students' performance for the Group Project. It would appear that even though the BIS-NF workshops and computer labs were only half the duration of those for BIS-F, the constant weekly exposure to the material helped the BIS-NF students to perform at a higher level.

Since the workshop was shorter in BIS-NF than in BIS-F, the case studies evaluated and discussed were necessarily shorter; therefore more could be studied. The non-significant result associated with the Activity Folio is to be expected. The folio contained a record of the students' preparation for tutorials, notes taken during plenary/keynote sessions or lectures, evidence of completed computer laboratory exercises, and additional research notes. Since the Activity Folio related to each student's own learning, the learning environment would have played an insignificant role in the determination of their performance in this item.

As expected, the students with better TE scores were able to perform well in all three of the assessment items. This reinforces the validity of TE scores as a predictor of future academic performance. In addition, students who demonstrated a higher level of computer playfulness obtained higher scores in the concept tests. While this result concurs with previous research using the computer playfulness measure (for example see Martocchio and Webster 1992), it may simply reflect student familiarity with the technology through constant use. Notwithstanding, Webster and Martocchio (1992)

Table 4a. Indicators of student performance – comparison of scores on assessment items by delivery mode

Performance Indicator	Concept Test Score (%)			Group Project Score (%)			Activity Folio Score (%)		
Delivery Mode	**BIS-F**	**BIS-NF**	**Combined**	**BIS-F**	**BIS-NF**	**Combined**	**BIS-F**	**BIS-NF**	**Combined**
Mean	20.24	18.98	19.39	32.46	34.94	34.02	13.41	14.62	14.22
Std Deviation	3.69	4.02	3.98	8.37	6.79	7.52	4.52	4.59	4.64
Count	119	203	322	119	203	322	119	203	322
Range Min	10.00	5.00	10.00	5.00	7.50	5.00	2.50	1.00	1.00
Range Max	28.00	28.00	28.00	47.50	46.00	47.50	20.00	20.00	20.00

Table 4b. Indicators of student performance – comparison of grade distribution by delivery mode

Grade Delivery Mode	Fail	Pass	Credit	Distinction	High Distinction	Overall Mean	Overall Std Deviation	Overall Range
BIS-F – #	7	38	45	21	8	66.10	12.03	24.5 - 92.5
BIS-NF – #	4	67	64	51	17	68.53	11.77	23.5 - 92.0
BIS-F – %	5.88%	31.93%	37.82%	17.65%	6.72%	-	-	-
BIS-NF – %	1.97%	33.00%	31.53%	21.12%	8.37%	-	-	-

Table 5. Multivariate analysis of covariance of the difference in student performance in flexible learning mode with computer playfulness and TE score as covariates

Source of Variation	Dependent Variable	Sum of Squares	*df*	Mean Square	F	Sig.
Corrected Model	Concept Tests	560.786	3	186.929	13.151	.000
	Group Project	1494.752	3	498.251	9.505	.000
	Activity Folio	417.815	3	139.272	6.814	.000
Intercept	Concept Tests	4154.076	1	4154.076	292.262	.000
	Group Project	13466.648	1	13466.648	256.910	.000
	Activity Folio	2601.096	1	2601.096	127.263	.000
Tertiary Entrance Score	Concept Tests	379.170	1	379.170	26.677	.000
	Group Project	1014.062	1	1014.062	19.346	.000
	Activity Folio	291.561	1	291.561	14.265	.000
Computer Playfulness Measure	Concept Tests	55.516	1	55.516	3.906	.049
	Group Project	26.197	1	26.197	.500	.480
	Activity Folio	3.078	1	3.078	.151	.698
Teaching Method	Concept Tests	212.184	1	212.184	14.928	.000
	Group Project	190.544	1	190.544	3.635	.057
	Activity Folio	47.738	1	47.738	2.336	.127

consider that users with a high level of playfulness are more motivated and are better able to react to new technologies.

5.1 Limitations of the Research

While this study provides support for the effectiveness of web-based flexible learning environments, there exist a number of limitations that reduce the reliability of our results. For example, the research design used may not have adequately controlled for other factors that might have influenced academic performance. One such factor is the importance of the skill and knowledge differences between novice and expert computer users. Since some students might have had greater experience using computers then others, our findings may not have been due solely to the learning environment treatments. Also, we have not considered the composition and dynamic of each of the participating class groups. Student performance may be dependent on the quality of the social interaction within the class and with the learning resources.

5.2 Efficiencies Evident as a Result of the Research

While not the focus of this research, efficiencies were evident for the flexible learning version of the course from the perspective of both the students and teaching staff. Although the development of the web site required a large amount of initial effort on the part of the lecturer and the flexible learning support staff, substantial benefits will accrue over time as the course is presented in subsequent semesters. The modular structure of the course and the progressive nature of the assessment items provided efficiencies to the students. That is, they were able to study and submit assessment on each module before moving on to the next. Once a module had been completed, students did not need to return to it

unless the feedback on the assessment item indicated they had not fully understood the concepts it covered. Efficiencies were also evident in that they could choose how much material to study at any one time and where that study was undertaken.

6. CONCLUSION

This study is a step towards determining the efficacy of using web-based technologies for teaching information systems. While our findings support the use of web-based technologies in flexible learning environments, student performance was not equal across all of the three assessment items. In particular, the flexible learning cohort did not perform as well on their group project item. This suggests that student networking and socialization processes might be better established in traditional learning environments where regular physical presence leads to the formation of better functioning work groups.

Further research is required to gain a better understanding of the interaction between technological and social factors, and how attitudes toward web-based flexible learning resources are developed within other university contexts. Further research is also required to determine the extent to which individual aspects of flexible learning or combinations of these aspects impact on student performance. This is especially important with respect to Concept Tests. Further research should also be undertaken to clarify whether it is the order in which content is presented rather than the flexible learning approach that has the greatest impact on performance.

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