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2011

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Publication Details

Norhayati Baharun and Anne Porter, Improving Statistical Education through a Learning Design, Proceedings of the Fourth Annual ASEARC Conference, 17-18 February 2011, University of Western Sydney, Paramatta, Australia.

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This conference paper is available at Research Online: http://ro.uow.edu.au/asearc/3

Improving Statistical Education through a Learning Design

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Abstract

This paper presents the results of a study examining the student learning experience of statistics within e-learning environment at the University of Wollongong. This study involves a cohort of 191 undergraduate students who enrolled in an Introductory Statistics subject in Autumn 2010 session. A learning design map was used within the subject e-learning site aiming at providing guidance which details out timing tasks and resources, and supports materials on week-by-week basis to students in learning the subject. The findings reveal the students gained benefits from the use of the map in helping them to learn and understand the subject; however they highlight some issues on the design of subject particularly within e-learning environment in terms of browser compatibility, file accessibility, map layout, and choices of design varieties. The paper concludes with a discussion on the needs of learning design in teaching practices and the learning of statistics and followed by suggestions for further research.

Keywords: learning experiences, learning design, e-learning environment

1. Introduction

Over the last decade, the use of Information and Communication Technology (ICT) in the higher education sector has been growing exponentially in supporting teaching and learning processes as well as providing benefits to students who can learn any subjects anytime and anywhere without limits [5]. As for teachers, the use of e-learning has created the potential to extend to new student markets, offering more flexible learning environments for students. E-learning provides the possibility of monitoring student progress and activity, as well as providing space for creating new and innovative learning resources. E-learning has much potential, but requires teacher commitment and many other resources. To benefit from this commitment means that the e-learning materials should not only be designed well and be student centred but also these resources along with adequate student support should be delivered appropriately [4]. It has been further suggested that an effective e-learning should involve high authenticity, high interactivity, and high collaboration [7].

With regards to the use of technology in teaching of statistics, it is evident that today, the use of the Internet, web-based courses, online discussions, collaborative tasks, electronic texts and associated assessment materials have changed the way statistic teachers work as well as what and how to teach [2].

There has been tremendous increase in research studies focussing on the utilization of technology in the teaching and learning of statistics over the past fifteen years. These studies span many technology tools used for many different purposes but they lead to one aim, the improvement of student learning of statistics. The focus in this study is on how to improve the effectiveness of e-learning so as to enhance learning outcomes for students. More specifically, it explores the role of Learning Designs as a means of more effectively delivering resources to students.

Learning design may be at the level of a whole subject, subject component or learning resources [1]. Learning design may be defined as a variety of ways of designing student learning experiences such as planning schedules, preparing or designing course or subject outlines and materials, determining assessment tasks, anticipating students' needs, implementing new learning strategies or modifying a previous course or subject by updating materials [9].

The study draws upon the experiences of a cohort of undergraduate students enrolling in Autumn 2010 session, of Introductory Statistics subject at the University of Wollongong. It examines the students' experiences on the subject design delivered and displayed via a learning design map integrated within e-learning site (*Blackboard Learning System*). The paper includes a description of the study method along

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with the context and setting of the study, the results and findings, and suggestions for future research.

2. Method

In Autumn 2010 session, the subject presentation was redesigned based on the Learning Design Visual Sequence (LDVS) representation [8]. This has been developed from work by Oliver and Herrington [6] which focussed on three elements for designing an effective online learning environment that are: (i) the content or resources learners interact with, (ii) the tasks or activities learners are required to perform, and (iii) the support mechanisms provided to assist learners to engage with the tasks and resources. The LDVS extension involves illustration of the chronology of tasks, resources, and supports using symbols for each of the three elements of learning design. This together with a brief textual description summarizes the aim of the tasks and describes what learners are required to do. The LDVS represents a visual summary of a learning design from the perspective of the teacher, thus this project (Learning Designs Project; www.learningdesigns.uow.edu.au) produces generic learning design resources and tools for the purpose of helping teachers who might want to use the template for the design or modification of further teaching.

In this study, the three elements were put together and displayed as a flowchart or a learning design map illustrating the teaching and learning activities on a week-by-week basis (see figure 1). The aim of the learning design map was to provide guidance to students in learning this subject through variety of learning resources. As can be seen in figure 1, the students could access to the resources by a click on the links provided within the map. The primary resources included lecture notes, Edu-stream (audio recorded lectures); the tasks i.e. laboratory work, laboratory tests, worked solutions, data sets; other specific learning resources such as video resources to support most topics and SPSS notes; and ongoing support materials i.e. learning strategies, student forum, past exams and laboratory tests, student support advisers and learning modules.

The assessment system designed in Autumn 2010 session permitted the students to sit a mix of two in-class and two take-home tests, with a pass mark of 70%. Students who did not pass a test for the first time were required to sit a second version of the test (re-test) out-of class. Students were provided with feedback on their own work in the first test and were also provided with worked solutions. The re-test completed out of class involved a different data set, for the same topic but where possible different wording and sequencing of questions were used. A mark of 70 per cent had to be obtained on the re-test, but this was now the maximum mark possible. The tests, re-tests, sample tests, worked solutions, and feedback were provided to students as links that can be accessed through the map. This assessment system was useful it allows the lecturer to identify students who are at risk early. Of particular interest were students who did not attempt a particular test on a second occasion, or did not follow up despite direct feedback as to how to correct their answers was provided. The challenges turned out to be how to identify the type of help required and how to provide it. For example some students needed to find ways to communicate what they knew.

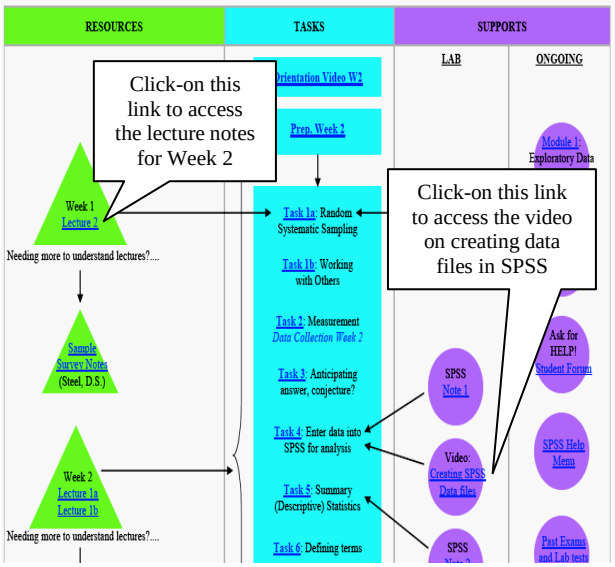

Figure 1. LDVS map for one week combining the resources, tasks and supports

A survey questionnaire was used to collect the background information on the students such as gender, their nationality either international or domestic, also included items on their expectations of the subject (anticipated grades). Other questions were on their use of the learning resources particularly the learning design map, their confidence in major topic areas, and suggestions on areas to be improved in the subject. The students were asked to complete this survey via e-learning site at the end of session (in Week 13) before their final exam.

Participants

From a cohort of 191 students, there was a large percentage of computing students (74%) enrolled in this subject. In regard to the survey, 109 students (57%) took part via the subject e-learning site. 19% of them identified themselves as being international students while the remaining 81% as domestic students. 17% of them identified themselves as females and 83% as males. In terms of grade

anticipation, 59% of them anticipated to achieve a credit or above credit at the end of session.

3. Results

Value of learning resources

In the questionnaire survey, the students were asked to rate each of the learning resources in terms of their usefulness in helping them learn and understand the subject. From previous experience, the authors expect the ratings of primary resources (lectures, assessment, laboratory tasks and worked solutions) to be high, above 80%, noting that the value of one resource changes with the improvement of another. Support resources such as student forum and other learning supports tend to be rated lower as they are not necessary learning aids for all students (see table 1).

Table 1. Rankings of learning resources in helping students to learn and understand the subject

	Moderate %	Extremely %	Total %
Worked solutions	23.4	73.0	96.4
Laboratory tests	42.3	47.7	90.0
Laboratory tasks	53.2	35.1	88.3
Lecture notes	45.5	39.1	84.6
Laboratory manual	45.9	36.9	82.8
Lecturer	56.8	24.3	81.1
Re-tests	30.3	45.9	76.2
Lectures	54.1	19.8	73.9
Tutor	38.7	33.3	72.0
Laboratory class	29.7	41.4	71.1
Learning design map	38.7	30.6	69.3
Group project	46.3	13.0	59.3
Video resources	28.8	20.7	49.5
Student forum	30.6	3.6	34.2

Specifically, the learning design map was valued high by the majority (69%) of students in helping them to learn and understand the subject. Comments indicated that some students (83%) appreciated the use of this resource because of the linking between tasks and other learning resources in the subject, the provision of references (77%), improved their ability to organize their work and update learning materials (71%), used for revision purposes (82%), and as a study checklist (62%). Examples of comments made on the use of the map were as given below.

> *"I used it to download the content as the map contained the links required"*
> *"To gauge when I needed to study for the lab tests etc as they worked out to be a week or two behind"*
> *"I used it to download the lecture notes and lab solutions and to see what parts link to where"*
> *"As a learning compass"*

However, there was room for improvement in the development of the map in the subject. Out of 83 students, a small percentage of them (17%) responded negatively (as stated below), for instance, many computing students shifted their files to another computer system and thus they dislike the multiple files used within the map.

> *"The materials were somewhat harder to access owing to browser issues, it would be useful if the files were also available without having to access the learning map, but rather to use the learning map as an alternate access/organizing method"*
> *"It seemed harder to use. I prefer the folder design that has lectures in a lectures folder etc. However I do like the fact that each week has a subheading with the topics covered in that week which makes it a lot easier to revise each individual topic.."*
> *"Technical issues make using it quite difficult. If access could be reliable I'm sure it would be good"*

On the other hand, 6% of students were positive but experienced frustration or difficulties with technical issues, for example,

> *"The flowchart was very visually appealing but some of the links did not work properly on most computers and I had trouble accessing the information, other subjects however had a less visually appealing layout but I was able to access all the information. If the links to the information worked properly then the design map was a great idea"*
> *"Quite good if it was integrated, using a pdf is not very effective as some browsers do not allow you to view the pdf's inside the browser and downloads it to your computer instead"*

Similarly, there were also positive and negative comments made by tutors as stated below.

> *"As a tutor, the weekly map identifying tasks and associated resources was extremely useful. It was an incredibly useful organizer in the lab class, allowing download of the particular task either the teacher or students wanted to be worked together"*
> *"It is better than normal teaching via e-Learning site because the teaching materials are more organized"*
> *"It was good experience using the weekly learning design map, but it was slightly worse than normal teaching via e-learning site as it needs longer time to go through the tasks"*
> *"I was a bit confused about the new structure used in the subject e-learning site, and I think the normal one was much easier to be used"*

Confidence in the subject at the end of session

An analysis of topics indicates that majority of the students were confident in most topic areas at the end of session (see table 2). However, the students might need more resources, such as video supports and better lecture notes and worked examples particularly on the topic of normal and exponential distributions.

Table 2. Student confidence in major topic areas

	Can do %	Total % (Moderately confident & Can do)
Exploratory data	50.5	86.7
Correlation and regression	32.0	81.5
Binomial and Poisson	32.0	74.7
Confidence intervals	29.5	74.3
Using SPSS	34.9	72.6
Model fitting (Goodness of Fit Test)	30.8	71.2
Hypotheses tests	24.0	68.2
Normal and exponential	16.5	58.2

Assessment

An analysis of assessment results indicated the average marks achieved by students in Test 2 (out-of-class) and Test 4 (in class) were slightly higher than the other two tests (see table 3). These results may appear to contradict the perception of confidence in some topics highlighted above as this was observed at the end of session i.e. after the assessment has been carried out.

Table 3. Assessment marks in Autumn 2010 session

	N	Average	S. deviation
Test 1 (Exploratory data)	174	5.52	1.88
Test 2 (Correlation & Regression)	159	7.87	1.79
Test 3 (Probability & Models)	160	6.74	2.10
Test 4 (Hypothesis testing)	166	7.34	2.51

Final marks and grades

The final marks revealed an average mark of 59.73 with a standard deviation of 23.82 in Autumn 2010 session. The grade distributions were: 9% of the students achieved a high distinction (HD), 18% distinction (D), 26% credit (C), 24% pass (P), 5% pass conceded (PC), and 18% fail (F) grades. With respect to failures, the rate would have been much higher had the assessment system not allowed the identification of students at risk and the subsequent work with them to have them reach the standard required.

4. Conclusions

This study was in line with [1] principles of high quality learning, that is, effective learning designs should be based on the learners' perspective as in [8], "learning arises from what students experience from an implementation of a learning design". Whilst the learning of statistics has been associated with students having difficulties in learning and poor academic outcomes [10], this study examined the potential learning design particularly the use of learning design map within e-learning system as to improve the teaching practices and the learning of statistics.

In this paper, we were able to highlight the results on the students' experiences of the subject via the learning design map on e-learning system. The students commented that they gained benefits from the use of learning design map, however this study suggests there is a need to redesign the subject particularly within e-learning environment be more interactive, easy access, multiple browsers compatibility, choices of designs variety (folders system, learning design map, webpage, concept maps, subject content timeline) and better layout.

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