Student Attitudes to Learning Business Statistics: Comparison of Online and Traditional Methods

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ABSTRACT

Worldwide, electronic learning (E-learning) has become an important part of the education agenda in the last decade. The Suan Dusit Rajabhat University (SDRU), Thailand has made significant efforts recently to use Internet technologies to enhance learning opportunities. The results reported here are part of a pioneering study to determine the effectiveness of a new online learning course in the subject "Business Statistics". This paper compares two groups of students, one studying using a traditional lecture-based approach, and the other studying using e-learning. The comparison is based on students' attitudes towards statistics measured using a validated questionnaire, both before and after the 16-week course, and for each of the modes of study. Comparisons are also made with students studying by distance, although the numbers in these groups are too small for sensible statistical analysis. The questionnaire data are augmented by material from interviews and other student reports of their experience. The results showed highly significant differences in attitudes towards statistics between the students studying online and the students using a traditional approach.

Keywords

E-learning in Thailand, Business Statistics, Online learning, Distance education, Web-based instruction

Introduction

Over the last decade, online learning or E-learning has become an important part of the education agenda around the world. Online learning uses the Internet and other information technologies to create educational experiences for students (Horton, 2001). One of the reasons for the popularity of teaching online in higher education is the advantage it affords for learning anywhere, at any place and at any time students may desire.

There is a large body of research on online learning from the years 1995–2003 that seems to conclude that there is no significant difference in learning effectiveness between technology-based and traditional methods of learning. Several studies indicated that students taking online learning courses have similar test scores as students in traditional classrooms. For instance, a review of studies carried out by Capper & Fletcher (1996); Moore & Thompson (1997); Schutte (1997); Morrissey (1998); Paskey (2001); Parker & Gemino (2001); Benbunan-Fich, et al. (2001); Tacker (2001); and Lynch (2002) comparing the effectiveness of online courses with face-to-face traditional classroom-based teaching leads to the conclusion that online education is as effective as traditional classroom teaching and shows no significant differences in learning outcomes. To put these results in context, Russell's (1999) book entitled *The no significant difference phenomenon* provides a review of 355 research reports and papers from 1928–1998 that found no significant difference in grades, satisfaction, or effectiveness among training conducted in classrooms by several types of media, ranging from postal correspondence to video tapes and E-learning (Horton 2001).

Nevertheless, studies such as Daugherty & Funke (1998), Hiltz (1994) and Jonassen (1999) found that online instruction has led to significantly better results on examinations in solving complicated problems and in perceived learning outcomes. In addition, Hiltz's (1994) studies regarding the effectiveness of online education found that mastery of course material was equal or superior to that of conventional courses. Student participation in courses increased and in general produced higher satisfaction. Students' ability to synthesize information and deal with complex problems improved and levels of interest in the content of the course increased. Hartman et al. (2000) found that in an Asynchronous Learning Network (ALN) course there were lower withdrawal rates and higher success rates. Navarro & Shoemaker (2000) found that online learners learn as well as or better than traditional learners, regardless of gender, ethnicity and academic background and computer skills.

In addition to factors concerning learning, using technology in education is seen as a means of improving productivity, efficiency and reliability. There are also other factors that combine to encourage the need for investment in education (Weller 2002). Recently, the Suan Dusit Rajabhat University (SDRU) in Thailand has encouraged the development of effective and efficient course materials for delivery through Internet technologies, in order to increase and enhance opportunities for both campus-based and distance learning. The University's goal is to become a 'Cyber Institution' in the next five years. Presently, there are two methods of teaching the Business Statistics course: either by traditional campus-based or distance learning. The traditional mode uses transparencies and textbooks for delivery of information to students based on the standard lecture approach; distance (remote) students are taught using lectures delivered via a video conferencing system, with four 3-hour sessions each semester. A preliminary investigation of current problems faced by students in the Business Statistics subject found that high failure rates required many students to repeat the subject. Most students felt that it was difficult to understand the statistical concepts and were unable to apply these concepts to the real world. If students missed lectures, their understanding seemed to be impaired when they returned to their studies. Also, in the limited lecture time, it was difficult for teachers to cover all the topics that they felt were important. The major problems with distance learning using the video conferencing system were that students could not always attend during broadcast times, and there was a lack of interaction between teachers and students. Students could not ask questions when they had problems during lectures, because the communication was only one-way. Essentially, they have to study by themselves based on the input from videos and their text book. Overall, these factors result in high failure rates and negative attitudes towards this subject.

The unsatisfactory experience with Business Statistics highlighted the need for a new teaching strategy to improve its outcomes. Coinciding with the rapid expansion of the Internet as a course delivery platform, the SDRU sought to trial a pioneering study of the effectiveness of an online course in Business Statistics in Thailand.

The aims of the research reported here were to investigate a number of factors that are known to influence student learning, primarily students' attitudes towards statistics, but also including their computer literacy, current use of the Internet, educational background, and preferred learning styles and characteristics. Gal & Garfield (1997) suggest that student attitudes are very important because they can affect the extent to which students will develop useful statistical thinking skills and apply what they have learned to their life outside the classroom. It is important to assess student attitudes and beliefs regarding statistics for three major reasons: (1) their role in influencing the teaching and learning process, (2) their role in influencing student behaviour in statistics, and (3): their role in influencing whether or not students choose to pursue further studies in statistics. Gal, Ginsburg & Schau (1997) summarise this by writing: "Thus, it is incumbent upon Statistics educators to know their students' attitudes and beliefs towards statistics before, during and after taking a statistics course."

In keeping with these objectives, this paper focuses on investigating student attitudes towards Business Statistics, comparing the results from classes using online learning, traditional campus-based learning, and distance learning.

Method

Online course design

The online course was constructed and managed using Blackboard 5 (Blackboard, 2003). For more details of instructional design see Suanpang & Kalceff (2003). The four major components of the online system were contents, communications, a groups page and student tools.

Content areas

The main content areas included Announcements, Course information, Staff information, Course Documents, Assignments, Books, and External Links. The most important part was Course Documents, which contained two modules including Descriptive Statistics (Module 1) and Inferential Statistics (Module 2). A pre-test was administered before commencement of each learning module, followed by a post-test upon completion. The online course was based on an 'Electronic Classroom' learning model, engaging students in a planned series of activities via the Internet, and implementing the six 'Learning Pedagogies' as reviewed by Weller (2002). This study incorporated elements of constructivism for the content area, and used the Internet for resource-based instruction with individual and group projects; finally, collaborative learning was used when the students combined for group work. With limited time available for developing material for the online course, only lectures 1-3 (Descriptive Statistics) and 6-8 (Inferential Statistics) were included, the remainder of the course being taught as normal. 'Learning Activities' included weekly study plans, a weekly activity plan (virtual classroom discussion), and assessments. There were also individual and group projects in the online course. The individual project applied a resource-based learning approach to encourage students to use a variety of sources to develop their understanding of using Descriptive Statistics in the business world. Students had to discuss a topic in which they were interested, located from a variety of sources including the Web, discussion, books and journals. The co-operative component was implemented through a group project that required students to work as a team. Each group had to find a real world case study using Inferential Statistics in business. Online students had to participate weekly to complete their tasks with the minimum requirement being at least one hour per week.

Communication areas

Communication between students–teacher and amongst the students used both asynchronous and synchronous modes. Asynchronous communication included e-mail, discussion board and fax. Synchronous communication included roster, virtual classroom (chat), MSN, Yahoo Messenger and the telephone.

Group areas

Group areas included a Home page, Discussion Board, File exchange, Virtual Classroom, and E-mail between group members.

Student tools

The Student Area provided tools to support learning activities, including grade listings, a Digital drop box (for submitting completed work), editing facilities for Students' homepages, Course Searching, Calendar, Student personal information, setting a CD-ROM drive for sharing information, changing passwords and setting privacy options.

Participants

There were approximately 1,000 students enrolled in this subject and of these 230 volunteers participated in the research: the study was approved by the appropriate ethics committees and participating students gave informed consent. The research group was separated into two modes, namely traditional campus-based and distance learning. The sample group was divided into 6 groups: two groups with traditional campus-based teaching, two groups doing online learning, one group doing distance learning, and one group doing distance online learning. Research was conducted in two phases, consisting of an orientation period followed by the main research.

Data were collected over a period of 16 weeks and the results from online learning were then compared with those of traditional teaching. Attitude data were collected from pre- and post-study questionnaires. The purpose of the orientation phase was to introduce the online learning system and provide an example of the online course to the students; it was given to all the students enrolled in Business Statistics by electronic-based delivery (E-based). Students were given the web address for the course (http://e-learning.dusit.ac.th) and shown how to logon to the system.

Those students who volunteered to participate were arranged into classes of 40-50 students, except for the distance learning class, which had 20-30 students. Of the total 230 students, there were 112 online students and 118 traditional learning participants. The six groups were categorized as follows:

Groups 1 & 2: Online campus-based learning. These two groups used the computer facilities at the Jarunsanitwong Campus, including the computer lab and virtual library at SDRU. Group 1 had 53 participants, while Group 2 had 48. They used the same textbooks and handouts, and had the same set of midterm and final exams as Groups 3 & 4 but a different teaching method. Online students had to participate weekly to complete their tasks with the minimum requirement at least one hour per week. Communication between students and teachers was via telephone, e-mail, discussion board, and face-to-face by appointment.

Groups 3 & 4: Campus-based traditional learning. These two groups attended classes at the Jarunsanitwong Campus. The sample size in Group 3 was 61 students and Group 4 was 48 students. The two groups were taught as a normal class, which included 16 lectures in one semester. Each lecture was of 3 hours duration.

Group 5: Traditional learning by distance. This group studied at the Central Pinklao Department store in Bangkok. There were 20 students enrolled in the class, some participants being mature-age students seeking to change careers. The traditional distance education course has only 4 lectures per semester, spread over 16 weeks. Each lecture presented 3 chapters in 3 hours via a video conferencing system from the central campus, broadcasting into 7 campuses around Bangkok. Distance students had to participate in the conference class, submitting homework and sitting a final exam.

Group 6: Online learning by distance. This group studied in Nakon Nayok province. There were only 5 students enrolled in this course. The method of teaching was the same as traditional distance learning. Students got the same lectures via the video conferencing system, and had the same textbook and final exam. However, students had authorized access into the online course.

Instruments

Various questionnaires are reviewed in the literature, such as the Statistics Attitude Survey by Roberts & Saxe (1982); Statistical Anxiety Rating Scale by Cruise et al. (1985); Attitude Toward Statistics by Wise (1985); and Survey of Attitude Toward Statistics (SATS) by Schua (1995) and Dauphinee (1997). The questionnaire type decided on for this research was the SATS. The Pre-Test and Post-Test study contained 28 questions (see Appendix 1), consisting of five-point Likert scale items (1 = strongly disagree to 5 = strongly agree) measuring four aspects of students' attitudes to statistics: Affect, Cognitive competence, Value and Easiness (Schau et al. (1995) used the term Easiness, but high scores represented lower difficulty, so we have re-named the scale). As summarised in Table 1, Affect had 6 questions measuring positive and negative feeling concerning statistics; Cognitive Competence had 6 questions measuring attitudes about intellectual knowledge and skills when applied to statistics; Value had 9 questions measuring attitudes about the use, relevance and worth of statistics in personal and professional life; and Easiness had 7 questions measuring attitudes about the ease or difficulty of the statistics subject. The four subscale scores were formed by summing the item scores in Table 1 for each subscale. The scoring for the starred (*) items should be in reverse (1 becomes 5, etc.). Higher total scale scores then correspond to more positive points. Since each subscale comprised different numbers of questions, the scores were converted to a percentage scale (0–100%) using a linear transformation. Data were analysed using SPSS version 11.0.

Table 1: Questionnaire items summarised according to the aspect of student attitude surveyed.

ASPECT	QUESTION NUMBER								
Affect	1	2*	11*	14*	15	21*			
Cognitive Competence	3*	9*	20*	23	24	27*			
Value	5*	7	8	10*	12*	13	16*	19*	25*
Easiness	4	6*	17	18*	22*	26*	28*		

Results

Quantitative results

The attitude scores on the four subscales were analysed using multivariate ANOVA models. Initially, three independent variables and their interactions were studied: TIME (before and after), MODE (traditional and online) and PLACE (campus or distance). TIME, MODE and their interaction were found to be highly

significant ($p < 0.001$ in all cases). The factor PLACE was found to be marginally significant in the multivariate analysis ($p = 0.03$), but not significant for any of the component subscales. Essentially, this was due to the small numbers of students studying off-campus (25 students, 20 in the traditional mode and 5 online). As a result, we decided to present analyses from the campus-based students only.

From the multivariate results, it was found that MODE, TIME and their interaction were all significant, with $p < 0.001$ in each case. The univariate results showed that the interactions and the factors were significantly different on each dimension. A summary of results is shown graphically in Figure 1.

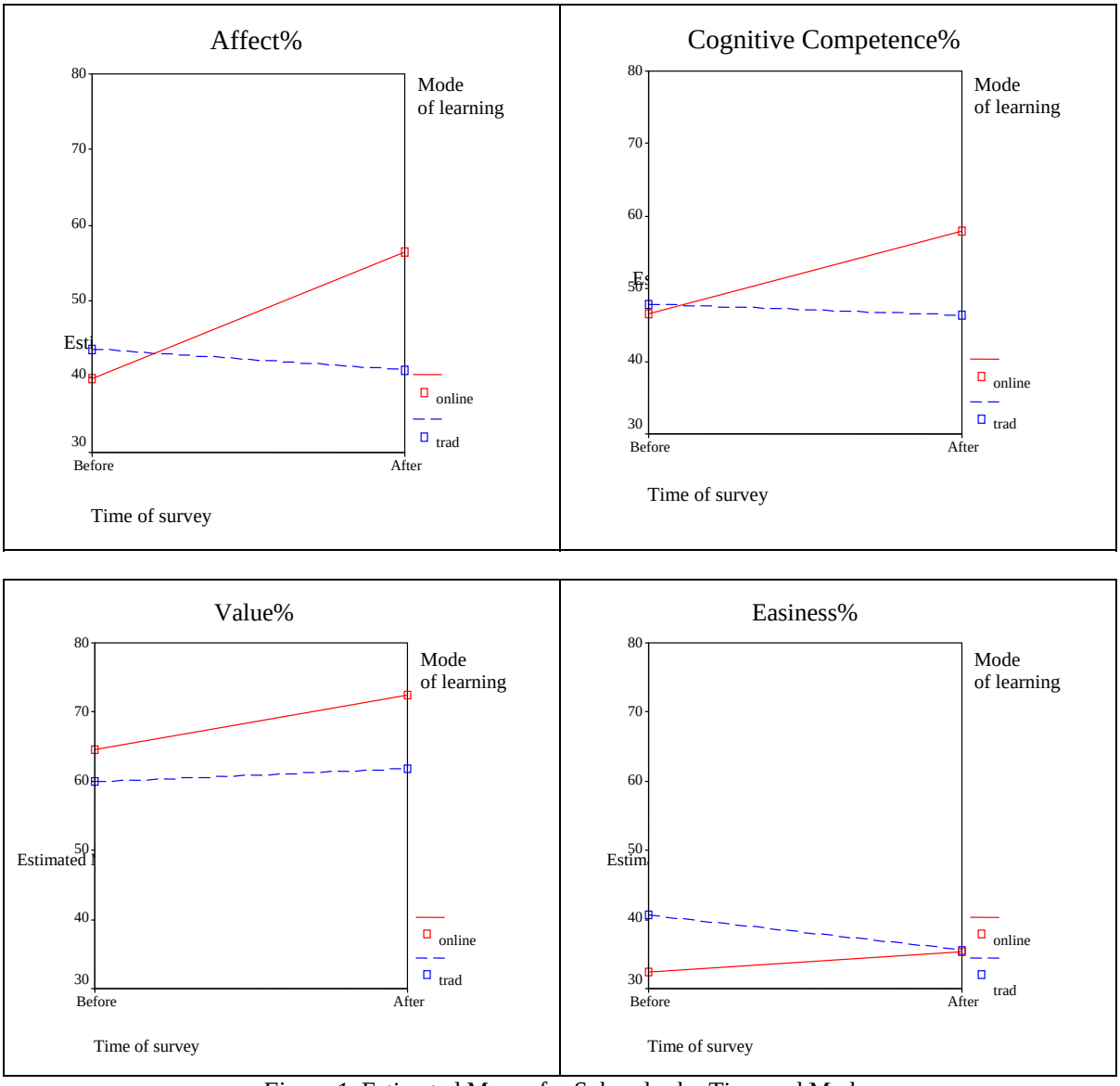

Figure 1: Estimated Means for Subscales by Time and Mode
(Campus-based Students only)

Before instruction, the means for the traditional and online groups were roughly equivalent for Affect and Cognitive Competence; the mean was higher in the online group for Value and lower for Easiness. In all four dimensions, the online group means increased significantly, while the traditional group means remained much the same, and even decreased significantly for the Easiness dimension. It seems that the online group increased the positive aspects of its view of statistics, while the traditional group stayed essentially unchanged, except for an increase in their perception that the subject was difficult. After studying this statistics course, online students had a more positive attitude, a greater ability to solve problems, a greater sense of the importance of statistics in their daily life and future work, and a greater confidence in their ability to do statistics. The traditional group, by

contrast, stayed essentially unchanged, with the exception that they viewed statistics as more difficult at the end of the course. Tables 2 and 3 show the details of the analysis.

Table 2: Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Affect%	15768.730[a]	3	5256.243	25.015	.000
	CogComp%	8225.369[b]	3	2741.790	18.466	.000
	Value%	7638.561[c]	3	2546.187	20.098	.000
	Easiness%	2191.411[d]	3	730.470	7.850	.000
Intercept	Affect%	615353.423	1	615353.423	2928.494	.000
	CogComp%	743604.281	1	743604.281	5008.222	.000
	Value%	1260975.103	1	1260975.103	9953.185	.000
	Easiness%	389811.640	1	389811.640	4189.366	.000
TIME	Affect%	3645.303	1	3645.303	17.348	.000
	CogComp%	1824.139	1	1824.139	12.286	.001
	Value%	1813.045	1	1813.045	14.311	.000
	Easiness%	79.042	1	79.042	.849	.357
MODE	Affect%	2486.052	1	2486.052	11.831	.001
	CogComp%	1935.270	1	1935.270	13.034	.000
	Value%	4357.327	1	4357.327	34.393	.000
	Easiness%	1381.769	1	1381.769	14.850	.000
TIME * MODE	Affect%	7140.641	1	7140.641	33.983	.000
	CogComp%	3118.569	1	3118.569	21.004	.000
	Value%	651.102	1	651.102	5.139	.024
	Easiness%	1183.667	1	1183.667	12.721	.000
Error	Affect%	65139.142	310	210.126		
	CogComp%	46027.780	310	148.477		
	Value%	39274.088	310	126.691		
	Easiness%	28844.847	310	93.048		
Total	Affect%	742024.000	314			
	CogComp%	845365.000	314			
	Value%	1386072.000	314			
	Easiness%	431169.000	314			
Corrected Total	Affect%	80907.873	313			
	CogComp%	54253.150	313			
	Value%	46912.650	313			
	Easiness%	31036.258	313			

a. R Squared = .195 (Adjusted R Squared = 0.187)

b. R Squared = .152 (Adjusted R Squared = 0.143)

c. R Squared = .163 (Adjusted R Squared = 0 .155)

d. R Squared = .071 (Adjusted R Squared = 0.062)

Qualitative data

Qualitative data were collected from several sources. In this paper we support our results with some quotes from the student interviews. These interviews were conducted before, during and after the study, both face-to-face and by e-mail. The interviews took place in Thai, and have been translated into English for the purposes of reporting. The results of a content analysis found that the majority of the students have positive attitudes from their experiences of learning statistics. Students' attitudes towards statistics in term of *Affect, Cognitive Competence, Value and Easiness* were changed after their study, as shown in the following examples:

Table 3: Estimated Means - Time of survey * Mode of learning

Dependent Variable	Time of survey	Mode of learning	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Affect%	1 Before	1 online	39.700	1.733	36.291	43.109
		2 trad	43.690	1.903	39.944	47.435
	2 After	1 online	56.385	1.479	53.474	59.296
		2 trad	40.911	1.528	37.905	43.918
CogComp%	1 Before	1 online	46.514	1.456	43.649	49.380
		2 trad	47.879	1.600	44.731	51.028
	2 After	1 online	57.865	1.244	55.418	60.312
		2 trad	46.367	1.284	43.839	48.894
Value%	1 Before	1 online	64.543	1.345	61.896	67.190
		2 trad	59.879	1.478	56.971	62.787
	2 After	1 online	72.385	1.149	70.125	74.646
		2 trad	61.844	1.186	59.510	64.179
Easiness%	1 Before	1 online	32.343	1.153	30.074	34.611
		2 trad	40.586	1.267	38.094	43.078
	2 After	1 online	35.281	.985	33.344	37.218
		2 trad	35.600	1.017	33.599	37.601

In terms of *Affect*, there were interesting comments on how students felt about statistics, enjoyed the course, or were stressed by and scared of statistics. For example:

> *Student 1: "This subject was fun and I really enjoyed studying it. I like to calculate statistics values that I have never done before. I could forecast some events."*
>
> *Student 2: "I spent 16 weeks learning the Business Statistics subject. I feel very happy and have good experience from learning this subject."*
>
> *Student 3: "At first, I felt that there were a lot of numbers and formulas and I might get a headache. But after a while when we had problems, the teacher and my friends helped to clarify them and taught me how to think systematically via the online and traditional class. These made me understand and remember. It was a fantastic experience and very interesting to learn. I had fun studying. Statistics is not as difficult as I thought."*

Cognitive Competence was associated with their understanding of statistics, their methods of learning such as solving equations, skill in problem solving and ability to learn. The following are some comments:

> *Student 4: "I admired everything in the course that she taught especially teaching methodology, disciplines, knowledge of statistics and the Internet. I was so proud of myself, that I could analyse a real world case study which is applicable in Business Statistics. It is not as difficult as I thought before."*
>
> *Student 5: "I am impressed with learning this subject by traditional and online modes. Especially online made me know about using computer programs that I could use in my daily life, such as EXCEL and SPSS."*
>
> *Student 6: Because of my lack of mathematics knowledge and calculation skills, I felt negative and lazy. While I was learning and doing my individual report, it was hard for me because I had no experience of searching for information from the Internet. This is the first subject for me in using Internet data searching. At first, it was hard but it was not beyond our effort, and we could use this knowledge in future. This made me understand this difficult subject, because the teacher had a good technique for teaching which made us understand this difficult subject."*

Value was associated with the importance of statistics that related to their daily life, future work, and professional job. Following are some typical comments:

> *Student 7: "Besides the knowledge of Business Statistics, I have learned how to use a computer and the online course to search and study widely. I can apply this knowledge to work for the future. I realise this subject can be learned not only from the teacher but also from all kinds of information technology that enhance efficiency and flexibility."*
>
> *Student 8: "I used to think this subject was boring and not useful. I was wrong because I can now use my knowledge in my daily life."*
>
> *Student 9: "I think it is useful for further studies, such as Master degree or we can get a good job in the future."*

Easiness measured how easy students found it to study and learn statistics and to apply the results of their studies to computation skills, and ways of thinking in statistics. Students commented on this dimension as follows:

> *Student 10: "I was so much impressed with this subject and I realized that this subject was not as difficult as people imagined."*
>
> *Student 11: "After finishing the Business Statistics course, I realised that statistics is not difficult or boring. We can understand it easily and statistics methodology can be trusted."*
>
> *Student 12: "I used to believe that statistics was extremely hard. Besides, I saw a high drop out rate in seniors. At first, I was scared to study this subject. But when I had finished it, my views changed because statistics wasn't as difficult or scary as I thought."*

In addition, there were some interesting positive comments from the online campus-based students:

> *Student 13: "For the traditional way of learning, we learned from the teacher by attending in the class regularly. When we did not understand the lesson, we could ask the teacher directly. For online learning, we studied via Internet technologies. It was convenient because we had no need to attend classes. We could study whenever we wanted and could revise lessons as much as we wanted."*
>
> *Student 14: "Learning by online technologies enhanced our knowledge, saving time and travel costs. I could learn and test by myself at home."*
>
> *Student 15: "I paid a lot of attention, such as learning in class, doing exercises and tests. I also learned by online and introduced my relatives to learn by online too. I felt that I was modern."*

There were also a small number of comments from students in the traditional groups concerning further improvements in the method of teaching and learning statistics in the future:

> *Student 16: "We had problems with understanding statistics because we do not have a good mathematics background from college. Before entering the Business Statistics course, the institution should have an intensive course so that students can have enough knowledge."*
>
> *Student 17: "Most of us were scared of statistics because we saw the high failure and drop out rates from seniors. It made us worried very much. The teacher should encourage and motivate students to study too."*
>
> *Student 18: "There should be a new way of learning statistics that is fun and more enjoyable than just sitting in the class and waiting for the lecture to end, going home, doing homework and going to exams. It was kind of boring and routine stuff because after the exam we forgot everything that we had learned. Besides, we have no idea how to apply it in daily life."*

Finally, several students from the online group commented about their experience in studying statistics in this mode as follows:

Student 1: "Although doing the report was difficult, it also gave us practice in analysing data. In the past, I did not like analytical subjects because I could not do them. Right now I can do it and I like it very much. Everything was a good experience."

Student 2: "At the beginning, I did no know how to do many things. After trying to learn with fun, I got a of knowledge and good experiences of studying online, which increased my knowledge of using computers and the Internet. I really had a good experience and my attitude to learn statistics was changed. I like statistics."

Student 18: "I like Internet technology to help me learn from a distance. I have more friends in the online course. I can revise lessons many times, as much as I can, because I am old and a slow learner. This is really good because I am too shy to ask questions in front the classes. Besides, I did not have a chance to ask questions in the video conference. Statistics online is great and fantastic. It makes me like statistics, and want to learn more and more."

Conclusion

Some important findings have emerged from the analysis, the most important being:

Significant differences were found in student attitudes towards Statistics between the different modes of learning.

Although students in the online groups had similar scores to students in the traditional groups on the four subscales at the beginning of the study, the online groups improved noticeably on each subscale, while the traditional groups tended to stay at about the same level or even scored lower by the end of the study. Online students had higher scores than traditional students at the end of the course in terms of *Affect, Cognitive Competence* and *Value*, and the *Easiness* scores were comparable. Students' attitudes toward statistics were increased positively by e-learning on all four dimensions – *Affect, Cognitive Competence, Value and Easiness.* Gal et al. (1997) explain that scores on these four attitudinal aspects vary in their interrelationships. Scores on *Affect* and *Cognitive Competence* tend to be strongly related to each other. Scores on the *Value* and *Easiness* are moderately related to those on the *Affect* and *Cognitive Competence* scales but seem not to be related to each other.

We can conclude that students taught online develop strongly positive attitudes towards learning statistics, which influence their learning and make understanding statistics easier for them than for students taught in the traditional mode. These results are supported by information from the interviews. In particular, Internet technologies assist students' learning of statistics and make the experience less frustrating, less fearful and more effective.

It could be argued from the evidence in the student interviews that the online group would have rated *Easiness* even higher at the end of the course, except for the occurrence of various computer-based problems. These included computers "hanging up", the slow speed of the Internet connection to the SDRU server, and for at least some of them, a lack of basic computer skills (such as searching for information on the Internet). Many students did not have computers at home, so they were able to study online only when they were on campus, causing occasional access problems due to insufficient numbers of computers.

No significant differences were found in students' attitude towards statistics between the different places (campus-based, distance) of learning

Although the number of students studying by distance was relatively small, we found no significant differences between attitudes of students studying on campus and those studying by distance. In all four subscales, the patterns from before to after, from online to traditional, were essentially the same for the distance students as for the campus-based students. If anything, the distance students studying in the e-learning mode were even more positive than the campus-based students, especially on the *Affect* and *Cognitive Competence* dimensions. However, due to the small numbers involved, the differences observed were not statistically significant (that is, they were reasonably consistent with chance differences).

The consequences of these findings for Suan Dusit Rajabhat University are very positive. SDRU's push to become a 'Cyber Institution' seems to be progressing in the right direction. Students in *Business Statistics* who

have studied using E-learning seem to be very positive about the experience. Their attitudes towards statistics have become more positive on each of the four dimensions measured by the survey, in contrast to the results from the traditionally taught groups, and they have made positive comments about their studies during interviews. The pattern of results is repeated for those students studying by distance education – again, the experience of learning online produces positive improvement in attitudes. SDRU could provide more computer facilities and ways of utilising information technologies to improve and expand educational opportunities to students in rural areas by distance education.

Not only has online learning improved students' attitudes towards statistics, but preliminary results (Suanpang & Petocz, Submitted) indicate that it seems also to improve the outcomes of such learning, as measured by the standard approach of looking at students' results from class work and end-of-course examinations. Of course, the finding that positive attitudes correlate with positive outcomes is not new, and is discussed in the context of statistics in Schau, et al. (1997) and Garfield & Gal (1999), who suggest that one way of improving outcomes of statistics courses is to focus on improving the affective aspects of the course.

Looking beyond the present study, it seems reasonable – although we have no direct evidence – that other statistics courses in Thailand could benefit from an online approach along the lines that we have described. Further, courses in similar "technical" areas, such as accounting or Information Technology, could be enhanced in this way, and the approach could be extended to other countries in South East Asia at a similar stage of development to Thailand. Although the Internet can play a part in learning in any subject, it may be that traditional "humanities" subjects, that rely more on face-to-face discussion and debate in traditional tutorials, would present more of a challenge in E-learning mode. Further, it seems from the comments that students made in interviews that one feature that contributed to the success of the E-learning mode was its novelty and excitement: this may not count for so much in countries such as Britain or the United States that have a longer history of Internet availability and education use.

This study has focused on students' attitudes towards statistics. Further research along these lines could examine the following questions:

- How does technology affect students' learning in Statistics?
- How does technology influence students in developing and changing their attitudes towards Statistics?
- How do students interact with Statistics using an online learning course?
- How can students' learning be improved using an online learning approach?
- What additional information can we get from qualitative research on students' experience of learning online compared to traditional approaches?

Finally, a theoretical framework should be developed for online learning of statistics that combines instructional strategies and delivery media to create positive attitudes in our students and results in the best learning outcomes.

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