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Relationship between learning outcomes and online accesses

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This paper reports on a study carried out in Thailand investigating the relationship between students' use of an e-learning system and their learning outcomes in a course on Business Statistics. The results show a clear relationship between accesses to the e-learning system, as measured by number of "hits", and outcomes, as measured by final results. While the results do not establish a direct casual connection, they indicate that under appropriate conditions a component of online study provides significant benefits to learning. In this, it contrasts with the results of recent studies that find no relationship between access and results. Quotes taken from interviews with some of the students illuminate the relationship between the online learning environment and their own learning.

Introduction

The increasing use of computers and the Internet in higher education is causing fundamental changes to many students' learning experiences. There are obvious practical, economic and administrative advantages to incorporating an online component into courses of study, or even setting up whole courses online, and these advantages alone would ensure the continuation of the trend to "e-learning". As Aggarwal and Bento (2000, p.2) write: "*The same time, same place, only some people* traditional educational environment is giving way to *anytime, anyplace and anybody* instructional models." However, for educators and students alike, the truly important questions revolve around the effects of such approaches on the quality of the learning that takes place when all or part of a course is online.

This paper reports on the results of an investigation into the relationship between students' accesses to an e-learning system and their learning outcomes. It is based on a study carried out in Thailand, a country without a long history of widespread use of online learning in higher education, in the context of a comparison between traditional and online learning (see Suanpang & Petocz, 2003a). The results from the students who were studying using an e-learning component show a clear relationship between learning outcomes, as measured by their final results, and the accesses to the e-learning system, measured simply as number of "hits". For the 84 students involved, every doubling of number of accesses corresponded to an increase in the final result of about 4%. While a causal relationship cannot be inferred from this observation, it contrasts with the results of other contemporary studies that find no relationship between accesses and results (for example, Bedgood, 2002; Hibberd *et al.*, 2003). It certainly lends support to the general thesis that, under appropriate conditions, online study provides a significant benefit to overall student learning.

Background

Research in higher education has shown that there is a strong relationship between students' perception of their learning situation, their previous learning experiences, the manner in which they understand their current learning context, the way they go about studying in that context and the role of assessment for their learning (see Biggs, 1999, for example). Prosser and Trigwell (1999) discussed learning situations that students find themselves in, and the manner in which those learning situations can either enhance or impair the outcomes of their learning. In the field of statistics education, Reid and Petocz (2002) described the need for educators to closely align core statistical components with the intended learning outcomes and the students' own aims for learning. Students' expectations of professional work - and in the context of this paper, students' expectations of using statistics in their business career - have an impact on the sorts of things that they choose to focus on when learning (Reid & Petocz, 2003).

Making an explicit connection between students' learning and their own ideas about professional work is essential to enable students to find value in that learning situation: indeed, any students, in any context, need to find value in their experiences as a student. For instance, Petocz and Reid (2003) have shown that students often expect their teachers to provide the enthusiasm for their studies. The impact of this finding is overwhelming. "Traditional" learning environments, which may include face to face lectures or tutorials, need to provide a learning situation in which students

see the value and benefit of being in the classroom: “non-traditional” learning environments, including online forms, also need to be set up in such a way that students see the value and benefit of participating. From the students’ point of view, a reasonable outcome from any course is that they have learned something that will better prepare them for their futures. From an institution’s perspective, a reasonable endpoint lies in the measurable student learning outcomes, often those that have been demonstrated through assessment tasks.

A growing body of literature has explored student learning outcomes in an online course. A crucial theme is the comparison between online courses and traditional learning methods. The majority of the studies have found that the learning outcomes have been similar for the two learning approaches. Russell (1999) reviewed 355 studies on distance education from the years 1928 to 1998. He discussed what he called the *no significant difference phenomenon*, the tendency for comparative education studies to find no statistically significant differences between educational approaches. In this review, only 40 of the 355 studies specifically included computer based instruction, since the compilation predated the rapid expansion of Internet use in education. Researchers have been continuing to conduct comparative studies, leading to the overall conclusion that an online learning course is about as effective as (but no better than) traditional classroom teaching (for example, Bradford, 1999; Johnson, 2000; Machtmes, 2000; Paker & Gemino, 2001; Paskey, 2001; Yatrakis & Simon, 2002). A compilation of relevant studies concerning technology for distance education is available on a website (International Distance Education Certification Center, 2004), although the short extracts and descriptions give only limited information about the learning contexts being compared.

Focusing on learning outcomes to determine the effectiveness of learning, several studies have concluded that there is no significant difference between online and traditional methods in terms of examination results (for example, Carey, 2000; Russell, 1999; Wade, 1999; Utts *et al.*, 2004): some reports even indicate that an online approach resulted in worse outcomes than the traditional approach (e.g. Richardson and Price, 2003). Several studies have provided useful recommendations and methods for assessing online learning. Wade (1999) included evaluation of students’ responses in threaded discussion and email for quality and clarity of writing and content of ideas expressed. Meyer (2002) suggested the use of student learning outcomes for evaluating and understanding whether and to what extent improved learning approaches have occurred. He identified two problems of relying on learning outcomes: firstly, it is difficult to quantify or reliably express what learning is desired, and secondly, the assessment methods chosen tend to shape what is being assessed.

However, learning outcomes should include content knowledge and relevant skills, but might also include higher level abilities such as synthesis and analysis, creativity and the development of new ideas of learning. Techniques of assessing outcomes could include in class tests, professional entry exams (if applicable), portfolios and simulations. Finally, in order to confirm the importance of defining and assessing outcomes, Cleary (2001) identified outcome indicators such as pass rate on examinations, improvement of critical thinking skills and writing skills.

Going beyond the comparison of online courses and traditional learning approaches, there are few studies that investigate whether the use of online materials and techniques has any effect on the quality of student learning. Two investigations which include such information are reported by Bedgood (2002) and Hibberd *et al.* (2003): in each case, the results seem to indicate that students' use of the online learning environment does not significantly improve their learning outcomes.

The study

The location of this study was Thailand, a country without a long history of using information and communications technologies (ICT) in education, but one that has recognised its importance for national and economic competitiveness (Pillay 2002). The Thai government became aware of the need for educational change, and responded by enacting the National Educational Act 1999 (Office of the National Education Commission, 1999). According to the Act, the national educational system should be based on three guiding principles: lifelong education, participation in education by all sections of society, and reform of administration management. It promotes teaching and learning innovations incorporating more active student centred learning and curriculum revision that results in a closer relation to the community and the world (Ainley *et al.*, 2003).

Online or e-learning learning became the official "technology of choice" for Thai higher education in 2001. Online education creates opportunities for universities to provide an open learning environment wherein all information and resources are accessible (Berge 1997; Matthews 1999), particularly in the concept of flexible learning using the notions of "anytime, anyplace and anybody" (Aggarwal & Bento, 2000, p.2) - any student can access online course material at any time or place. Moreover, online learning has been promoted as being a more effective mode of learning, increasing access to resources, increasing student and faculty satisfaction, and being cost effective (Bourne & Moore, 2002).

The study was conducted at Suan Dusit Rajabhat University (SDU), Bangkok, a member of a group of technological higher education institutes. Traditionally, teaching and learning in Rajabhat Institutes are arranged either through campus based or (print based) distance learning modes. Campus based teaching requires students to attend classes 20-25 hours per week. This high number of class contact hours, as well as the traditional respect for the teacher, helps to explain the general lack of independent learning activities among students. Most Thai students are used to authoritarian practice, and are willing to accept what their teacher says without any argument or question, because they see the university as a continuation of their traditional schooling in which they receive information submissively and passively (Prangpatanpon, 1996). Research from other countries in the area indicates that they share this background (see, for example, Neo, 2003). Despite this background, SDU has been fully equipped with the information technology needed to enhance its educational mission, and has encouraged the development of course materials for delivery through Internet technologies. The university's goal is to become an "e-university" within the next five years (Suan Dusit Vision and Image, 2003), to utilise IT in effective and efficient teaching and learning.

The Business Statistics subject was chosen for the prototype online course, to study the process of development and the effectiveness of the result. In its traditional form, the subject had a very high failure rate, caused in part by students' problems in catching up after missed lectures, and their difficulties in understanding the statistical concepts and applying them to the real world. This unsatisfactory experience with Business Statistics highlighted the need for a new teaching strategy to improve its outcomes.

The research project involved 269 second year students, comparing online learning (113 students) with learning in the traditional mode (156 students) over a period of 16 weeks (see more detail in Suanpang and Petocz, 2003a). The students were part of a larger group studying Business Statistics who were given information about the study. Those who volunteered to participate were randomly allocated to one of the groups: they had the opportunity to decline the allocation, although none of them actually did so. The study was approved by the appropriate ethics committees (University of Technology, Sydney and SDU), and participating students gave informed consent.

The research compared the effectiveness of using an online component in teaching as opposed to traditional teaching, measured by student learning outcomes, their satisfaction, attitude and overall experience of learning (Suanpang & Petocz, 2003a,b; Suanpang *et al.*, 2004). The traditional teaching methods used textbook and paper based materials, delivered by

face to face interaction between teacher and students. The online approach was implemented using a system of instructional design appropriate to the Thai context (Suanpang & Kalceff, 2003). The online course was developed into the "electronic classroom" type of online learning, engaging students in a planned series of activities via the Internet using the Blackboard 5 program. Using the approach described by Horton (2001), students were engaged in a pedagogy involving constructivism, resource based and collaborative learning. The language of instruction was Thai, necessitating the development of e-learning resources or the translation of existing resources from English: this aspect of the study involved significant investment of the lecturer's time. Of course, since the international language of IT is English, students were encouraged to acquire some familiarity at least with technical terms, but for the most part they did not have enough proficiency to use English language resources.

There were four major components of the online system:

1. *Contents:* About half the course, lectures 1-3 (Descriptive Statistics) and 6-8 (Inferential Statistics), were included in the online environment, the remainder of the course being taught as normal. The learning activities planned included weekly study using online materials, weekly activity in the form of virtual classroom discussion, and assessments, both individual and group. For the first assignment, each student was asked to carry out an individual project, using the web to find a topic in which they were interested and data concerning that topic. They then used methods of descriptive statistics to summarise the data and present their results in a report submitted electronically on the website.
2. *Communication:* Both asynchronous (email, discussion board) and synchronous (chat) modes of communication were possible between student-teacher and student-student. Students could make appointments for face to face meetings with the teacher.
3. *Team access:* Because online learning might develop a sense of isolation and lack of social interaction, the second assignment was designed as a collaborative team project. Groups of 3 to 5 students worked together using collaborative online tools such as file exchange, chat and email. Each group was asked to find a case study using inferential statistics in the business world. The groups reported and presented the results in their home page and in front the class.
4. *Administration:* This component provided students with tools to support their learning activities, including check grade, digital drop box, edit personal homepage, course search, calendar, student personal information, set CD drive for sharing information, and set privacy options.

Thus, the online component of the Business Statistics course was able to make a substantial contribution to diversifying the learning environment for those students who were in the online group. This contribution included course materials, online learning activities, online discussion and communication, and assessment tasks.

Results

In terms of the comparison between the two modes of learning, the study indicated that online students achieved significantly better learning outcomes in term of grades/marks and levels of satisfaction with their learning compared with students in traditional classes (Suanpang & Petocz, 2003a). For instance, the total mark for students in the online group averaged 70%, compared to 59% for the students in the traditional group. Moreover, attitudes to statistics in the online group were more positive than in the traditional group (Suanpang *et al.*, 2004), as measured by the SATS questionnaire (Gal *et al.*, 1997) and overall they seemed to have a qualitatively better experience of learning (Suanpang & Petocz, 2003b). The possible reasons for these results are discussed in the papers referred to: however, the study gave a clear demonstration of the significant benefits of using e-learning to assist and support Thai students in their study of statistics.

In this paper, the focus is on the results obtained from the online group alone. Students' survey results and comments indicated that the majority of them were using the online course for reading course materials, doing exercises, searching for information, taking quizzes and communicating with other students and the online instructor (Suanpang & Petocz, 2003a). Most of them appreciated working on the individual projects that were given in the first assignment, especially as this was their first experience of individual work using an online system. However, they were also pleased with the second group work assignment, particularly as this gave them an opportunity to share ideas and counter any feelings of isolation.

In terms of their final results, the graph in Figure 1 shows the strong relationship between the number of times they accessed the online system and the total mark that they received for the course. The curved relationship, and the fact that the total mark had a maximum of 100, suggests a transformation: a logarithm of accesses linearises the relationship, and base 2 provides a convenient interpretation in terms of "doubling of accesses". The relationship between total mark and log base 2 of access is shown in Figure 2.

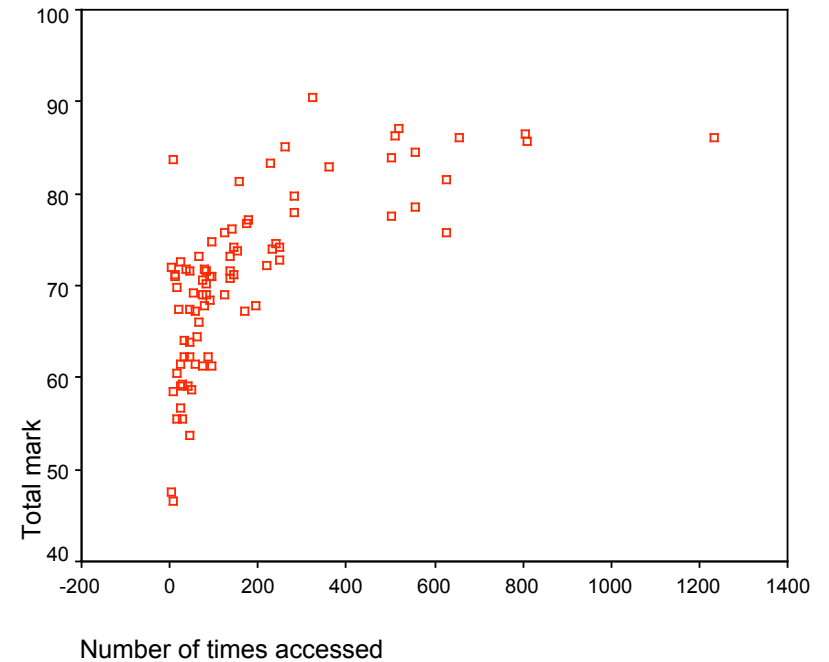


Figure 1: Total marks and number of times accessed

A linear regression model fitted to the data gave the following results:

$$\text{Total mark} = 46.4 + 3.79 \log_{\text{base } 2} \text{Access} \quad (\text{standard errors } 2.5, 0.37; \\ s = 6.3, R^2 = 0.56)$$

The residuals from the model satisfied the assumption of normality, and the regression was significant overall with $F = 102.6$ on 1 and 82 degrees of freedom, $p < 0.001$. On the other hand, the residuals were more variable for the lowest and the highest numbers of accesses (at the lower end there was one student with only 8 accesses who got a total mark of 84).

These results can be interpreted in the following way. The minimum number of accesses was 4, corresponding to an estimated final mark of 54. Each doubling of the number of accesses corresponds to an estimated final mark that is about 4 higher (actually, 3.8). At 1024 accesses ($\log = 10$), close to the highest number, the estimated final mark is 84. The increased variability at the extremes indicates that the relationship may be influenced by other factors in those situations where there were very small

or very large number of accesses, and the students' comments given later throw light on this.

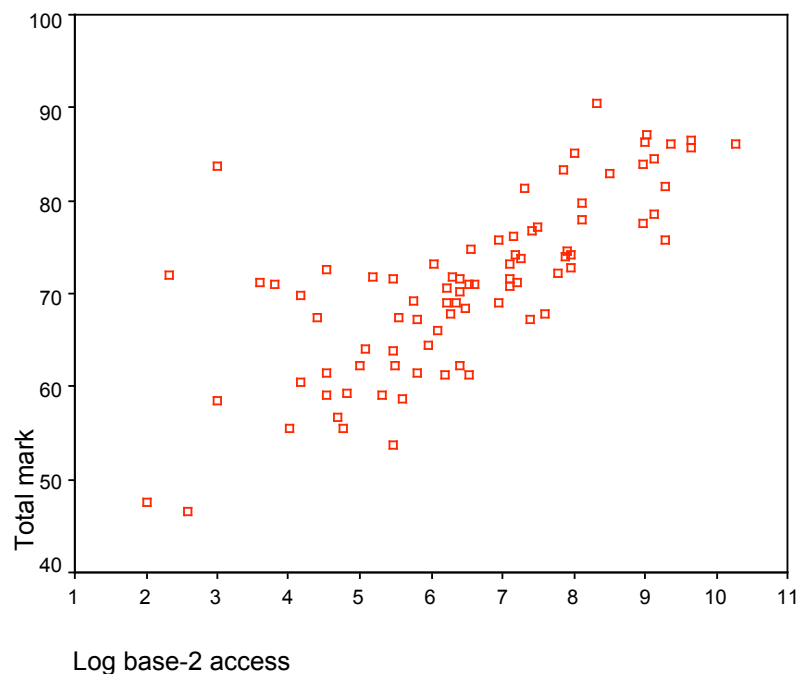


Figure 2: Total marks and log base 2 of number of times accessed

Regressing total mark on the (logarithms of the) four different components of access (contents, communication, team access and administration) showed that contents and communication accesses were significant ($p = 0.002$ and $p = 0.02$ respectively) while team access and administration were not ($p = 0.74$ and $p = 0.18$ respectively). The relationship between access and outcome holds only for contents and communications accesses, and is not significant for the other types of access.

In the e-learning group, there is evidence that students who accessed the online system more often, particularly for reasons of content or communication, also achieved higher final results. We note, however, that a causal connection is only an inference, although an educationally tempting one. It could be that those students who were doing better were more interested in accessing the system, and it was certainly the case that a small number of students with very low access achieved high results.

Nevertheless, it seems that on average every doubling of access corresponded to an extra 3-4% on the total mark. From the comments that some students made in their diaries or interviews, we can conclude that the time they spent on the system did, in fact, help their learning and improve their results. This would be of interest to the next group of students, and it might encourage some of the weaker students to spend more time with the learning materials.

Students' comments

Several students from the online group took part in interviews at the conclusion of the semester. Students who volunteered were interviewed in groups (of students with similar numbers of accesses) or individually. Their comments add an interesting dimension to the relationship between online accesses and learning outcomes.

One student who accessed the online study component frequently said:

The reason why I got a high score in the class is because I used the online system to help me to study at home. I got a great experience of studying online because I could study everywhere and every time that I wanted. I love to chat via MSM and Yahoo Messenger where I can see the teacher's face and hear her voice. I'm keen on posting messages on the discussion board and of course I always want to be the first one. It's a good way for me to express and exchange ideas with friends and the teacher. Overall, I enjoyed studying both face to face and online. In particular, online I can explore, communicate, navigate, update and search for information in order to increase my knowledge of statistics. (access 1233, mark 86, male)

This student very clearly describes the importance of opportunities for collaboration within a social setting for his learning. Online environments often focus on the textual components, but in this situation the learning environment was carefully designed to enable the development of collaborative friendship groups. O'Reilly and Newton (2002) recognised this significant component of an online environment and said of their study "the importance of social interaction was evident in particular informing the friendships, offering advice, empathy and encouragement to online studying in a new learning environment."

Another student in the same interview group describes a different sort of experience. As with the previous student, access to the system is high, but here the student saw that the online component provided an opportunity for him to participate actively and thoughtfully in discussion.

The main reason why I always access the online course is because I like to study by myself. Personally, it seems like I don't show much expression or participation in the class. I always sit at the back of the class and keep quiet

because I'm not a talkative person. But when I access the online course, I can post a lot of messages and say what I want to say without feeling embarrassed, like I would speaking out in front of the class. (access 808, mark 86, male)

One of the aims of the Thai government, outlined earlier in this paper, was to increase the capacity of Thai students to engage with modern forms of learning and communication. The resulting, deliberate, focus on using ICTs for learning seems to have generated enthusiasm for learning using technological tools. The quote below describes how one student felt proud of his technological achievements:

I was so keen to learn online because our teacher showed us how to use the online system and demonstrated it to us using her laptop integrated with all types of new computer equipment. She had wireless Internet connected to her mobile phone. God, how cool is that! I was so excited because we could use the conference system via a web camera. I could see my friends' funny faces and hear their voices, and it was like TV broadcasting. It was very interesting for me because I saw this kind of thing only in the movies, but now I could do it. I'm so proud of myself and feel really up to date!

[How do you use the online system?]

Basically, I love to post and reply to messages on the discussion board. Every time our teacher posts a message in the new forum, I'm the first one who replies to the message. I think, it's cool to be the first person who replies to the messages. I like to tease my friends by using the web board, for example, to post funny pictures of them. Actually, I use online for communication more than study. I like to play around with the new things more than doing homework. (access 629, mark 76, male)

Although most of the interviews were carried out with students who had a particularly large or small number of accesses, the following quote is from a student with average accesses. It points out the ways in which she used the particular opportunities afforded by the online technology to enhance her learning.

I also learned a lot of things, not only theory but also technology such as calculators and online learning. I'm sure statistics can be used in my job. The online learning developed my knowledge and skill in using the Internet. Actually, I'm a very slow learner and need a lot of time to learn things, and that's why online helps me to learn easily because I can revise the lesson as many times as I like. I can also test myself with the quiz after I've finished studying, so I know what level I'm at and what are my weaknesses. (access 249, mark 74, female)

There were students who made only minimal use of the online opportunity. The quotes below show that some students prefer learning

situations where they can interact directly with people rather than through the mediation of the technology.

I didn't access the online course that often because personally I don't really like online. I found that online makes me feel lonely and isolated. That's why I prefer to attend classes and see friends. I logged on a few times to download all the documents and printed them out for reading. I don't like to interact with the computer. I think it's very difficult because statistics has a lot of formulas. I still like to use paper and pencil for solving equations because it is easy and I can remember what I write. (access 8, mark 84, male)

The disadvantage of online was that we were studying at different times, so I think the traditional way is better because we can talk to friends directly and see the expression on their faces. (access 8, mark 59, female)

The final representative quotes demonstrate an important aspect of learning. These students were constrained in their opportunities to participate in the learning program through lack of ready access to a computer. It is important to remember that "anytime, anyplace and anybody" is an ideal that may not be achieved with every group of students, and to make appropriate allowances in the online course design.

I had no computer at home to access the online system. Another problem was that I was not good at using the computer, so I couldn't use it the way I wanted. If I had a good computer background, I would use it better. That's why I still study in the traditional way by reading the text book and doing the exercises. In the end, I still got a good mark. (access 5, mark 72, female)

Different people have different learning styles, and different people study at different times. Because of these different times, I can't chat online because I have part time job. If there are several points that I can't understand in the lesson, sometimes, I would like to talk to the teacher online, but I can't because I don't have a computer at home. If I had a computer at home it would be better. (access 6, mark 47, male)

These student quotes offer an opportunity to consider the graphical results (Figures 1 and 2) within a specific context. Students are typically unaware of the curriculum design that goes into the development of their specific learning situation. Their quotes indicate that they have recognised the deliberate use of Horton's (2001) framework as an essential component for learning.

Discussion

Overall, the study showed that the students whose learning included an online component did better than the traditional group on various aspects, including their actual marks (Suanpang *et al.*, 2004; Suanpang & Petocz, 2003a,b). Importantly, those students who made more use of the e-learning

system (as measured by number of accesses) ended up with better results (as measured by total marks). The regression analysis described previously does not allow the deduction of a cause and effect relationship, but some of the student quotes shed light on the relationship between the online learning environment and their own learning.

Students who had a high number of hits and a high total mark talk about the way that the online environment allowed them to study flexibly and to communicate their questions without embarrassment. A high number of hits resulted in only average results for one of the quoted students, but his quote shows that he focused on “playing” with the technology. Another student accessed the system a minimal number of times, but achieved a high total mark. His quote shows an approach to learning that eschewed the online system, focusing instead on personal interaction with peers. A student with average access and average results points to the benefit of using online for revising and testing understanding. Finally, quotes from students who had low numbers of hits and low total marks raise the problems of accessing the online system without adequate equipment at home.

The mix in the present “online course” of e-learning and more traditional learning may contribute to the success of a course that has the best features of a variety of approaches. The students in Thailand were generally not very familiar with the technology, and yet knew that it was modern and important, and so were very happy to be involved with this new form of learning: it is very likely that this influenced the results. In other situations, with students who are more familiar, and maybe more indifferent about the technology, the results may be different. Bedgood (2002) reports on the relationship between access and results for US students of chemistry at Arizona State University, and concludes that “student use of the web resources is not necessarily predictive of subject performance” (p.23), with the sole exception that the very weakest students seemed to use the materials significantly less than other students. A report on the British MELEES (Mathematical Electronic Learning Environment in Engineering and Science) project (Hibberd *et al.*, 2003) provides data that indicate a non-significant relationship (correlation of 0.09) between access and outcome. The authors’ conclusion is that this “confirms that the provision was seen as helpful to students from all ability ranges” (p.32).

The research reported in this paper suggests that a careful learning design can result in a situation where students can find value in participating. Hill (2001) indicates that a successful e-learning environment is one which provides ample opportunities for collaboration which result in a ‘community of learning’. Similarly McLoughlin (2002) suggests that it is the nature of students’ online collaborations that promotes effective team

work. In this Thai example we can see that students' learning opportunities were carefully scaffolded. First, they were introduced to the technology in the context of an individual statistical activity. Then, their technological expertise was stretched through the chat/discussion opportunities afforded by the group assignment. Here, the statistical focus was related to real data obtained from real business situations. Reid and Petocz (2002) would maintain that such a work oriented task would enable students to make the important link between their studies and their future work.

The most significant finding from this study was the relationship between engagement with online learning as measured by number of accesses and learning outcomes as measured by total marks. On average, every doubling of number of accesses corresponded to an increase in total mark of 3-4%. Although learning outcomes are certainly much broader than marks obtained at the end of a course, the study seems to indicate that there is a significant relationship between accesses and outcomes. Students' quotes show that they were using the accesses predominantly for course content and for the intellectual and social aspects of communication. It seemed that the students found value in the online environment, which was designed to provide a space where they could generate their own enthusiasm for learning. Given the aim of Suan Dusit Rajabhat to become an e-university, this study illustrates an important implication, that online course design contributes best to students' learning by developing a judicious mix of technological and traditional forms of study.

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