Analysis about Achievements of e-learning on University Calculus

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Abstract: The development of the e-learning will become the trend in the future, especially the MOE in Taiwan still strife on the promises that they made a few years ago. This study is to analyze 2003 school year (2003.8.1 to 2004.7.31) data about calculus of 129 freshmen who are majoring in three departments (Computer & Communication, Information Management, Applied Statistics & Information Science) at Ming Chuan University in Taiwan concerning with achievements of e-learning. The way for e-learning of these classes still focus on traditional classroom, but aided with Internet teaching, students can preview and review through the WWW, also, the platform have the ability for interactions (online Q & A, discussion board, etc.). This study were initially analyzed the records of system, that were included some numeric data of students' activities such as logins, discussions, etc. Then, applied the Rogers' theory of diffusion of innovation as the experiment, and recorded the first login time, to explore active participation concerning with impact on achievements of e-learning. The results were shown that active and participation in e-learning behaviors had some degrees of influence on final grades.

1. Introduction

The use of new technologies in university teaching and learning is growing rapidly, with many claims for its increasing impact on the processes and outcomes of teaching and learning. Much of this is occurring in an ad hoc way, driven by the technology itself. Many of the developments adopt a teacher-focused rather than student-focused perspective in the process of translating teaching practices into new forms. They involve designing and presenting materials using technology rather than utilizing knowledge of how students' experience learning through the technologies. Indeed, a study by Alexander and McKeniz [1] showed that much of development and evaluation focused on improving students test scores or on improving the productivity of teaching and learning. In their study they found little emphasis on demonstrating an improvement the quality of students' experience using the new technologies, despite the claims often made that new technologies enhance the quality of learning [2].

Taiwan originally had chance to build up a good Internet teaching environment under NII construction, various projects from NSC (National Science Council), and Ministry of Education (MOE); however, it missed for some reasons. Most people can tell you a lot of projects are project-oriented, and not conduct according to the goals. As a teacher and researcher, we have the responsibility to improve the relationship between teaching and learning. That was the true essence and motivation for this study.

A lot of studies were focus on the development of Internet teaching, and heavily stressed on the functions of Internet system, and evaluation on course design; however, not so much research was endeavored on the learning achievements, and learning behaviors. Also, there were shortage about the interactions between teachers and students. Evaluation on Internet teaching behaviors and learning achievements, except can help designers to adjust course contents, and it also can provide the students' learning information to teachers for improvement.

The purpose of the study was to analyze students' learning achievements of e-learning on University calculus course concerning with learning activities under combination of traditional class and Internet teaching environment.

2. Review of Literature

2.1. Educational Technology in Taiwan

The integration of technology into learning in Taiwan can be divided into 3 stages: 1980s, 1990s, and the 1990s [3]. Computer technology began to be integrated into teaching and administrative work in colleges and high schools in early 1980s and in junior high schools in the mid 1980s [4]. An official 6-year plan for CAI in the school was introduced in 1986 as a joint project of the MOE, NSC and the Provincial Government of Taiwan. Its goals were to stress on the implementation of CAI, teacher training, development of CAI and encouraging its use in schools [5] [6]. This project was also to set computer classrooms in every junior high and senior high schools. In 1987, government funding provided high schools with a certain amounts of hardware. By establishing the central curriculum system, schools received support from the central and local governments. By the summer in 1988, over school teachers had been trained by various workshops on CAI and more than 200 CAI courseware units had been developed under first 6-year technology plan on government funding [6]. From late 1980s to early 1990s, some discrepancies between the expectations of government and the actual operation of the governmental plan at the school level became apparent during the second stage [7]. In 1991, most of the computer hardware had not been used, and the computer software had not been integrated into classroom instruction. Certain subjects that were to incorporate computers in the standard curriculum were not executed at schools. As a matter of fact, computer classrooms were locked most of the time and were not being used. Many individual schools typically computerized for administrative purposes more readily than for the purposes of instruction [8].

Hsin [9] indicated these problems resulted from unsystematic planning for curriculum development, teacher training, hardware availability and software development by authorities, a lack of knowledge of effective planning and implementation as outlined by the national and local policies among institutions, and the plan made it difficult for the government to adequately scrutinize its implementation. Actually, local schools typically developed their own strategies to use, create and develop plans to integrate computers into teaching [3]. In 1997, MOE promulgated 3 5-year major technology reform plans to increase the integration of technology into teaching between 1997 and 2001: Information Education Fundamental Plan, NII project, and Medium-Range Plan for Distance Education. These 3 plans mainly focused on 5 goals [3]: (a) building computer hardware, software, and networks in all levels of school, (b) increasing teachers competent to implement CAI and computer networking into instruction in all subjects to enhance the quality of teaching, (c) developing an educational technology resource database and make it available to teachers, students and all citizens, (d) applying distance learning technology to achieve the goals of lifelong learning, and (e) developing better organization, continuing planning, and allied facilities to fulfill long term and systematic educational technology missions

These maneuvers showed better planning fro the application of educational technology. The goals and different curricula for educational technology were incorporated and accommodated to all school levels. The current stage is approaching its end. The MOE has projected a second phase to follow the previous 3 5-year plans. Networking is the most significant additional to previous plans. The upcoming plan contains 5 goals [10]: (a) educational technology curriculum to be started in the elementary education level, (b) training professional computing skills to meet the needs of information technology, (c) integrating IT into all subject areas using interactive and heuristic methods as instruction strategies, (d) utilizing networking to assist open learning, and (e) applying networking to share instructional and professional information.

2.2 . Crucial Issues concerning with e-learning

Current implementation of educational technology is facing a few obstacles and challenges although the authority has plans for educational technology. They further indicated the difficulties and challenges were: instruction vs. technology, inadequate teacher education, poor curriculum integration, lack of research support, inadequate hardware and software availability, attitude toward school entrance examination, and lack of alternative funding resources. They further concluded that the evidence shows that computer availability in Taiwan's schools has increased significantly in recent years, but computers are still inadequately employed for interactive instruction. Although school personnel, teachers, and students hold positive attitudes toward computers in schools, many difficulties and challenges still persist because of the conflict between educational technology and traditional education systems. Moving Taiwan toward a learning community is an ideal and ultimate goal. Technology-based learning serves a vital tool to enhance learning. Learning, knowledge and goals students need assistance to attain. Content, hardware and software do not equal knowledge. The utilization of various learning technologies will allow Taiwanese to select their ideal learning methods to achieve the definitive goal: "life is learning; learning is life" [3].

2.3 . Roger's Diffusion of Innovation Model

Rogers' diffusion of innovation model is regarded as the most widely known description of the diffusion process. This model categorizes potential adopters of an innovation by innovatiness, the degree to which an individual or group adopts a new idea earlier than other members of a social system. Innovativeness is normally distributed among adopters, who are labeled innovators, early adopters, early majority, late majority, and finally laggards [11]. This typology, however, fails to mention those who do not adopt.

The attributes of an innovation are the basis upon which potential adopters form their perceptions of the innovation [11]. All innovations can be thought of as having five general attributes according to Rogers: (a) relative advantage, is the degree to which an innovation is perceived as better that the idea it supercedes. It is often expressed in terms of economic profitability, (b) compatibility, is the degree of perceived consistency between the innovation and the past experiences, existing values, and needs of the individual, (c) complexity, is the degree to which an innovation is perceived as difficult to understand or to use. The complexity of an innovation is negatively related to the rate of its adoption within a social system, (d) observability, is the degree to which the results of an innovation are viable to others. The benefits of a new mode of transportation, for example, would be more observable than a new contraceptive technique. The observability of an innovation contributes positively to its rate of adoption, and (e) triability, is defined as the degree to which an innovation may be experimented with on a limit basis. Zaltman, Duncan, and Holbek [12] emphasize the negative side of the triability dimension: "the degree to which and the ease with which the status quo ante can be reinstated" (p. 42).

3. Methodology

3.1. Studied Samples and Manipulation of Constructs

Research data gathering were separated as two parts: (a) Studied samples were consisted by three class students who were registered the "U2 study Web" (http://cu.edu.tw), and instructed by one teacher (researcher). Data came from system records that were included some quantitative data such as students' learning activity (numbers of login to class, posted discussion, time spent on reading, pages of reading, etc). These classes were Department of Applied Statistics and Information Science (ASIS), Information Management (IM), and Computer and Communication Engineering (CC) at Ming Chuan university, and the total selected sample after erased the "Final-absent" students, was 149; (2) About the end of the year study, the researcher conduct survey to investigate the same studied samples to understand the level of satisfaction about Internet teaching. The definition and measurement of research constructs of the study were: (a) teacher behaviors (TB), (b) classmate perceptions to e-learning (CPTEL), (c) system platform (SP), (d) teaching material (TM), (e) interaction during learning (IDL), (f) learning achievements (LA), and (g) acceptance of e-learing (ACCEP). All these constructs were measured by 5-point Likert-type scale from 1- not strongly satisfactory to 5 – strongly satisfactory.

3.2. Learning Environments and Function of Internet Teaching System Platform

Learning environments were classified as follows: (a) course contents: This parts was included introduction, arrangement (syllabus of the course for this semester), catalogue, unit tests, homework / grades, projects 6 sections. The catalogue allowed students to connect with teaching materials by hyperlink, students can read the contents, find relative information, or used search engine to find some information. The unit tests provided the test to measure the level of understanding of the courses, to serve as the evaluation mechanism of learning performance. By homework function, teacher can check out the due assignment was provided by students, (b) course information: The functions were included latest information, bulletin of course, FAQ, registered and audited students, and top 20 students, and (c) course interaction: The course interaction provided whiteboard discussion, on-line group discussion, issue discussion, sharing place, these interactions allowed users not only to read from bulletin board, but also respond, and post the message immediately, and fully assist mutual interaction between students, and teacher. Group discussion was classified as E-mail discussion, asynchronous discussion, and synchronous discussion. Except the above complete learning environment, the system was also automatically recorded students' learning activities as following 3 items: (a) the condition of students login to preview and review the contents: Numbers of login, previews, reviews, seconds for previews and reviews, and path as well as time for course browsing, (b) the condition of students participate in class discussion: The condition here mainly focus on the contents concerning with students who used discussion boards, topic discussion, and on-line discussion, and the numbers of students posted on discussion boards, and (c) the condition of students evaluate on Internet: These conditions were included tested time, numbers, and results.

3.3. Data Analysis

Analysis of Research data were separated as 2 sections: (a) analyzed the 92 1st semester school year data about three class students' learning activities on "U2 Study Web", and (b) Analyzed experimental design data (initial login time of students) about the difference of active learning between 1st semester and 2nd semester of 92 school year. Difference of this 2 semester was no remind on 2nd semester that students have to complete the registration for this course. In this way, 1st semester was a treatment group, and 2nd semester was an experimental group on a contrary, then applied Rogers [11] "diffusion of innovation model" to explore students' learning activities.

4. Results and Discussion

4.1. Descriptive Data of Students' Background

Percentage of the male was 59%, and female was 41%. Departments of ASIS and IM are social science oriented, while CC is more inclined to engineering oriented. The detailed information of gender dispersion for three classes was summarized at Table 4-1.

Table 4-1. Gender Dispersion for Three Classes

Class	ASIS	IM	CC	Total	%
Male	26	33	30	89	59%
Female	28	25	10	63	41%
Total	54	58	40	152	100%

4.2. Overall Learning Achievements

Table 4-2 listed the average final grades, average numbers to login the class, average numbers to read teaching materials, and average numbers of posted discussion of students' learning activities from system records for 92 1st semester school year. The average final grade for ASIS and CC was close, and IM is worse than them, and the difference with ASIS was 7.2 deficits. Average login to the class was around 30 times, average numbers to read teaching material was around 27, and average numbers of posted discussion was approximate 1.

Table 4-2. Students' Learning Activities from System Records

Items / Class	Average final grades	Average Login to the Class	Average numbers of Reading	Average posted discussion
ASIS	68.38	30.89	27.39	1.04
IM	61.18	31.25	26.27	1.02
CC	66.85	32.24	27.58	1.38
Overall Avg.	65.47	31.46	27.08	1.15

4.3. Influence of Internet Learning Behaviors to the Final Grades

Tables 4-3, 4-4, and 4-5 were shown the correlation between learning behaviors of three classes and final grades.

Table 4-3. Correlation between Learning Behaviors and Final Grade for ASIS Class

Variables	Final grade	Login class	Reading	Posted discussion
Final grade	1			
Login class	-0.014	1		
Reading	0.002	0.946*	1	
Posted discussion	-0.023	0.335*	0.425*	1

* statistically significant at 5% level of significance

Table 4-4. Correlation between Learning Behaviors and Final Grade for IM Class

Variables	Final grade	Login class	Reading	Posted discussion
Final grade	1			
Login class	0.152	1		
Reading	0.217	0.939*	1	
Posted discussion	0.022	0.537*	0.544*	1

* statistically significant at 5% level of significance

Table 4-5. Correlation between Learning Behaviors and Final Grade for CC Class

Variables	Final grade	Login class	Reading	Posted discussion
Final grade	1			
Login class	0.517*	1		
Reading	0.477*	0.952*	1	
Posted discussion	-0.005	0.229	0.425*	1

* statistically significant at 5% level of significance

These three Tables shown that CC class was obviously different with other two classes. Logins, reading teaching materials had statistically positive influence on final grade, and both class of ASIS, and IM did not showed any statistically significant results relate to their final grades. The ASIS class even had shown more negative impact than other two classes. In Table 4-6, the results shown that reading had statistically positive impact on the final grade for the overall three classes.

Table 4-6. Correlation between Learning Behaviors and Final Grade for Overall Three Classes

Variables	Final grade	Login class	Reading	Posted discussion
Final grade	1			
Login class	0.177	1		
Reading	0.198*	0.943*	1	
Posted discussion	0.004	0.373*	0.432*	1

* statistically significant at 5% level of significance

Difference analysis between learning achievements and Internet behaviors was used the t-distribution. The results for each variable to judge the differences between high score group (above 60), and low score group (below 60), were summarized in Tables 4-7, 4-8, 4-9, and 4-10.

Table 4-7. Difference between High Score Group and Low Score Group with Final Grades

	ASIS	IM	CC	t	df	Sig.
High Score	77.28	77.50	77.05	91.62	69	< 0.0001
Low Score	57.63	52.11	55.58	46.53	78	< 0.0001
Whole Class	68.38	61.18	66.85			

Table 4-8. Difference between High Score Group and Low Score Group with Login Times

	ASIS	IM	CC	t	df	Sig.
High Score	30.18	33.30	40.79	9.96	67	< 0.0001
Low Score	31.76	29.97	20.64	10.72	70	< 0.0001
Whole Class	30.89	31.25	32.24			

Table 4-9. Difference between High Score Group and Low Score Group with Reading Materials

	ASIS	IM	CC	t	df	Sig.
High Score	26.31	29.30	33.58	10.15	67	< 0.0001
Low Score	28.64	24.38	19.43	10.39	70	< 0.0001
Whole Class	27.39	26.27	27.58			

Table 4-10. Difference between High Score Group and Low Score Group with Discussion Times

	ASIS	IM	CC	t	Df	Sig.
High Score	0.90	0.65	1.62	4.67	67	< 0.0001
Low Score	1.20	1.25	1.11	5.42	75	< 0.0001
Whole Class	1.04	1.02	1.38			

From above Tables, high score group for each average variable within classes of IM and CC were higher than low score group; however, ASIS was somewhat different, except the final grades, other average variables were vice versa compared with both groups. Classes of IM and CC had revealed that while the level of participation in learning was high, the grade was high too. However, it was not same case in ASIS class. No matter what in high score group or low score group, there were statistically significant differences between three classes.

4.4. Analysis of Internet Learning Behaviors

As a teacher, the most concern thing to us are students self-readiness toward learning. In that purpose in mind, the experiment was conducted to distinguish the Internet learning behaviors between 1st and 2nd semesters 92 school year of three classes. In 1st semester, teacher asked every student have to register and access Internet class; however, it was no remind at 2nd semester.

Figure 4-1 shown that ASIS class registered numbers in 1st semester were accumulated in the first three weeks, and was decreased after three week. In 2nd semester, after week 1, the curve was down, however, the registered numbers was little be short compared with 1st semester. Overall speaking, self-readiness of most ASIS students were high, since week 1 has already have 30 students registered, and higher than 1st semester; however, self-readiness for whole class was not performed well than 1st semester.

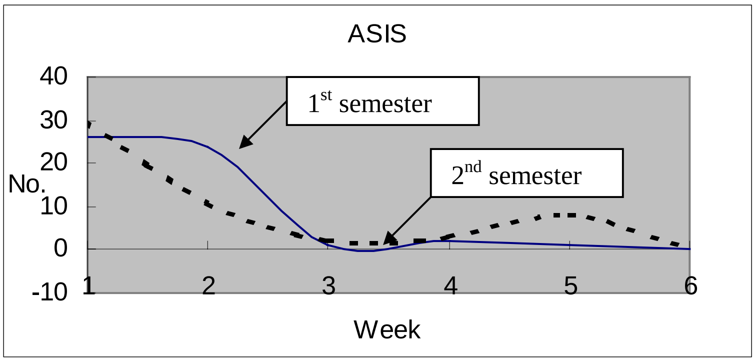

Figure 4-1. Comparison between 1st and 2nd 92 School Year of ASIS Students Registered on Internet Calculus Teaching Course Website

The bell-shaped line of 1st semester in Figure 4-2 was more likely to match the Roger's diffusion of innovation theory, especially the 5 categories of people during the process of innovation. However, since no remind on 2nd semester, and these IM major students were more sensitive to technology, the registered line shown irregular form, it's more like the condition of ASIS class.

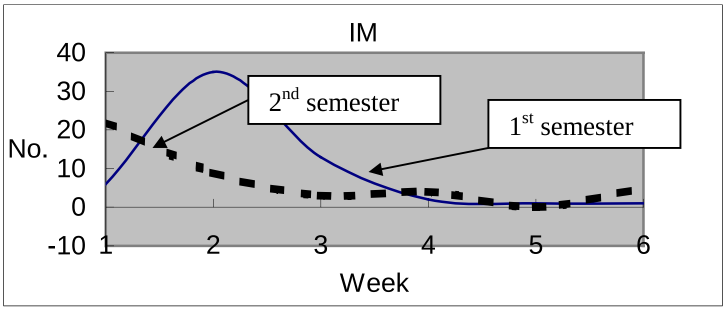

Figure 4-2. Comparison between 1st and 2nd 92 School Year of IM Students Registered on Internet Calculus Teaching Course Website

The situation of CC class in Figure 4-3 was more like in IM class, since this two class have some kind similarity about technology acceptance.

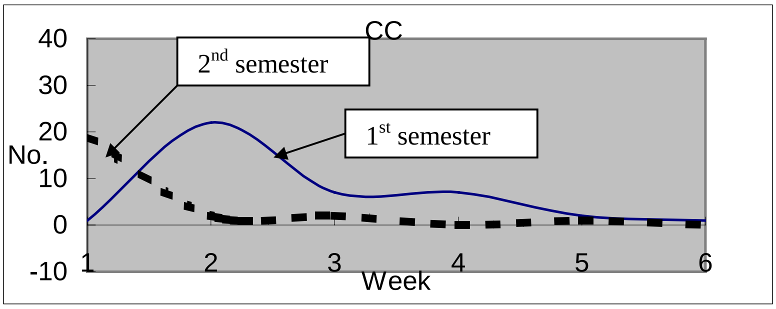

Figure 4-3. Comparison between 1st and 2nd 92 School Year of CC Students Registered on Internet Calculus Teaching Course Website

4.5. The Relationships between Factors of Level of Satisfaction by Students toward Internet Calculus Course Teaching

To evaluate level of satisfaction to calculus Internet teaching, a surveyed questionnaire was designed based on significant literature reviews, and expert opinions. After careful check out the validity and reliability, this questionnaire was administered to students on 16 week. Table 4-11 has shown that the results of each factor's mean, standard deviation (SD), and rank. The highest was on TM, whereas lowest was on IDL. In fact, ACCEP was ranked no. 2.

Table 4-11. Dispersion of Level of Satisfaction of Students toward Calculus Internet Teaching

Rank	Factor	Abbre.	Mean	SD
1	Teaching Material	TM	3.39	0.87
2	Acceptance of e-learing	ACCEP	3.38	0.87
3	Teacher Behaviors	TB	3.36	0.87
4	System Platform	SP	3.35	0.83
5	Learning Achievements	LA	3.33	0.81
6	Classmate perceptions toward e-learning	CPTEL	3.12	0.81
7	Interaction during learning	IDL	3.12	0.76

5. Conclusions and Recommendations

5.1. Conclusions

(a) The average final grade of IM was less than ASIS and CC. IM and ASIS should classify as same group of social science oriented, however, it looks like no difference on majors, while CC is engineering oriented, and the final score was less than ASIS.
(b) The CC class was obviously different with other two classes on Internet learning activities. Variables of logins, readings had statistically positive influence on final grade, and both class of ASIS, and IM did not shown any statistically significant results relate to their final grades. The ASIS class even had shown more negative impact than other two classes. The overall results shown that reading the Internet teaching materials had statistically positive impact on the final grade for the overall three classes.
(c) High score group for each average variable within classes of IM and CC were higher than low score group; however, ASIS was somewhat different, except the final grades, other average variables were vice versa compared with both groups. Classes of IM and CC had revealed that while the level of participation in learning was high, the grade was high too. However, it was not same case in ASIS class. No matter what in high score group or low score group, there were statistically significant differences between three classes.
(d) If we put experimental results information together, we can conclude that IM has a more standard bell-shaped distribution than other two classes on 1st semester. Registered students numbers for all three classes were rapidly decreased after 3 weeks period in 1st semester, and 2nd semester registered numbers were less than 1st semester.
(e) The highest Level of satisfactory was on teaching material, whereas lowest was the interaction during learning. In fact, acceptance of e-learning by students was ranked no. 2. Students most expectation was still stress on interaction that is why the interaction during learning is the last ranking.
(f) Among detailed dispersion of variables within each factor, some results of above 3.5 were "teacher adds the results of learning and discussion on web-site", and "my level of acceptance toward e-learning is high". These two crucial things were applaused by students, they really appreciated what the teacher efforts on interaction, on the other hand, their level of acceptance toward e-learning was high too. These two things for the future development about incorporation of technology into education could not be ignorant.

5.2. Recommendations

(a) For those students had math experience before (most students in ASIS class), the Internet teaching should put some additional thoughts on interesting topic.
(b) IM class should have a lot of senses about technology; however, their final grade was worse than ASIS and CC, actually, their dropout rate was also high too. For this class, while in the design of courses should classify as second level, that means when design their course should give easier and more drill and practice contents on the web.
(c) CC class is engineering oriented, so the results of data on this class was pretty normal than other two classes, especially compared with high score group and low score group. Their self-readiness obviously higher than other 2 classes. Future classification on different fields (natural science, engineering, social science, etc.) of same course should have vivid segmentation to meet students' needs.

(d) Some reasons about lacking self-readiness still needs to clear out for ASIS and IM classes. By using open-ended questionnaire to gain their opinions, and make summary in the future is a good suggestion.
(e) There should have an automatic mechanism to remind students to read the teaching materials on Internet system for a long period of absences, since the results shown that reading the materials did help to gain high final grades.
(f) Some efforts have to stress on improving students active participation in learning. Students are really interested in new technology, but they also need to get into learning. Some suggestions can be made from student services either in traditional way or Internet.

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