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Use of webcasting technology in teaching higher education

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Schools and universities all over the world are continuously exploring ways to use the web technology in improving teaching effectiveness. The use of course web pages, discussion groups, bulletin boards, and e-mails have shown impact on teaching and learning in significant ways, across all disciplines. e-Learning has emerged as an alternative to traditional classroom-based education and training, especially for distance learning programs. Thus, this research study was conducted to investigate the effectiveness of the implementation of webcasting technology in teaching in higher education. In this research, three modes of webcasting lectures were experimented on three different groups of students, using the pre test-post test-control group experimental design. The modes are live streaming, pre-recorded streaming and video on demand (VOD). The group that attended the face-to-face lecture acts as the control group. The overall analysis showed that the students who went through the VOD group showed the most gain in the tests.

Webcasting technology, online learning, web-based learning, distance learning, higher education

INTRODUCTION

Computer-based systems have great potential for delivering teaching and learning material. According to Evans, et al. (2004), the growth of the internet has boosted the use of the web for teaching and learning. There are several advantages in using a web-based learning system in education. It can be used at any time and place, learning materials can easily be updated, interaction between the learner and the teacher can be fostered in several ways, multiple media such as text, audio, graphics, video and animation can be incorporated, it allows learners to form

learning communities, learners' progress can easily be checked, and a learner-centred approach can be implemented to take into account the many differences between learners (Jolliffe, Ritter and Stevens, 2001).

Web-based learning has also been promoted as a better teaching method and as a tool that can improve students' performance, although research findings have shown contradictory results. Research has not shown consistent teaching and learning advantages on the use of these technologies (Devitt and Palmer, 1999; Greenhalgh, 2001; Watson, 2001). Research in science education has also been slow to investigate the outcomes of the changes that ICT brings (Greenhalgh, 2001).

According to Armstrong (2000), many courses are now taught over the internet. Armstrong described the use of video conferencing and webcasting technology in traditional courses. He claimed that the technology is a sustaining product for higher education because it enables lecturers to perform many of their existing functions better. Armstrong proposed that classes could be taped, allowing the students to review the lecture at any time. This would create the opportunity for a student to study the material in a non-linear fashion. Students could learn the material in the order that is most comfortable for each individual. He also described how this technology allows for guest speakers to make appearances over the webcasting easily and allows students to repeat lessons that they do not understand or to learn lessons that they have missed.

Webcasting technology has made it possible for the delivery of digital information over the internet. Webcasting is defined as sending digital information over the internet for reception, viewing and listening by the public, possibly involving some interaction between the sender and recipients. In a technical sense, webcasting is the published and subscribed or broadcast and tune-in methodology for distributing information from one to many recipients (Miles, 1998). This study focuses on the effectiveness of using webcasting technology to deliver lectures to students at Universiti Putra Malaysia. The research focuses on three modes of webcasting delivery, live streaming, pre-recorded and video-on-demand.

Live Streaming

Data streaming, commonly seen in the form of audio and video streaming, is when a multimedia file can be played back without being completely downloaded first. Most files, like shareware and software updates that have been downloaded off the internet, are not streaming data. However, certain audio and video files such as Real Audio and QuickTime documents can be streaming files, meaning users can watch a video or listen to a sound file while it is being downloaded to their computer. With a fast internet connection, users can actually stream live audio or video to their computer. Among the advantages of live streaming are (a) transfer of data that allows for longer or live video images to be watched as they are downloaded to a computer, (b) streaming media that is broadcasted to many people at a set time, and (c) broadcasting (streaming) of lectures in a remote location but there is no element of interactivity.

Pre-recorded

One of the simplest and most direct applications of webcasting technology is the indexing of pre-recorded sessions to bring a level of interactivity to an otherwise linear media. In addition to the embedded on-screen menus necessary for time shift-delivered indexed video, cassette jackets can carry printed instructions and menus for easy access at any time by the user. It involves recording at an earlier time for transmission later and allows delayed broadcasting of lectures at specified pre-arranged slots.

Video-on-Demand (VOD)

In video-on-demand (VOD) delivery, videos of lectures are archived on the server for anytime anywhere access by students. It involves the ability to stream video and audio content over the network in real time to computer with full video control functionality. It is also known as a virtual video player for every user.

Unlike conventional systems, cost effective VOD system provides high quality, full screen digital video streaming over an ethernet network using internet protocols. Full on demand control for each individual user is available directly to any computer on the network.

This new technology is being developed all the time, because VOD has so many different applications to offer to the customers and its economical possibilities have been seen. Many companies, organisations and universities are developing products and standards. The University of Putra Malaysia (UPM) is one that is involved in research on the effectiveness of VOD technology for students.

OBJECTIVE OF THE STUDY

The key objective of the study is to determine whether there are differences in students' achievement through different modes of teaching: face-to-face and three types of webcasting technology (live streaming, pre-recorded, and video-on-demand).

In this study, effectiveness is measured using students' achievement in a pre-test and post-test developed by the course lecturer.

METHOD

The study adapted the pre-test post-test control group experimental design to investigate the effectiveness of the various modes of webcasting technology in teaching. Figure 1 illustrates the research design used.

R	**O_1**	**X_1**	**O_2**
R	**O_1**	**X_2**	**O_2**
R	**O_1**	**X_3**	**O_2**
R	**O_1**		**O_2**

R: random assignment to groups
O_1: pre-test
O_2: post-test
X1: pre-recorded technology
X2: live streaming technology
X3: video-on-demand (VOD) technology

Figure 1. Research design

The teaching experiment involved a course on Bioinformatics, a core course offered for fifth semester students of the Bachelor of Science (Biotechnology) program. Apart from the students in the fifth semester, there are also students in the sixth and seventh semester. Besides the Bachelor of Science (Biotechnology) students, a large group taking this course are students from the Bachelor of Science (Biochemistry) program.

For the teaching experiment, teaching materials amounting to six hours of lectures were prepared for the different modes of teaching. The teaching was conducted in three two-hourly sessions. The experiment was conducted in the May semester over two years. The first experiment involved 104 respondents, while the second involved a total of 112 respondents. In the first experiment, 28 students (27%) were randomly assigned to the Face-to-Face group, 24 students (23%) to the Live Streaming group, 26 students (25%) to each of the Pre-Recorded and the VOD groups. In the

second experiment, a total of 79 students participated: 21 students (27%) were randomly assigned to the Face-to-Face group, 17 students (22%) to the Live Streaming group, 21 students (27%) to the Pre-Recorded group, and 20 students (25%) to the VOD group.

In the first experiment, while students of the face-to-face control group attended the lecture, the live streaming group accessed the lecture in a computer laboratory close to the lecture room. The students were each provided with a computer equipped with headphones. As in normal lectures, the students took notes during the lectures. The next day, the technical group edited the recorded lecture and uploaded the lecture in the Webcasting Group server. Apart from storing the lectures on the server, the lectures were also prepared in 10 compact discs (CD) as backup. The VOD group came in during their free time to view the pre-recorded lectures. They were given the URL to download the lecture from the server. The pre-recorded group viewed the lecture at a specified time arranged by the technical group in the laboratory. Attendance was recorded for all sessions.

However, it was observed that students in the VOD and the Pre-recorded groups could have shared information with students assigned to the live streaming and face-to-face groups, prior to the time that they were to view the lesson. Therefore, in the second experiment, it was decided that all four groups would attend the lecture at the same time. Therefore, the lectures were pre-recorded without any students attending. The recorded lectures were then edited and merged with the Power Point presentation. Considerations were made as to when segments of the lecturer and segments of Power Point presentation were to be focused on. The recorded lectures were then stored on the server and saved on CD as backup for the teaching sessions.

During the teaching sessions, the lecturer repeated the lecture with the students from the Face-to-Face group and keeping very strictly to the same materials and discussions made during the pre-recording of the lectures. At the same time, the live streaming group received the ongoing lecture streamed to them live in a computer laboratory. The pre-recorded and the VOD groups viewed the pre-recorded lectures from the server. In some cases, where students had problems accessing the server, the CD was then used.

Prior to the teaching experiment, respondents were given a pre-test. The test comprising 60 items covered the content to be taught in the six hours of lecture. Post-test was given after the teaching. In order to ensure equivalence between pre-test and post-test, the same questions were maintained but the sequence of questions was changed and in some of the questions, the questions were rephrased.

In the first experiment, the post-test was given after the six hours of lecture sessions. However, to control students' interaction with lecture materials and course mates or even maturation, the post-test in the second experiment was administered after every two-hourly lecture session. This ensured that the test measured only what the students had gathered during the two-hour long lecture through the different modes of teaching, the face-to-face and the three modes of webcasting technology.

Students were randomly assigned to the four groups in the first experiment. However, in the second experiment, extra measures were taken to ensure that the four groups were equivalent. Subjects were randomly assigned to groups based on their cumulative grade point average (CGPA). Equal distribution of subjects based on gender and race was also considered. Students were first grouped into three categories: (a) CGPA greater than or equal to 3.5, (b) CGPA greater than 3.0 but less than 3.5 and (c) CGPA greater than 2.5 but less than 3.0. None of the students had CGPA less than 2.5. From each category, students were divided into four subgroups taking into account gender and race as criteria in forming the subgroups. Each subgroup was randomly assigned to form the four groups required for the experiment. The four groups were then randomly assigned to the four groups, control (face-to-face) and the three webcasting groups.

RESULTS

Table 1 shows the pre-test and post-test scores of the Phase 1 experiment for all four modes of delivery. There is an increase in the post-test scores for all modes of instruction.

Table 1. Test scores for Experiment Phase 1

Modes of Delivery	Tests	Experiment Phase 1 (n=104) Mean	SD
Face to Face	Pre-test	60.89	10.98
	Post-test	83.75	4.00
Live Streaming	Pre-test	62.71	13.19
	Post-test	83.13	4.38
Pre-recorded	Pre-test	60.77	13.24
	Post-test	81.15	4.08
VOD	Pre-test	57.50	14.02
	Post-test	80.38	8.59
Overall Score	Pre-test	60.43	12.81
	Post-test	82.12	5.69

Table 2 shows the pre-test and post-test scores of the Phase 2 experiment for all four modes of delivery. Similar to Phase 1 experiment, there is an increase in the post-test scores for all modes of instruction. As noted in the method section, the pre-test and post-test were administered before and after every lecture.

Table 2. Test scores for Experiment Phase 2

Modes of Delivery	Tests	Experiment Phase 2 (n=79) Mean	SD
Face to Face	Pre-test 1	8.81	1.75
	Post-test 1	17.38	2.01
	Pre-test 2	9.67	2.08
	Post-test 2	18.24	1.41
	Pre-test 3	9.14	2.54
	Post-test 3	18.29	1.93
	Overall pre-test	9.21	2.14
	Overall post-test	17.97	1.82
Live Streaming	Pre-test 1	10.94	2.54
	Post-test 1	18.00	1.00
	Pre-test 2	11.71	1.74
	Post-test 2	18.12	1.45
	Pre-test 3	9.71	2.86
	Post-test 3	17.41	2.53
	Overall pre-test	10.78	2.51
	Overall post-test	17.84	1.77
Pre-recorded	Pre-test 1	10.81	2.62
	Post-test 1	17.48	1.60
	Pre-test 2	11.48	2.52
	Post-test 2	18.76	1.26
	Pre-test 3	11.00	2.30
	Post-test 3	16.81	1.50
	Overall pre-test	11.10	2.46
	Overall post-test	17.68	1.65
VOD	Pre-test 1	10.90	2.00
	Post-test 1	16.65	2.37
	Pre-test 2	11.15	1.84
	Post-test 2	18.20	1.40
	Pre-test 3	9.40	1.39
	Post-test 3	14.70	2.52
	Overall pre-test	10.48	1.90
	Overall post-test	16.52	2.56

Based on the results of the ANOVA analysis, it was found that there was no significant difference between the three pre-test scores and the three post-test scores for each of the four groups. It shows that the three pre-test or post-test scores for each group are about the same.

Since the overall pre-test scores are different between groups, therefore achievement cannot be measured based on the subjects' performance in the post-test. Therefore, comparison was made based on the difference in performance between the pre-test and post-test scores for each mode of instruction (see Table 3). For example, the increase in performance for Lecture 3, VOD group is equal to the difference between Pre-test 3 and Post-test 3 for the VOD group. ANOVA results presented in Table 3 show that there is a significant difference between different modes of instruction on the mean difference in pre-test scores and post-test scores on the set of tests given during the lectures.

Table 3. ANOVA results on differences in test performance based on modes of lectures

		Sum of Squares	df	Mean Square	F	Sig
Increase in performance in Lecture 1	Between Groups	85.449	3	28.483	3.718	0.015
	Within Groups	574.501	75	7.660		
	Total	659.949	78			
Increase in performance in Lecture 2	Between Groups	48.111	3	16.037	2.860	0.042
	Within Groups	420.496	75	5.607		
	Total	468.608	78			
Increase in performance in Lecture 3	Between Groups	192.410	3	64.137	7.739	0.000
	Within Groups	621.539	75	8.287		
	Total	813.949	78			

* significant at 0.05 level

Based on Lecture 1, post hoc test show that there is a significant difference between the mean difference of pre-test and post-test scores between the Face-to-Face group and the VOD group. Based on Lecture 3, it was found that there are significant differences between the mean difference of pre-test and post-test scores between the VOD group and the Face-to-Face group and between the VOD group and the Pre-recorded group. Differences between post test and pre-test is found to be greatest for the VOD group (mean = 9.14) as compared to that of the Pre-recorded group (mean = 5.81) and the Face-to-Face group (mean = 5.30). Based on these findings, shown in Table 4, it was found that the VOD group gained the most from the series of lectures.

CONCLUSIONS

The overall results show that the students who went through the VOD group had the greatest gain in the tests. Lecture through VOD technology gave positive impact towards students' learning as compared to the other two webcasting technologies used. It could be due to the interactive features of VOD technology. Students were able to control the lecture video sequences and suit the sequence to their needs. For example, they could decide when to play, pause or stop. As for the content, technicians were able to edit the lecture content without changing the originality of the lecture. Video lecture editing could increase the audio as well as the visual quality before the video was used for subsequent lecture sessions. Editing could rectify the videos before they were stored on the server for video lectures filing retrieval. With the data transmission speed of 300 kilobytes per second (progressive download), the video files played were stable in terms of audio and visual. Apart from that, the conduciveness of the room used by the VOD group might also be a contributing factor to students' better scores.

Among the benefits of VOD are as follows: (a) full video functionality for each user, (b) maximum access to content, (c) interactive information delivery, (d) improved security of resources, (e) low cost content distribution and (f) full online management interface. In VOD delivery, the photographer makes the decision as to when the slides are the focus and when the

instructor is the focus. This helps navigate the learning for the students. In a face-to-face setting, students may be focusing on the lecturer whereas the slides are the focus at that particular time. In all the webcasting modes of lecture, students tend to be very focused. They put the headphones on and focus on the computer monitor. However, in face-to-face setting, many things can disrupt the students' attention, especially friends who are sitting close by.

Table 4. Sheffe's analysis of mean differences in pre-test and post-test scores of webcasting modes

Difference between Post-test and Pre-test	(I) Mode	(J) Mode	Mean Difference (I – J)	Sig	95% Confidence Interval	
					Lower Bound	Upper Bound
Lecture 1	Live Streaming	Pre Recorded	0.392	0.979	-2.19	2.97
		Video on Demand	-1.513	0.428	-4.10	1.07
		Face to Face	1.309	0.564	-1.30	3.92
	Pre Recorded	Live Streaming	-0.392	0.979	-2.97	2.19
		Video on Demand	-1.905	0.183	-4.35	0.54
		Face to Face	0.917	0.772	-1.56	3.39
	Video on Demand	Live Streaming	1.513	0.428	-1.07	4.10
		Pre Recorded	1.905	0.183	-0.54	4.35
		Face to Face	2.821*	0.018	0.35	5.29
	Face to Face	Live Streaming	-1.309	0.564	-3.92	1.30
		Pre Recorded	-0.917	0.772	-3.39	1.56
		Video on Demand	-2.821*	0.018	-5.29	-0.35
Lecture 2	Live Streaming	Pre Recorded	-0.874	0.734	-3.08	1.34
		Video on Demand	-2.160	0.058	-4.37	0.05
		Face to Face	-0.638	0.880	-2.87	1.60
	Pre Recorded	Live Streaming	0.874	0.734	-1.34	3.08
		Video on Demand	-1.286	0.383	-3.38	0.80
		Face to Face	0.236	0.992	-1.88	2.35
	Video on Demand	Live Streaming	2.160	0.058	-0.05	4.37
		Pre Recorded	1.286	0.383	-0.80	3.38
		Face to Face	1.521	0.247	-0.59	3.64
	Face to Face	Live Streaming	0.638	0.880	-1.60	2.87
		Pre Recorded	-0.236	0.992	-2.35	1.88
		Video on Demand	-1.521	0.247	-3.64	0.59
Lecture 3	Live Streaming	Pre Recorded	1.896	0.262	-0.79	4.58
		Video on Demand	-1.437	0.509	-4.12	1.25
		Face to Face	2.406	0.102	-0.31	5.12
	Pre Recorded	Live Streaming	-1.896	0.262	-4.58	0.79
		Video on Demand	-3.333*	0.005	-5.87	-0.79
		Face to Face	0.510	0.956	-2.06	3.08
	Video on Demand	Live Streaming	1.437	0.509	-1.25	4.12
		Pre Recorded	3.333*	0.005	0.79	5.87
		Face to Face	3.843*	0.001	1.27	6.42
	Face to Face	Live Streaming	-2.406	0.102	-5.12	0.31
		Pre Recorded	0.510	0.956	-3.08	2.06
		Video on Demand	-3.843*	0.001	-6.42	-1.27

* The mean difference is significant at 0.05 level

The results of the data analysis also show that the effectiveness of Face To Face lecture is lowest as compared to the use of webcasting technologies. Apart form students' concentration being disrupted by friends and whatever other happenings during the lecture session, students' concentration may be also be distracted because the recording was done during their session. The recording done during the face to face lecture is streamed live to the Live Streaming group. Therefore, such existing logistics problems need to be resolved to reduce interference, such as providing the accessibility of a centre lecture room where the camera can be remotely controlled by a cameraman from a control room. The settings in the other webcasting modes are quite

different from the VOD mode. Headphone usage cuts off the connection between students and the existing environment and thus further reduces the interference, allowing students to give full concentration to the lectures.

Performance of the pre-recorded group is also low as compared to the VOD and Live Streaming groups. The production of the pre-recorded materials is based on an existing video, which needs to be encoded. The encoding process can reduce the video quality. Video that is encoded can be streamed at a compression rate of 150 kilobytes per second. Students who receive video at a lower compression rate than 150 kilobytes per second have a poorer video quality. Due to this problem, students' concentration towards the pre-recorded lectures can be lower.

Live streaming is being streamed through progressive download with a compression rate of 300 kilobytes per second. Since the broad band loading burden is high, this reduces the data transmission speed rate to about 150 to 200 kilobytes per second. It also reduces the satisfaction of student learning due to the poorer quality of audio and visual.

In summary, VOD can be used as an alternative to face to face lectures. This study shows the effectiveness of VOD mode of delivery as compared to pre-recorded and live streaming webcasting deliveries and face to face delivery. However, more studies need to be conducted, especially to ascertain the effectiveness of Webcasting technology in the delivery of lectures for content such as mathematics, and for courses that involve demonstration or laboratory work.

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