Implementation of a Lecture Video System for after-Class Learning: Study on Change of Learning Behavior

Greg C. Lee and Chiung-Fang Chiu

***Abstract*—This study reports on the implementation of a Lecture Video System that was developed to aid after-class learning. The purpose of the study was to investigate the pedagogical effects of the Lecture Video System with which the in-class lectures could be taped, edited and made available on the course website. This paper addresses students' learning behavior from six perspectives: intrinsic goal orientation, self-regulation, cognitive strategy use, self-efficacy, test anxiety and attitude towards the course. Experiments were conducted in two sophomore-level requirement courses. Data such as the usage statistics of the course website, student questionnaire, student interviews and course instructor interviews were collected and analyzed. The results reveal that student's sense of self-efficacy and attitudes towards the Linear Algebra course were improved by having the lecture videos available on-line. Although in both courses students' intrinsic goal orientation, self-regulation, test anxiety, and cognition strategy use were not affected, the majority of the students thought the lecture videos were useful to their post-lecture learning. It helped them better understand the more difficult concepts discussed in class. These findings pave a way for future practices of putting lecture videos on a course website.**

***Index Terms*—ICT integration, lecture video, on-line education.**

I. Introduction

The use of videos to enhance learning has many advantages. For one, audiovisual experiences can heighten students' awareness and encourage critical thinking skills.Past researches indicated that repeated viewings of explanations on difficult to grasp concepts can enhance learners' ability to understandcontents [1], relate topics or lessons that seem unrelated[2]and facilitate reflective thinking[3], which are important to effective learning.

Taping lecture videos can afford students' repeated viewing and rehearsing of the lecturematerials. It can enhancethe development of deep understanding in topics initially ignored [4],[5].With the friendliness ofWeb interface and the development of streaming technology, the implementation of lecture video systems is much easier than before. Therefore, many universities have developed lecture-capturing systems to assist students' learning, including the Lecture Browser system of Cornell University [6], the Inter Labs system of Bradley University [7], the Lectern system of New York State University [8], the Lecture Recording System of Kyushu Sangyo University [9], and the eClass system of Georgia Institute of Technology [10].

Implementation practicability is an important factor to be considered when developing lecture video capturing systems to facilitate learning. If the implementation cost is too high, such as needing an electronic whiteboard or a classroom with special equipment, the practicability would be limited. A practical lecture video production and viewing system was developed for this study. The instructors lecture in a typical classroom without having to change their original teaching style. The system allows the lectures to be videotaped, semi-automatically post-processed, and, automatically uploaded to the course website.

This paper will introduce our lecture video production system and report the results of the evaluation study conducted in two college-level computer science courses. The focus of the studying was to investigate whether students' learning behavior will be affected through the aid of the lecture video learning system. The study addresses students' learning behavior from six perspectives: intrinsic goal orientation, self-regulation, cognitive strategy use, self-efficacy, test anxiety, and attitude toward the course. The intrinsic goal orientation assessed students' belief about the important and interest of the course. It concerns the degree to which the student devoted himself to learning. The self-regulation about learning is defined as student's ability and motivation to plan, implement, and monitor various learning strategies to facilitate knowledge growth. As to cognitive strategy use, it measures the strategies, such as rehearsal, elaboration, and organization, used by students when they study. In terms of self-efficacy for learning, it concerns the student's perception of efficacy in his ability to study the course. Test anxiety assesses the degree of anxiety the students experience when taking exams. Many researchers suggest that factors such as intrinsic goal orientation, self-regulation, self-efficacy, test anxiety and cognitive strategy use have significant impacts on student performance and achievement in the traditional classroom [11]-[13]. Thus, if these perspectives of learning behavior can be improved, it will have positive impact to students' learning. Previous researches [5]-[9] about lecture video focused more on the technology and development of system architecture and functions, but less on the investigation about educational implications. In this study, we want to investigate whether the usage of the lecture video learning system can result in improvements in students' attitudes towards the course and their learning behavior along aforementioned perspectives.

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II. The Lecture Video System

An in-house lecture video system was developed for this study. The system contains two subsystems: the lecture video production subsystem and the lecture video note-taking subsystem. The lecture video production subsystem allows for semi-automatic and rapid editing of the taped lectures, while the lecture video note-taking subsystem allows students to watch the videos and take notes at the same time.

A. Structure of the Lecture Video Learning System

As shown in Fig. 1, the lecture video system contains three servers: a web server, a database server, and a video streaming server. The lecture video note-taking application is a web-applet that resides on the web server. This web-applet synchronizes playback of the video clips (via the streaming server), the lecture slides (via the database server) and any notes that students may have written (via the database server). The application was written in PHP and based on the AJAX communication model.

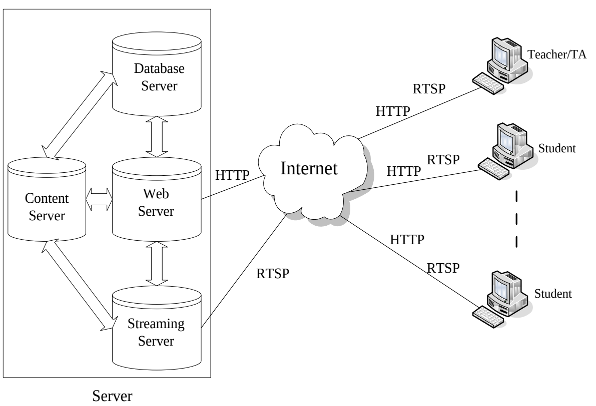

Fig. 1. Underlying structure of the Lecture video learning system.

B. The Lecture Video Production Subsystem

The lecture video's processing procedure is shown in Fig. 2. First, the lectures were video taped in class. The taped lectures were automatically segmented into video clips corresponding to the lecture slides [14]. The Teaching Assistant (TA) can quickly scan and correct any misplaced video clips. Finally each video clip was converted into streaming video format and automatically uploaded to the course website for playback over the Internet. Thus, the extra effort on the TA's part was minimal. The average time that a TA spent on post-processing was about 20 minutes per one-hour lecture

C. The Lecture Video Note-Taking Subsystem

This system has three main modules. The first module is the lecture video browsing module, the second is the note-taking module and the third is the viewing statistics analysis module.

1) The lecture video browsing module

The browsing module provides an integrated interface for selecting and viewing of lectures.A snapshot of the main screen is shown in Fig. 3. The screen is divided into four frames. The bottom-left frame contains a menu of available video clips. The video clips are arranged by lectures. Furthermore, the menu can display either the micro-image of the corresponding slides or simply the titles of the corresponding slides. When a particular slide is chosen, it is enlarged and shown in the Lecture slide frame on the bottom-right of the screen. In addition, the lecture video corresponding to the slide is played back in the Video playback frame on the top-left frame. The RealPlayer [15] streamline video player is embedded directly into the system so that the functionalities provided by the player, including pausing the video and fast-forwarding it to any particular point, are available to all users. The top-right frame contains the particular slide/video viewing information, such as the number of times that video clip has been viewed and students' rating of the video clip. The Video playback and the Lecture slide menu frames can be contracted so the currently displayed lecture slide can be seen in full. Furthermore, the Video playback frame and the Lecture slide frame can be interchanged so the student can watch the video in larger frame.

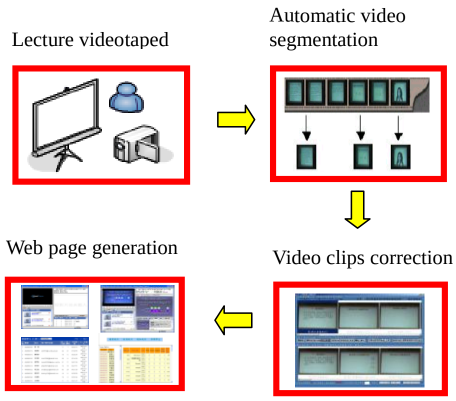

Fig. 2. Lecture video processing procedure.

2) The note- taking module

As depicted in Fig. 4, an editing tool bar is provided at the top of the lecture slide frame. The tool bar provides three slide annotation methods: the written input, keyboard input and highlight marker functions. With the written input function, if a tablet-pc is used, students will be able to write on the lecture slides. Students can also adjust the color and size properties of each annotation object. Since each annotation is treated as a separate object, annotations and notes can be erased individually. Furthermore, all the notes and annotations can be saved for future references. The next time the student viewed that slide, his or her own notes and annotation will still be intact.

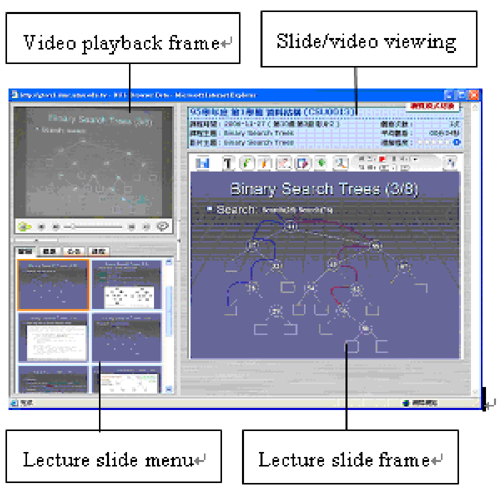

Fig. 3. Snapshot of the lecture video viewing system.

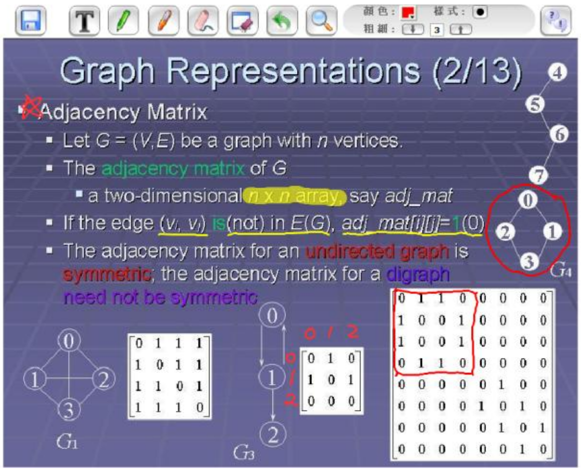

Fig. 4. The note-taking function in the Lecture slide frame.

3) *The viewing statistic analysis module*

The viewing statistic analysis module provides students and instructors useful system usage information. An open-ended data mining procedure is used so that users can virtually select what kind of data is to be displayed and how. Thus, an instructor may request to see the detail viewing statistics of a particular student or the class as a whole within a certain date range to gain an understanding of the particular lectures students might have most trouble with. For example, Fig. 5 is an example of student lecture video viewing statistics. The top chart shows the browsing frequency among all students in the class, while the bottom chart shows the frequency that each slide/video clips has been viewed. Furthermore, the system also mines the video viewing log file by association rule to provide video viewing pattern for students.

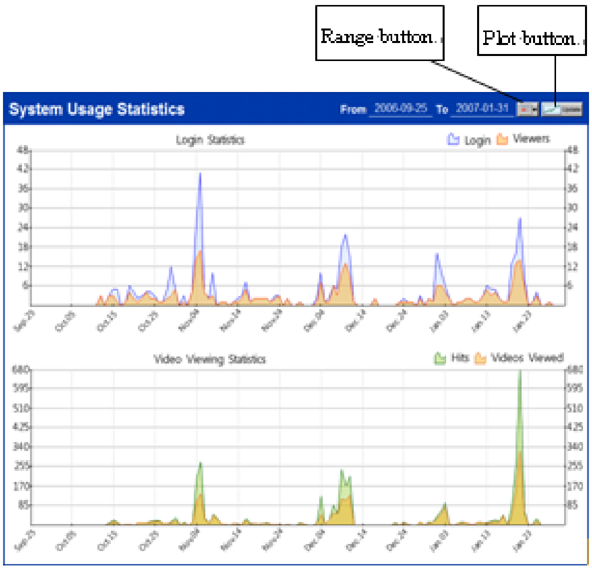

Fig. 5. Video viewing statistics.

III. Experimental Procedure

A. *Participants*

The experiment was conducted in two undergraduate requirement courses of the Computer Science curriculum: Data Structures and Linear Algebra. Forty-seven students were enrolled in the Data structures course, whereas 44 students were enrolled in the Linear Algebra course.

B. *Instrument*

The Motivated Strategies for Learning Questionnaire (MSLQ) [16], which consists of five sub-scales, is designed to measure university students' motivational orientation and their use of learning strategies to learn any particular course. This study used sub-scales with items designed to measure intrinsic goal orientation, self-regulation, cognitive strategy use, self-efficacy and test anxiety. Additional questions were designed to collect information on students' attitudes toward the two courses. Students were instructed to respond to the items of MSLQ in terms of their behavior in the specific course. The self-reported responses of these instruments can range from "strongly disagree" (1) to "strongly agree" (5).

C. *Procedures*

The TAs taped the in-class lectures (50 minutes per lecture) with video camcorder and used the in-house lecture video production system to prepare and upload the video clips onto the course website within 2 days after the lecture. The students can then view the taped lecture video at anytime from any place where Internet is available. At the third week of the semester, the MSLQ questionnaire was administered. Furthermore, the same questionnaire was administered again at the end of the semester.

IV. Results and Discussion

The MSLQ sub-scale scores were calculated for the students who had viewed lecture videos during the semester. Paired-samples T tests were conducted to measure the differences between the pre-test and post-test scores on each subscale. The results depicted in Table I reveal that in the Linear Algebra course, students achieved significant improvement in self-efficacy and attitude. However, in the Data Structures course, students did not show any significantly difference between the pre-test and post-test scores of MSLQ subscales.

TABLE I: T-Test of MSLQ between Pre-Test and Post-Test. (A) Linear Algebra Course (N=24). (B) Data Structures Course (N=23).

(a) Linear Algebra	Pre-test	Post-test	*t*	*p*
Intrinsic goal orientation	3.71	3.92	1.928	.066
Self-efficacy	3.36	3.57	2.340*	.028
Self-regulation	3.10	3.26	1.574	.129
Cognitive Strategy use	3.42	3.46	.418	.680
Test anxiety	3.36	3.25	-.696	.493
Attitude	3.70	4.04	2.390*	.025

*$p < .05$

(b) Data Structures	Pre-test	Post-test	*t*	*p*
Intrinsic goal orientation	3.67	3.73	.485	.721
Self-efficacy	3.47	3.49	.114	.590
Self-regulation	3.24	3.43	1.343	.062
Cognitive Strategy use	3.43	3.6	1.343	.194
Test anxiety	3.13	3.64	-2.333	.052
Attitude	3.66	3.54	.741	.371

It is encouraging to see that students achieved improvements in the reported degree of self-efficacy and attitude towards the Linear Algebra course. The self-efficacy subscale in MSLQ measured one's sense of self-efficacy and the expectancy for success. Self-efficacy refers to one's confidence in one's ability to study the course, whereas expectancy for success refers to learning expectations. Our results reveal that, in the Linear Algebra course, students were more confident in their understanding of the concepts taught in the class and they expected to do well in this course. The attitude measure, on the other hand, assessed student's attitude toward the course with the availability of the lecture video on-line. Our study showed that students improved significantly in their attitudes toward the Linear Algebra course. Many students stated during interviews that online lecture video is especially useful to mathematics courses. Due to limited class time, example and calculation are sometimes not understood in class. Through online lecture videos, students can re-attend part of the lecture based on their own learning condition or reviewing the lectures repeatedly.

Although students' intrinsic goal orientation, self-regulation, test anxiety and cognition strategy use were not significantly affected in both courses, the majority of the students thought the lecture videos to be useful for their post-lecture studying. It helped them understand the difficult concepts discussed in class better. Furthermore, students' post-lecture studying behavior is also different. In the past, discussions with peers were usually the first approach when students can't understand difficult concepts in class. However, online lecture video system provides an alternative. Many students mentioned that they now would review lecture videos first before discussing with peers. The lecture video system also served as a good reference during collaborative studies.

V. Conclusion

This study addressed the use of the in-house lecture video production system to automatically process and update course website with lecture slides and corresponding lecture video clips. The system and the lecture-video-enabled course website were put to use in the Linear Algebra and Data Structures courses. The findings reveal that student's sense of self-efficacy and their attitudes towards the Linear Algebra course improvedsignificantly with the availability of the lecture videos on-line. Although the system usage did not contribute to significant change in the perspectives of intrinsic goal orientation, self-regulation, test anxiety, and cognition strategy, the majority of the students thought that the lecture videos were useful to their post-lecture studying. It helped them better understand the difficult concepts discussed in class.

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