

Analysis of Daily Student Usage of an Educational Multimedia System

Albert I. Reuther and David G. Meyer
School of Electrical & Computer Engineering
Purdue University
West Lafayette, Indiana 47907-1285

Abstract - This paper presents an analysis of user logfiles from the Analog VideoJockey (AVJ) and the Digital VideoJockey (DVJ) Systems at Purdue University. The AVJ system is a digitally-controlled, analog video educational multimedia delivery system that serves videotaped lectures and video slide shows; the DVJ system is a fully digital Windows-based multimedia delivery system. This study explores how students are currently using the systems to determine potential improvements that could be made to existing and future educational multimedia systems under development at the School of Electrical and Computer Engineering. Emphasis is placed on understanding how students are using the systems on a daily basis by exploring the specific lectures and slides that are being accessed. From this information, a profile of daily media accesses is derived. Also, comparisons are made between expected and actual system usage. The paper concludes with a discussion of future research directions.

Introduction

Our society is ready and anxious to use more multimedia for education. According to a *Macworld* national survey of 600 adults, "consumers are much more interested in using emerging networks for information access, community involvement, self-improvement, and communication, than for entertainment." [1] According to the same *Macworld* poll, 65% of those surveyed had at least a moderate level of interest in distance learning, while 38% had high or extremely high levels of interest [1]. Furthermore, *Macworld* states, "Customers of commercial online systems and the Internet ... have demonstrated ... a hunger for all manner of educational resources." [1]

This learning is not only in our schools, but also at home and in business. "Organizations are linking learning to productivity, rather than [training] in advance of the act," says Robert Johansen, director of the new-technologies program at the Institute for the Future in Palo Alto California. "This is what we call "just-in-time learning." [2]. Furthermore, studies have shown that in a classroom setting, other benefits for computer learning come to light. In a Software Publishers Association (SPA) document that summarizes 133 studies, *Report on the Effectiveness of Technology in Schools, 1990-1994*, it is noted that "educational technology clearly boosted student achievement, improved student attitudes and self-concept, and enhanced the quality of student-teacher relationships"

[2]. Reinhardt goes on to say, "Especially promising technologies were interactive video, networking, and collaboration tools." [2]

To meet the demands for educational multimedia systems and facilitate advances in this trend, a greater understanding of today's educational multimedia systems must be acquired in order to better serve the system users and to improve future implementations of the systems.

This study is an effort to understand how students are using the Analog VideoJockey (AVJ) and Digital VideoJockey (DVJ) systems at Purdue University by analyzing the user logfiles generated by these systems. First, this paper briefly describes the AVJ and DVJ systems and explains how system usage information was extracted from the logfiles. An analysis of the usage data is presented next. The direction of future research on this project is presented in the conclusion.

The AVJ and DVJ Multimedia Systems

The AVJ and DVJ systems developed by School of Electrical and Computer Engineering at Purdue University are "multi-user, autolocatable, interactive multimedia delivery systems" [3]. The systems are used extensively in teaching EE 362 *Microprocessor Systems and Interfacing* and as aids in teaching several other courses offered by the School of Electrical and Computer Engineering, including: EE 266 *Digital Logic Design*, EE 364 *Software Engineering Tools*, EE 467 *Advanced Digital Systems and Embedded Microcontroller Design Laboratory*, and EE 477 *Digital Systems Senior Project*. The first version of AVJ is extensively described in [4] and [5], while version two (a thorough overhaul of version one) is described in [3]. The DVJ system is described in [6]. Several papers, [7], [8], and [9], describe further development and utilization of the AVJ and DVJ systems at Purdue University, as well as experimental course formats designed around them.

The AVJ system is a digitally-controlled, analog video delivery system. A representational block diagram of the system is presented in Figure 1. Access to the system is provided by the user interface program `vji` that runs on networked computer terminals. The command requests are routed through the data network to the Video Controller (implemented by an Intel x86 PC running Linux).

The Video Controller uses a bank of serial ports to communicate with the analog portion of the system. These serial ports provide control information to the laserdisc and

videotape playback units. Each laserdisc and videotape playback unit broadcasts audio and video on its own individual channel on the School of Electrical and Computer Engineering's closed circuit cable television network. Therefore, when a user is controlling one of the media devices, the user must set the tuner of the television receiver to the channel indicated to see the program that he or she is controlling. The Video Controller maintains a database that delivers still frames, animation sequences, and full motion video segments. When a user requests access to a specific media, the video controller finds where the media is located and then enables the user to control the media playback unit.

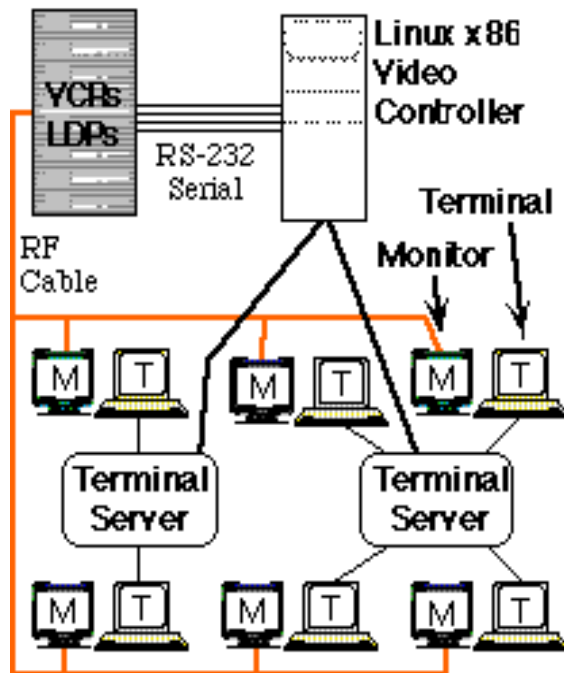


Figure 1. AVJ system block diagram.

In the current AVJ system configuration there are two laserdisc playback units, each holding the entire set (approximately 2000) of EE 362 course slides on a single disc. Thus students are able to access the entire set of slides at any time in the semester. The current system also has eight S-VHS playback units, each containing one or two videotape lecture modules. As the semester progresses, the modules that are being covered in the class lectures at that point in the semester are placed on-line. However, if a student wants to view a module that is not currently on-line, he or she can E-mail the course administrator who then puts the requested module on-line (students can also check out individual tapes, if desired).

In terms of user stations, the system also includes two lab clusters, two public clusters, and two classroom/lecture

hall installations that are capable of AVJ multimedia control and delivery. The two lab clusters have 12 user stations each, while the public clusters have 5 user stations each. Although only 10 users can control media, many more users can watch passively and still learn from the media. There are also "automated broadcasts" at least once each day (depending on the semester) that students can watch (but not control).

The students use VideoJockey Interface (vji), a UNIX text windows based environment, to navigate through menus to choose media items and choose control commands with single keystrokes. A short synopsis of the control commands follows.

Before any media is accessed, the user must log into the system. At this point the user is presented with menus to select the desired topic. When a media item is chosen within the topic, a *Find Best Target* command is issued which finds the media in the video controller computer's database. Then either a *Show Video*, or *Show Video Sequence* command is issued, depending on whether the media is on videotape or on laserdisc, respectively. To control the laserdisc players, there are two options to advance to the next or previous slide. The first is to advance to the next absolute slide on the laserdisc with the *Step +1* and *Step -1* commands. The second option is to advance within the slide module set since the slides are organized into groups, and groups are not always stored sequentially on the laserdisc. The *Step +1 Mod* and *Step -1 Mod* commands advance to the next slide within the group.

A much larger set of commands is available to control the videotape players. The commands *Play x1 Fwd*, *Play x2 Fwd*, *Play x2 Rev*, *Play x6 Fwd*, and *Play x6 Rev* play the desired tape media at various speeds and directions. Also *Goto & Play* will advance the tape to a specified location and start playing the tape. Finally, *Fast Fwd*, *Rewind*, *Pause*, and *Stop* implement the usual videotape functions.

The DVJ system is a fully digital Windows-based educational multimedia delivery system that serves digital video lectures and bitmapped slides over an Ethernet network and multimedia PCs [6]. A representational block diagram of the system is presented in Figure 2. The video and slide sessions are controlled and viewed in a Windows-based Microsoft Visual Basic application called DVJ that was developed for the system. Since the Fall 1996 semester, when this system went online, only videos have been available (software is in place to offer slide presentations as well). The file/video server can store digital copies of all of the videos for the entire course. Also, since the DVJ system is completely digital, there is no possibility for media contention. Currently, DVJ videos can only be viewed on PCs on the lab local area network, but future plans include allowing outside access via ISDN lines or similar technologies. The lab local area network includes two digital systems labs with 12 stations each, and the Multimedia Learning Lab with 15 stations.

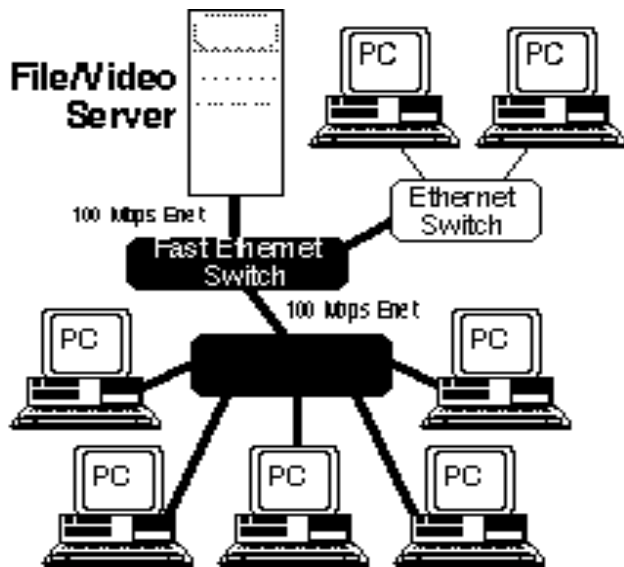


Figure 2. DVJ system block diagram.

Extracting Usage Data from the Logfiles

The intent of analyzing the AVJ and DVJ logfiles was to discover how the educational multimedia delivery systems were being used by students. The data does not necessarily provide a full picture of how individual students use all of facets of the technology because there are many ways students can view the course material. The logfiles that were analyzed are from the Summer 1995, Fall 1995, Spring 1996, Fall 1996, and Spring 1997 semesters for the AVJ system; and Fall 1996 and Spring 1997 for the DVJ system. In these semesters, students had several options for accessing the course material. One lecture video was broadcast early each weekday morning on the community public access cable television channel; some students would videotape these broadcasts and watch them later. All of the lecture videos that were loaded on the AVJ VCRs were broadcast on the School of Electrical and Computer Engineering's closed circuit cable television system at least once a day (for these scheduled broadcasts, no user control was allowed). Finally, students could access the videos and slides and control viewing these media in an interactive fashion. Since all of these viewing opportunities exist, profiles of how a given student used the media cannot be found, but the usage of the AVJ and DVJ systems themselves can be analyzed.

The logfiles were originally intended as system debug files only, but were later modified to provide additional information on system (and media) usage. Two programs were written to extract the data used in this study from the raw logfiles generated by the AVJ system. The first program, *logparse*, analyzes each line of the logfile and decides which entries pertain to logins, logouts, video

sessions, slide viewing, media contention, etc.; *logparse* also attempts to deduce additional system usage characteristics from this data. The second program, *logins*, determines statistics on events within given intervals. For example, it is able to determine how many logins occurred each day of a semester. For the DVJ system, another program, *dvjparse*, extracts information from the DVJ logfiles pertaining to logins, logouts, and video sessions; *logins* is then also used on the *dvjparse* output.

Since the logfiles do not record all of the data necessary to fully analyze each event, some assumptions had to be made on how students are using the systems to extract more meaningful data. It is assumed that each user has a unique login name and that the users do not login multiple times simultaneously. Overall, very few multiple simultaneous login names occurred so the impact is only slight. Furthermore, since the Fall 1996 semester, additional information has been recorded that associates each command with a unique login session. For data logging purposes, a video session is defined to start with any video command besides *Stop* and *Pause*, and ends with a *Stop* command. Slide viewing sessions are extracted and recorded in a similar manner. Some users had extremely long login and video session times. After investigating the causes, it was determined that sessions longer than two hours (7200 seconds) were logins and video sessions that were forgotten. Therefore, any login session or video session that lasted longer than 7200 seconds was truncated to 7200 seconds.

The *logins* program determines statistics on events within given intervals. The interval was set in a header file and was set to one day (86,400 seconds) for these analyses. On each line of the output file, the *logins* program records the date stamp (date and time) of the interval, the number of logins and video sessions that started in the interval, the number of slides that were requested in the interval, the duration of the logins and video sessions that occurred within the interval, and the number of video and slide contentions that occurred within the interval. Starting Fall 1996, the names of modules that students accessed were also recorded. With this information, *logins* profiles how many times each video and slide presentation is accessed during each interval.

Results From the Logfile Analysis

First the login data from the AVJ system was analyzed. The usage statistics for the Summer 1995 semester are significantly lower than the statistics of the other semesters. This can be attributed to the fact that scheduled broadcasts of videos occurred three times a day, so many of the logins were for viewing slides, which generally took less time. Also, the Fall 1995 statistics are lower than the Spring 1996, Fall 1996, and Spring 1997 statistics. This can be credited to the greater use of *vji* as the Fall 1995 semester

progressed. As *vji* was used more, the popularity of the system increased since *vji* greatly simplified use of the AVJ system over the previous command line interface.

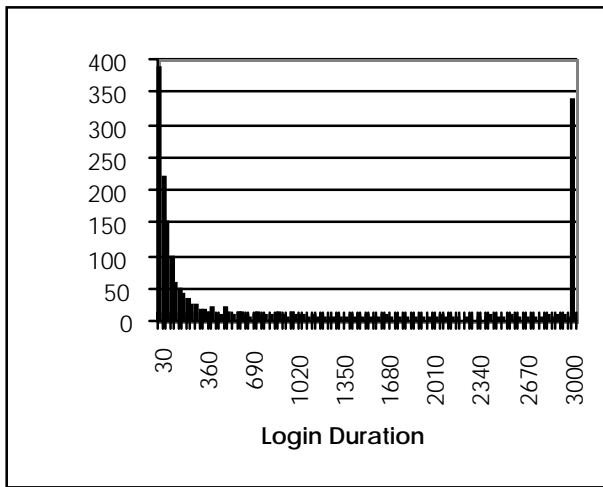


Figure 3. Login duration (secs.), Spring 1996.

Upon examining the distribution of login duration for the AVJ system (a representative distribution for the Spring 1996 semester is shown in Figure 3), it was noted that a large percentage of logins lasted less than 600 seconds (10 minutes). These short sessions were from students who were viewing slides to help with homework and practice exams. As evidenced in the output files, many students would log in, watch a few slides that help solve the homework problem at hand, and then log out. Some short logins were from students who were unable to access the media they desired. The logins that lasted longer than 600 seconds consisted primarily of video sessions.

The video session statistics for the AVJ system have distributions similar to those of the logins (see Figure 4 for a representative distribution from the Spring 1996 semester). Similar to the login duration statistics, there is a large percentage of video sessions that lasted less than 600 seconds (and many under 30 seconds). Many of these video sessions are fast forwards and rewinds while some are errant video playback starts.

For this analysis, a *day* is defined as starting at 3:00 a.m. and ending 24 hours later. It is defined in this way because many students are still working on the system in the early morning hours, but by 3:00 a.m. virtually all logins from the previous day's work are done. An analysis based on weekly data of both systems showed that Tuesdays, Wednesdays, and Thursdays were generally the busiest. This is expected, because many students are on campus with classes and are using the systems in-between classes and in the evenings. Also, it is easiest for students to gain access to user station labs during the week, while on the weekend some of these facilities are closed. Saturdays were usually the least busy. Sunday results were similar but

the values were not quite as low as Saturday values. These results are also expected, because many students don't study as much on campus on Saturdays, while Sunday evening is a time when many students study for the upcoming week.

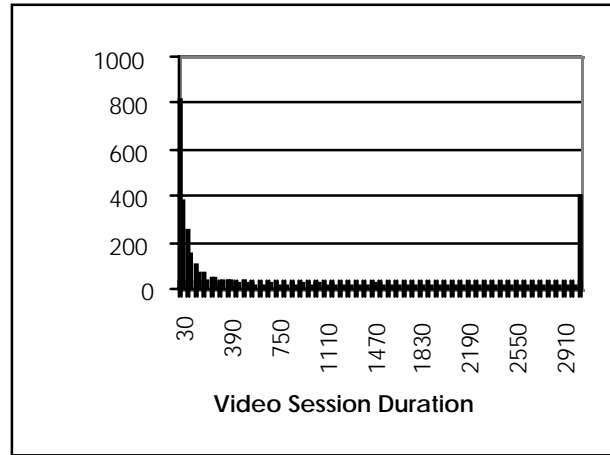


Figure 4. Video session duration (secs.), Spring 1996.

Comparing login durations to video session durations of the AVJ system, it can be concluded that during the Fall 1995, Spring 1996, Fall 1996, and Spring 1997 semesters, over half of all login time was spent watching videos. In the Summer 1995 semester, though, only a quarter to a half of all login time was spent watching videos. As many as three scheduled broadcasts of videos happened each day in the Summer 1995 semester, while at most one scheduled broadcast of videos occurred in the Fall and Spring semesters. Therefore, in the Summer 1995 semester, students didn't watch that many videos individually, opting to watch the scheduled broadcasts, and much of the individual login time that semester was spent watching slides.

In the Summer 1995 semester, the most logins and video sessions occurred in the first two weeks (out of eight) of the semester. The logins per day and video sessions per day drifted off as the semester progressed, but the slide usage was highest the week before and the week of exams. There were two "hourly" exams and one final exam the Summer 1995 semester. In the Fall and Spring semesters, the system usage rose before the two hourly and final exams. All of these results support that students are using the multimedia systems to review course material in preparation for exams. The time periods when significant declines in system usage occur are during vacation days, as might be expected. Also expected are the mild declines during the week after an exam.

Besides the rises in overall usage of the AVJ system explained above, there were some days when the number of slides viewed peaked significantly compared to the number of slides viewed during adjacent days. These peaks

correspond to days prior to a homework assignment due date. Since the slides have many example problems that are worked out step-by-step, students used these resources to help complete problems on their homework.

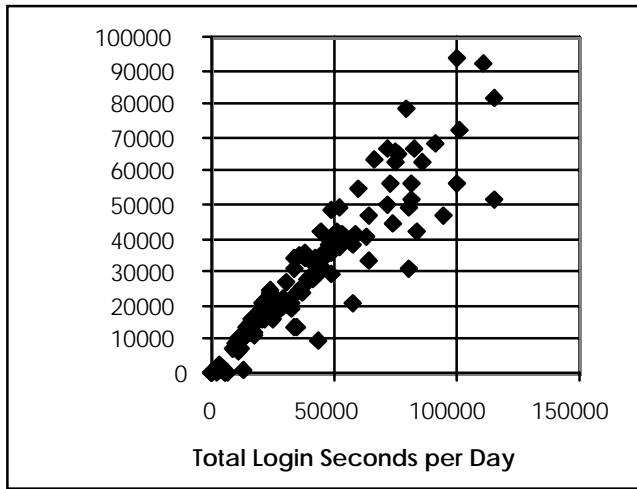


Figure 5. Login session time versus video session time, Spring 1996.

In general, all five statistics tracked together. In other words, when the logins and login durations rose, so did video sessions, video session durations, and slide viewing. These findings are also supported by the data in the logfiles. The durations of logins and durations of video sessions often track each other closely. This is expected, since students would not be able to be engaged in a video session if they were not logged in. This is also supported by the linear trend shown in the video session time per day versus total login time per day graphs. A representative graph from Spring 1996 is shown in Figure 5. These graphs show, generally, that when students were logged in for a large number of seconds on a given day, they viewed a similar number of seconds of video that day.

The slides per day, however, do not always follow the linear trend that video session time per day versus total login time per day graphs did. Figure 6 representatively shows the slides per day versus total login time per day graphs. There is no distinct pattern of how many slides would be viewed given the total seconds that users had been logged into the AVJ system.

When analyzing what individual video modules were accessed on both systems in the Fall 1996 and Spring 1997 semesters, there is a strong correlation between module and time of semester (since students are watching videos that pertain to the material covered in class). Also, there are certain modules that are popular early and then are popular again during exam time. Other modules are generally not reviewed before exams. These modules are also the ones that are not popular overall and for which no contention in the AVJ system was observed. The more popular video

modules are probably the videos that cover materials that students find they need to review most, and they review them over and over. Also certain modules carry two or three shorter video lectures instead of one long video lecture, so the multiple shorter ones might get more accesses.

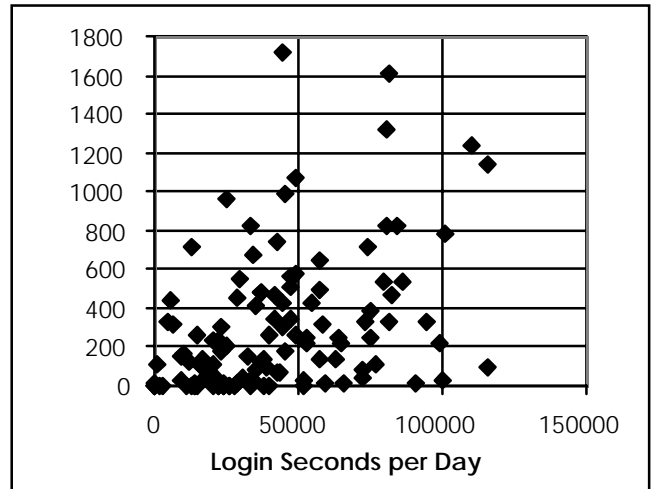


Figure 6. Login seconds per day versus slides per day.

On the AVJ system, there is much less contention for slide sessions than for videos. Between 1% and 2% of all slide accesses were in contention, while as many as 10% of all AVJ video accesses were in contention. This may be because there is a higher demand for videos than for slides and also because the usage patterns for videos and slide sessions are different. As mentioned earlier, slide sessions are usually much shorter than video sessions because students are just answering “quick” questions with them instead of viewing an entire lecture.

In comparing AVJ and DVJ video sessions, during the Fall 1996 semester there were very few days where there were more DVJ video sessions than AVJ video sessions. Usually there were many more AVJ video sessions than DVJ ones. This probably occurred because the DVJ system was just coming on-line that semester and had not gained any popularity among the students. In the Spring 1997 semester, though, there were many more AVJ video sessions than DVJ ones early in the semester, while in the second half of the semester the numbers were reversed. A graph comparing the number of video session per day is shown in Figure 7. The DVJ system probably became very popular among the students in the second half of the Spring 1997 semester (when more students were studying for exams) because there was no possibility of contention for videos as there is on the AVJ system. However, there are still many students that prefer using the AVJ system because it offers slide presentations and the video quality of the S-VHS videos on the AVJ system is currently better than the 320x240 digitized videos on the DVJ system.

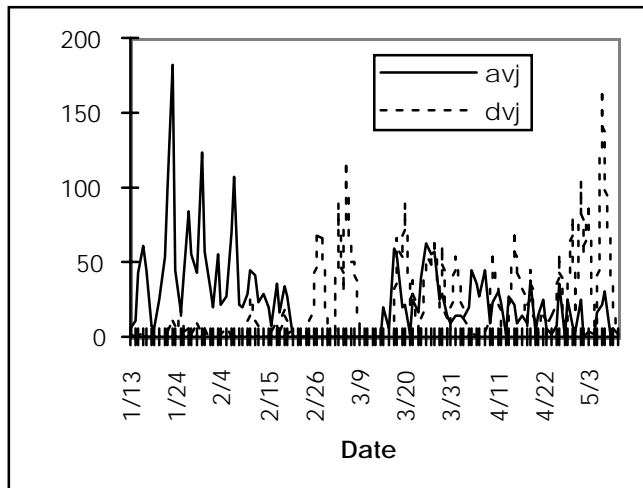


Figure 7. AVJ and DVJ video session per day, Spring 1997.

When considering the login sessions and login durations, there are generally fewer login sessions as well as less total time on the DVJ system than on the AVJ system. This can be explained by the fact that the DVJ system only offers videos and no slides yet, whereas the AVJ session offers both.

Finally, looking at how individual students utilized the systems, only a few generalizations can be made. First, there is a small percentage (around 25%) of the users each semester that utilize the system a great deal, and usually these "heavy user students" either prefer watching slides or videos, because one value is usually much higher than the other. This supports the notion that students will prefer one form of media over the other and will continue to use the one that fits their learning style throughout the semester.

Conclusions

Many of the results obtained support expectations of system utilization. For instance, the data indicates that videos are used extensively by students to review course material before exams, and that slides are used extensively for help on homework problems. Also, we have learned that the best time to update system software or change media modules is early in the morning or very late on weekends. Furthermore, we have learned that certain videos are much more popular than others on both systems, that the DVJ system is gaining popularity in its first year of service, and that there are groups of "heavy users" on both systems.

As part of our continuing research, the logfiles generated by each system (AVJ and DVJ) will be studied in greater detail. Slide presentations will soon be added to the DVJ system and more usage data will soon be saved by DVJ system for further analysis, especially for video module and slide presentation usage profiles. Venturing further into the future, a study could explore correlating questionnaire comments (as described in [7]) to students'

use of the AVJ and DVJ systems. Also, user preferences between the AVJ system, the DVJ system, and possibly other educational multimedia delivery systems can be studied. Finally as usage profiles of individual video modules and slide presentations are better understood, probabilistic usage profiles could be derived that can aid in studying future implementations of educational multimedia delivery systems.

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