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Examining the Use of Lecture Capture Technology: Implications for Teaching and Learning

Jovan F. Groen

University of Ottawa, jgroen@uottawa.ca

Brenna Quigley

University of Ottawa, bquig021@uottawa.ca

Yves Herry

University of Ottawa, yherry@uottawa.ca

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Abstract

This study sought to provide a better understanding of how lecture capture technology is used by students and how its use is related to student satisfaction, attendance, and academic performance. Using a mixed method design with both quantitative and qualitative methods to collect data, instruments included a student questionnaire, interviews and focus groups, lecture capture usage statistics, and grades. Results showed that 63% of students were satisfied with lecture capture and 75% of students indicated that it had facilitated their learning. Students primarily used the recordings to learn what they had missed while in class (79%) or because they were absent (72%). 70% of students reported having watched at least 50% of the recorded material (27% watched all the material), and only 8% of students did not view any recordings. Student satisfaction had a significant positive relationship with the number of lectures viewed. In regards to attendance, the self-reported data from students indicated that 61% of students did not miss classes (none or just one class). Students with the greatest number of missed classes viewed the recordings more frequently. As for student achievement, 68% of students indicated that lecture capture helped them to achieve better grades. Students with lower course marks accessed the recordings more frequently than those with higher marks. Instructor perceptions were that lecture capture predominately helped average to below average students achieve slightly better marks, but had less of an impact on the grades for particularly low and high achieving students.

Cette étude avait pour but de fournir une meilleure compréhension de la manière dont la capture de cours en vidéo est utilisée par les étudiants et comment son utilisation est reliée à la satisfaction des étudiants, à leur assiduité et à leurs résultats académiques. Grâce à un concept de méthodes mixtes comprenant des méthodes quantitatives et qualitatives pour recueillir les données, les instruments incluaient un questionnaire à remplir par les étudiants, des entrevues et des groupes de discussion, des statistiques sur l'emploi de la capture de cours, ainsi que des notes. Les résultats ont indiqué que 63 % des étudiants étaient satisfaits de la capture de cours et 75 % d'entre eux ont pensé que cette méthode avait favorisé leur apprentissage. Les étudiants ont principalement utilisé les enregistrements pour apprendre ce qu'ils avaient manqué quand ils étaient en classe (79 %) ou parce qu'ils étaient absents (72 %). Soixante-dix pour cent des étudiants ont indiqué qu'ils avaient regardé au moins 50 % des enregistrements (27 % avaient regardé toutes les vidéos) et seulement 8 % des étudiants n'avaient regardé aucune vidéo. La satisfaction des étudiants a eu une incidence positive importante en fonction du nombre de vidéos visionnées. En ce qui concerne l'assiduité, les données auto-déclarées par les étudiants ont indiqué que 61 % des étudiants n'avaient pas manqué de classes (aucune absence ou seulement une absence). Les étudiants qui avaient le plus grand nombre d'absences avaient regardé les vidéos plus fréquemment. En ce qui concerne les résultats des étudiants, 68 % d'entre eux ont indiqué que la capture de cours les avait aidés à obtenir de meilleures notes. Les étudiants qui avaient obtenu les notes de cours les plus basses avaient regardé les vidéos plus fréquemment que ceux qui avaient obtenu des notes plus élevées. Les instructeurs ont déclaré que la capture de cours en vidéo avait surtout aidé les étudiants de niveau moyen ou inférieur à la moyenne à obtenir des notes un peu meilleures, mais qu'elle avait eu un effet moins important sur les notes des étudiants très peu performants ou sur celles des étudiants très performants.

Keywords

lecture capture, lecture recording, vodcast, Echo 360, instructional technology, higher education

Cover Page Footnote

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While the recording of lectures for the purposes of content review, accommodation, and distance education has existed for well over a decade, institutions in higher education have only begun to invest in comprehensive lecture capture systems and make them available across their campuses. Current research shows colleges and universities are making significant investments in the development of infrastructures that provide flexible educational options to support the needs of a diversity of learners (Gosper et al., 2010). However, the focus of these investments has rested primarily on the installation and operational considerations of the technology, not on the pedagogical implications and support necessary for instructors and students to effectively integrate this technology into their teaching and learning.

Lecture capture technologies are also known as “web-based lecture technologies (WBLT)” (Germany, 2012, p. 1208) and are used for “capturing face-to-face lectures for web delivery” (Woo et al., 2008, p. 82). Lecture capture offers students personalized access to a full lecture outside of class time paralleling what was offered in the classroom. Students can download the files onto their laptops, tablets, etc. (Cooner, 2010). Echo360, the lecture capture system licensed for use at the University of Ottawa, captures what the instructor is saying as well as everything that is projected using the podium computer. The lecture capture system synchronizes the material presented with the explanations provided by the instructor. Students can scroll through the video of a lecture at their own pace, pausing and rewinding to re-listen to and/or re-watch segments of a lecture. Students can also select a section of the presented material and listen to the explanations provided by the instructor. Usually, videos remain online for the duration of the course permitting students to return and re-watch lectures throughout the semester. Instructors can also edit videos before posting them, cutting out sections of group work, for instance, which become largely inaudible in the video. The filming is directed towards, and focused on, the instructor only, so the full class is not in view nor being filmed.

In the pursuit of enhancing the student learning experience, this study sought to provide a better understanding of how lecture capture technology is used at the University of Ottawa, and how its use is related to student satisfaction, attendance, and academic performance.

The Use of Lecture Capture

The frequency of use and the ways in which students use lecture capture have been a recent subject of interest in several spheres of research. Lecture capture videos are typically used by students in a class when made available, but for different reasons and in different ways (Dev, Rindfleisch, Kush, & Stringer, 2000; Traphagan, Kucsera, & Kishi, 2010). For example, based on the results of an end-of-course survey, to which 50% of a Year 1 cohort and 62% of a Year 2 cohort responded, Davis, Connolly, and Linfield (2009) noted that by the end of the course, “the majority of students had accessed lecture capture material online” (p. 10). For Chen and Lin (2012) though, the number of users appears to be lower. They report that one-third of students in their study’s sample had accessed online recorded lectures. A study by Craig, Wozniak, Hyde and Burn (2009) that looked at usage data from over two years, despite a few gaps of missing data, notes medical students’ usage of lecture capture in a blended learning environment at the University of Sydney Medical Program increased considerably from one year to the next with views nearly quadrupling. Craig et al. (2009) concluded there was “an extremely high uptake by students of the online lectures” (p. 164). Gosper et al. (2010) studied lecture capture usage in four Australian universities and found that not only were lecture capture videos being used and well-received by students, they

were also being used by students for different reasons, which they note “mirrors” (p. 252) the findings of other research studies.

One of the most popular uses of lecture capture technologies noted by Davis et al.’s (2009) pilot study of 30 recorded lectures at the School of Electronic and Electrical Engineering at the University of Leeds was “for revision or to recap on difficult concepts” (p. 10). Being able to revisit excerpts of lectures, and the possibility of revisiting complex concepts in particular, appears to be a common way that many students take advantage of recorded lectures (Leadbeater, Shuttleworth, Couperthwaite, & Nightingale, 2013). Similarly, in a study examining the use of video recorded lectures at a University in Singapore, Soong, Chan, Cheers, and Hu (2006) found that “one of the main reasons why students access video recorded lectures is to watch selected parts of the lectures [. . .] which they do not understand ($N=904$, 34.5%)” (p. 791). Students participating in this study also noted that watching the videos helps them prepare for exams (21.5% out of the 904 participating students). Reported benefits also included being able to watch the videos anywhere and anytime, including when ill and missing classes, not having to wake up early for lectures, or being unable to attend a lecture due to other conflicting commitments. According to Collie, Shah, and Sheridan (2009) who studied six summer courses at the University of Auckland Business School:

[T]he most frequently cited benefits to students [. . .] were revision of hard concepts, then additional note-taking, followed by revision for the exam or assessment, then review of material they had missed in class through inattention. Time Shifting – where students might skip a lecture due to work or an appointment knowing that they can catch up online - was mentioned next. Students indicate that attending paid work, particularly if offered casually/at late notice, may have been a reason for using LRs [lecture recordings]. Finally [lecture recording] use did not appear related to the timetabling of classes (i.e. early morning classes). Academic staff reported minimal or no drop in attendance. (p. 79)

All of the students in the focus group by Chang (2007) mentioned using lecture capture videos for revisions purposes. Phillips et al. (2011) have also noted that access to recorded lectures increased before an assignment was due, and numerous other scholars have observed a peak during exam time (Chen & Lin, 2012; Gorissen, Van Bruggen, & Jochems, 2012; Winer & Cooperstock, 2002). Not all studies confirmed these findings though. Traphagan et al. (2010), for instance, found that both reviewing course material and trying to develop a better understanding of course content were less commonly the reasons as to why students said they were consulting video recordings. The study by Traphagan et al. (2010) of a Geology course found that out of approximately 136 students (89% of 153 students in one class), “Students watched webcasts to make up for a missed class (83%), to review course content before exams (70%), to understand lecture content better (46%), and to add more information to their notes (42%)” (p. 33). Other students report using the recorded videos to support linguistic differences. In particular, students whose first language is not the same as the language of delivery in a course benefited from being able to review material (Craig et al., 2009; Davis et al., 2009; McCrohon, Lo, Dang, & Johnston, 2001).

Aside from the reasons for using lecture capture, the ways in which students are using recordings also vary. However, the most common viewing preference seems to be watching specific segments of recorded lectures based on specific needs. Therefore, students tend to use lecture recordings strategically (Van Zanten, Somogyi, & Curro, 2012). This finding was echoed in the study by Chang (2007) who explained that, in terms of revision, “students indicated that

they would not listen to the entirety of the lecture but [would] focus only on the relevant sections” (p. 139).

Attitude Towards Lecture Capture and Student Satisfaction

Lecture capture is typically well received by students (Craig et al., 2009; Davis et al., 2009; Moskal, Dziuban, & Hartman, 2012; Sher & Gajendran, 2008; Woo et al., 2008). In fact, multiple researchers have noted that there is a strong demand from students to start incorporating more technology into the classroom, and more specifically, to make greater use of lecture capture technology. Many students who have used the technology in one course are also beginning to ask for access to lecture capture in other courses (Davis et al., 2009).

Students clearly note they find that video recorded lectures are useful (Davis et al., 2009; Soong et al., 2006). Soong et al.’s (2006) study found “94.9% (N=1140) of the students [agreed or strongly agreed that] the video recorded lectures are useful in relation to their studies” (p. 790). Davis et al. (2009) also noted almost all of those who had accessed the materials found them useful. Williams & Fardon’s (2007) study of “130 students with disabilities and medical conditions revealed overwhelming support of Lectopia at UWA [University of Western Australia] with almost all students rating it as an ‘Essential’ or ‘Useful’ learning resource (65.7% and 32.4% respectively)” (p. 4).

Some researchers are turning to different multimedia theories and technology-based trends and arguments to explain the positive reception of lecture capture technology (Bassili, 2008; Owston, Lupshenyuk, & Wideman, 2011). Studies informed by “media richness theory” (Bassili, 2008) focus on what different modes of communication can affectively relay to students while drawing conclusions about which modes students would favour under which circumstances. The notion of “digital natives” and the “Google generation,” or the notions that students are becoming more and more proficient at using a variety of tools and technologies as a result of frequent everyday use, are a few other arguments being used to support or justify student interest in lecture capture technology (Davis et al., 2009; Prensky, 2001). According to Davis et al. (2009) the “enthusiasm” for and usage of lecture capture can be, in part, credited to a shift occurring where young people are engaging more interactively with information in contrast with the more traditional expectation that learners are “passive consumers of information” (Davis et al., 2009, p. 5).

Lecture Capture and Attendance

Much has been written about attendance and lecture capture. Reduced class attendance is one of the greatest fears and causes for resistance from instructors who consider using lecture capture (Chang, 2007; Craig et al., 2009; Davis et al., 2009; Williams & Fardon, 2007). However, numerous studies note that these fears are often unfounded and research shows that the availability of recorded lectures does not have a significant negative impact on attendance (Chen & Lin, 2012; Craig et al., 2009; Deal, 2007; Holbrook & Dupont, 2009; Pursel & Fang, 2012; von Kinsky, Ivins, & Gribble, 2009).

Many of the students surveyed have reported that they do not equate the recorded lectures with the experience of attending a ‘face-to-face’ lecture (Davis et al., 2009). According to Traphagan et al. (2010), “students tended to agree or strongly agree (55%) [of 153 student participants] that they preferred getting course content in class, even when it was available in other

ways” (p. 30). There are key elements of the classroom experience that are not replicated through the online environment, and most students are not using the video recordings as a substitute for attending lectures in person and on campus (Davis et al., 2009). Numerous researchers have also noted that students are better able to focus in class because they have access to lectures again afterwards, and so they can focus more on the content and less on taking extensive notes (Davis et al., 2009). According to a study by Schreiber, Fukuta, and Gordon (2010), 13 out of the 55 students who provided written comments noted that one disadvantage about using podcasts or recorded lectures, despite all the convenience these tools afford, is “podcasts are less engaging [than live lectures]. They felt that podcasts ‘require discipline.’ They ‘can be put off’ and are ‘easy to put off.’ One is ‘less likely to do it’ and there is ‘often no incentive’” (p. 4). These reasons are a considerable deterrent for students who are working hard to stay on schedule with their learning and trying to maintain consistent study habits.

Not all research has denied a connection between attendance and the use of lecture capture technologies though. Through their review of 47 journal articles dealing with lecture capture, Pursel and Fang (2012) noted that class attendance was directly studied, or referenced, in 26 of the articles reviewed and of these articles “approximately 20% of the studies [perhaps indicating 5-6 articles] identified a relationship between lecture capture utilization and decreased attendance” (p. 5). Just as teachers are anticipating changes in attendance rates as a result of students having access to the tool, students also believe there might be a connection when they reflect on their own experiences. It is not clear there is an actual link, but this is definitely a primary consideration and observation for multiple stakeholders. Pursel and Fang (2012) add that “self-reported data and actual attendance counts indicated no influence or no negative influence of lecture capture technologies on attendance” (p. 5). Yet another view is offered by Franklin et al. (2011) who studied first-year and second-year medical students’ use of lecture capture. These authors note that “It is fairly acceptable at our school that attendance in the first year is generally greater than in the second” (p. 24). When surveying the second-year students, Franklin et al. (2011) found the availability of recordings reportedly led to a decrease in attendance in only 14.3% of responders. Surprisingly, 5.4% of other students reported an increase in attendance, perhaps because they could devote undivided attention to lecture content without having to focus on note taking during lectures. Thus, Franklin et al. (2011) conclude that the use of lecture recordings does not dramatically decrease lecture attendance. Most normal lecture attendees will attend lecture, irrespective of the other learning resources made available to them. Franklin et al. (2011) add:

What is interesting to note is that 48 of second-year responders also reported using recordings only. The 48 students, representing 26.9% of the entire class, may reflect students likely never to attend lecture, irrespective of how recordings might further influence their decision making process. It should be pointed out that in three of four second-year disciplines, students who did not attend lecture (e.g. used recordings only) statistically performed equal to their fellow students who attended lectures, or utilized both learning resources. (p. 26)

It is possible that factors other than just the availability of lecture content affects students’ decisions on whether to attend or not. All told, there appear to be different reasons for why there are no noticeable drops in attendance in some classes when lecture capture is being used. Chang (2007) believes it “may be due to the way they [referring to the lecturers] add value to their

lectures” (p. 140). If students value the lectures, they will want to attend them whether or not there is lecture capture available.

The value of the tool for students seems to outweigh the potential threats to attendance (Craig et al., 2009), especially since, in most cases, there appears to be at most only a slight impact, if any, on class attendance rates (Davis et al., 2009). There are ways that instructors are proactively working to mitigate potential decreases in attendance when using lecture capture. Of greatest significance was the type of experience and interactions that students gain from attending the face-to-face sessions that were not replicated with the lecture captures.

Impact of Lecture Capture on Academic Performance

Many studies have examined relationships between the use of lecture capture and students’ academic performance. Some research suggests that more frequent access to recorded lectures leads to an increase in positive results and learning behaviours (Phillips et al., 2011; Traphagan et al., 2010). Inglis, Palipana, Trenholm, and Ward (2011), on the other hand, found that “students who often accessed online lectures had lower attainment than those who often attended live lectures or the support centre” (p. 490). Owston et al. (2011) reviewed data from 860 undergraduate students and found the same was true: “[S]tudents who accessed the recordings once per month or less often achieved significantly higher grades than those who accessed them 4 to 6 times per week or more often.” (p. 265). Owston et al. (2011) also noted that students who accessed recordings only a few times per month had significantly higher grades than students who viewed them 4 to 6 times per week. Owston et al. (2011) suggest two possible interpretations of these results:

First, it may be that the higher achieving students do not need to access the supplementary videos as often in order to succeed in the courses, thus reflecting an efficient learning strategy of viewing them only when they feel necessary. Another interpretation might be that the lower achieving students lack the confidence, comprehension skills, and/or note taking ability so that they feel that they have to view the videos more often. (p. 265)

Gosper et al. (2010) found that 66.7% ($N=813$) of students in their survey believed that recorded lectures helped improve their results “in either a significant or moderate way,” and 79.9% of students felt that recorded lectures made learning “easier” (p. 255). In a study by Chen and Lin (2012) that surveyed 312 students studying microeconomics at a university in Taiwan, results reveal that students using online resources achieved higher grades than those who did not use online resources. Chen and Lin (2012) considered the different ways in which students are using the videos and the possible consequences of these applications though:

If students are using online videos for cramming, then the availability of online recorded lectures helps students pass the exam and promotes the less desirable learning style which could hamper students’ learning in the long term. Whereas if students are using the online recorded lectures concurrently with their notes, then the videos are complementing their studies. And if students are using the online recorded lectures to fill in the gaps in comprehension, then the online videos are acting as review sessions and help students’ learning too. (p. 9)

While positive impacts are often perceived, many studies show that there is very little or no significant impact on students' academic performance or course marks as a result of using lecture capture technologies (Chang, 2007; Franklin et al., 2011; Leadbeater et al., 2013; Savage, 2009; Traphagan et al., 2010). Savage (2009) considers this may be possible because a recorded lecture "replays the existing lecture and does not provide students with any new problem-solving opportunities that can be used to learn the relatively complex, integrated material covered on the final exam" (p. 352). Thus, students who engage with course material presented in lectures, despite not having access to "replay" the material, also have the potential to perform well academically. A closer look at students' usage patterns would be needed to determine at what point becoming entirely dependent on the recorded lectures, versus using them occasionally for a missed class, might start having an impact on student academic performance, as well as how lecture capture technology could be used to achieve more than what the traditional learning experience can offer students.

Research Questions

Based on the results of recent research on lecture capture, in conjunction with an interest in improving lecture capture usage at the University of Ottawa, this study sought to investigate the following research questions:

1. How are lecture capture recordings used by students?
2. To what extent might the integration of lecture capture technology affect student satisfaction, attendance, and achievement?

Method

This study used a mixed methods design with both quantitative and qualitative methods to collect data. Data collection methods included a student questionnaire, interviews and focus groups, actual logged usage of lecture capture recordings by students, and students' grades.

Student Questionnaire

Data was collected using a four-part questionnaire administered online to students near the end of the semester. The questionnaire consisted of questions relating to demographic and course information, study habits and motivation for learning through the use of a Study Process Questionnaire (Biggs, Kember, & Leung, 2001), as well as students' self-reported use of lecture capture recordings (Gosper et al., 2010; Vajoczki, Watt, Marquis, Liao, & Vine, 2011). The principal components of the questionnaire used in this study were adapted from an extensive study undertaken at four Australian universities (Gosper et al., 2010).

Interviews and Focus Groups

The study undertook a more detailed exploration of the educational implications of the use of lecture capture through student and instructor interview/focus group sessions, which were held after the completion of each course.

Participant Recruitment and Participation

Following ethical clearance, a member of the research team visited each course section at the outset of the semester to inform students of the Echo 360 component of the course and again at the end of the semester (before the final exam) to invite students to participate in the online questionnaire. The link was made available to students via the learning management system. Incentives to complete the questionnaire were offered in the form of a draw to win either an iPad or one of 50 coffee shop gift certificates.

Data was collected in the fall of 2012 and the winter of 2013 across 18 course sections. Participating courses, which included a total of 5925 students, originated from the Departments of Biology, Chemistry, Math, Business, and Population Health. 3625 students were enrolled in 17 course sections (average of 213 students per section), while the remaining 2300 students were introductory chemistry students who made use of lecture capture recordings via the lab components of their courses. It was not a requirement of the study that students in the courses use the lecture capture recordings.

A total of 1145 students completed the study questionnaire for a participation rate of 19%. Of this number, 775 students gave consent to correlate their responses with their grades and their viewing analytics, which were being logged through the online system. Of those that completed the survey 64% identified as female and 36% male, with 80% of respondents between the ages of 18-20 and the remaining 20% between 21-25.

Eight interview/focus group sessions were also conducted with a total of eleven students from Chemistry, Biology, and Mathematics courses. Six students participated in one-on-one interviews. There was one group of two students and one group of three students that participated during the focus groups sessions. Each session lasted approximately 45-60 minutes. Seven instructors participated in the individual interviews. Each interview lasted approximately 30 minutes.

Data Analysis

To answer the quantitative component, an analysis of aggregated statistical data, which included students' final grades, the tracking data on the frequency and patterns of student usage of lecture capture course material, and the student questionnaire data was performed, a multitude of exploratory analyses were performed to help gain insight on the usage patterns and academic performance. Since no more than two groups were ever compared, Mann-Whitney adjusted *t-tests* were used to compare mean scores of the amount of recordings viewed, and the frequency of missed class. The relationship between student satisfaction with the recordings and frequency of views was analyzed with a Pearson's correlation. Given the exploratory nature of the project, the rest of the data presented is purely descriptive, and is meant to provide general insights as to the impact of lecture capture use and guide future research.

To answer the qualitative component of this study, interview and focus group data were transcribed verbatim. These transcripts, as well as the open-ended questionnaire comments, were entered into NVivo to be thematically coded. Categories were created that corresponded to the research questions, and additional categories were created based on themes that emerged from the participants' contributions. Coding was reviewed a second time to ensure consistency in the use of the coded categories. Descriptions of the codes were also prepared to assist with re-reading and interpreting the categorized excerpts of the transcripts.

Results and Discussion

This section presents the results of the study and discusses the findings in light of the existing body of literature on the subject.

Student Satisfaction, Use, and Viewing Patterns of Lecture Capture Recordings

Overall, students reported that the inclusion of lecture capture enhanced their course and learning experience. 63% strongly agreed or agreed that their overall satisfaction with the course was greater because of lecture capture. 32% were neutral, and only 4-5% felt negatively about its integration in the course. Also, 75% of students indicated that lecture capture made it easier for them to learn in a significant or moderate way, 20% were not sure, and 5% felt that lecture capture did not help their learning.

When asked why they used lecture capture (Table 1), students primarily used the recordings as a backup to pick up on things they had missed while in class (79%) or because they could not attend class (72%). Students also mentioned that they used lecture capture recordings to revisit complex material (68%) and to revise for exams (64%). These findings align well, in terms of the top four most common uses of lecture capture recordings, with several other studies (Chang, 2007; Chen & Lin, 2012; Collie et al., 2009; Davis et al., 2009; Leadbeater et al., 2013; Phillips et al., 2011; Soong et al., 2006; Traphagan et al., 2010; Winer & Cooperstock, 2002).

Table 1
Rationale for Student Usage of Lecture Capture

Usage (Select all that apply)	All (n=1025)	B to A+ (n=618) Mean (SD)	F to C+ (n=115) Mean (SD)
To pick up on things I missed while in class	79%	77% (11)	73% (5)
As a back-up when I could not attend class	72%	70% (11)	72% (5)
To revisit complex material, ideas and concepts	68%	66% (12)	65% (5)
To revise for exams	64%	60% (12)	63% (5)
To work through the material at my own pace	46%	43% (12)	49% (5)
To take comprehensive notes	43%	36% (12)	45% (5)
To pick up on announcements and exam hints	31%	29% (11)	34% (5)
To revisit the material because the lecturer did not speak clearly	6%	6% (4)	5% (2)
To revisit the material because the language of instruction is not my first language	4%	5% (4)	5% (2)

Note. The grade distribution columns only represent those students who gave consent to correlate their responses with their grades. No comparisons between high and low achieving students were statistically significant. SD = Standard Deviation.

Numerous comments in the open-ended questionnaire responses echoed the quantitative data about using the video recorded lectures. Students were invited to respond to the following two open-ended questions: 1) If you were to give advice to an instructor on using lecture capture effectively, what would it be? 2) Have you experienced changes in the way you interact and

communicate with your fellow students and teaching staff? Please explain these changes (if any). Students were also provided with space to provide any further comments. In response to these questions, students highlighted how lecture capture is a useful tool when it comes to reviewing course materials. Students mention its usefulness in situations where the professor spoke too quickly, where the language of instruction was not the students' or not the instructor' primary language, or where the professor went through too much content in one class. Students stated that they felt it was reassuring to know that if they did not understand a concept in class, they could still have the opportunity to review the lecture online. This view aligned with conclusions made by Davis et al.'s (2009) study examining lecture capture usage.

In terms of using the videos as a back-up, students noted that the tool was very useful when they were at home for medical reasons or when they had family responsibilities, especially in the case of mature students. Students also mentioned that the lecture capture recordings allowed them the freedom to not attend class, and, therefore, to cut down on commuting time and the cost of parking in downtown Ottawa. Students also commented on how having the recorded lectures as a back-up "relieved stress" when they had to miss class. Finally, students mentioned that, since they could watch the video later, they did not have to take as many notes in class, which allowed them to listen more attentively while in class.

As for the percentage of videos viewed (Table 2), 43% of students said they watched at least 50% of the recorded material (11% watched all the material), and only 22% of students did not view any lecture recordings. Students' responses were supported by the analytic data, which also displayed that, depending on the course, between 5-15% of students had never accessed the recordings. Many students who did not access the recordings said that since they attended the lectures, they did not see the need to watch the videos or see the lectures over again. Also, some students claimed to not have time to watch the videos, as watching the recorded lectures was perceived as a time-consuming task by students. A few students mentioned that they simply were not disciplined enough to watch the videos. In that same line, some students also commented that they were required to make themselves a schedule, so that they had enough time to watch the videos throughout the semester. In a few cases, students mentioned technical or computer related issues to explain why they were unable to watch the videos. Lower achieving students (with final grades between F and C+) viewed a significantly higher number of recordings ($\mu = 45.97$, $SD = 35.83$) than the higher achieving students (grades B to A+) ($\mu = 34.88$, $SD = 33.27$; $t(764) = 3.29$, $p = .001$). Table 2 is presented for descriptive purposes.

Table 2
Percentage of Recordings Viewed

Recordings viewed (%)	All (n=1067)	B to A+ (n=648)	F to C+ (n=118)
100%	11%	10%	18%
75%	17%	14%	22%
50%	15%	13%	16%
25%	17%	18%	15%
10%	19%	21%	13%
I did not view any lecture recordings	22%	24%	16%

Note. The grade distribution columns only represent those students who gave consent to correlate their responses with their grades.

Students were also asked to describe their viewing patterns when a video was made available by the professor. Their answers presented in Table 3 were not exclusive. A third of the students said they had a tendency to watch the entire recording of the lecture. The remaining students did not watch the full video, but they tended to choose particular segments of the recorded lecture to listen to. A third of the students also said that they watched some segments more than once, and 21% listened to several weeks of lectures at one time. Finally, most of the students (81%) did not view the recordings on a regular basis. Additional comments concerned the location of viewing. Nearly all students watched the videos alone and from home.

Table 3
Student Viewing Patterns

Usage (Select all that apply)	All (n=1036)	B to A+ (n=624) Mean (SD)	F to C+ (n=118) Mean (SD)
I deliberately chose particular segments of the recorded lecture to listen to	46%	47% (12)	40% (5)
I generally browsed through the recording and stopped at points of interest	35%	34% (12)	37% (5)
I usually watched the entire recording of the lecture	34%	30% (12)	33% (5)
I usually watched the recorded lecture or parts of it more than once	32%	30% (11)	40% (5)
I listened to several weeks of lectures at one time	21%	16% (9)	23% (5)
I listened to the lectures on a regular basis throughout the semester	19%	18% (10)	20% (4)

Note. The grade distribution columns only represent those students who gave consent to correlate their responses with their grades. No comparisons between high and low achieving students were statistically significant. *SD* = Standard Deviation.

When correlating student satisfaction with the frequency of student views generated by the lecture capture system, student satisfaction had a significant relationship with the number of lectures viewed by a given student ($r=.418$, $p<0.001$). Williams and Fardon (2007) also found that positive attitudes toward lecture capture correlated with use. No significant differences were noted in viewing patterns across gender or age.

Student Attendance

When lecture capture was first made available on campus, decreased class attendance was a common concern brought up by inquiring professors. The self-reported data from students (Table 4, the “All” column) indicates that 41% of students did not miss classes (none or just one), 31% missed class once a month, and 28% missed classes regularly. Without having comparable data for the same course given without lecture capture, we cannot statistically identify the effect of lecture capture on attendance; however the anecdotal comments made by students and the information shared by instructors seem to indicate that attendance remained relatively unchanged compared to courses without lecture capture and compared to former iterations of the same course. All instructors shared that they observed minor or no effect to in class attendance. The literature tends to confirm this observation, as most studies provide evidence that no or little significant difference in attendance is observed with the integration of the technology (Chen & Lin, 2012; Craig et al., 2009; Deal, 2007; Holbrook & Dupont, 2009; Pursel & Fang, 2012; von Kinsky et al., 2009).

When we look at the achievement score, based on the actual students’ grades, in relation to attendance (the two last columns of Table 4), we see a significant difference in that higher achieving students missed fewer classes ($\mu = 1.91$, $SD = 1.01$) than the lower achieving students ($\mu = 2.19$, $SD = 1.02$; $t(764) = 2.23$, $p = .026$). Presented for descriptive purposes, Table 4 indicates that 24% of higher achieving students missed class on a regular basis versus 36% of the lower achieving students.

Table 4
Frequency of Missed Classes

Frequency (Based on 2 classes per week)	All (n=1068)	B to A+ (n=648)	F to C+ (n=118)
Once a term or never	41%	45%	31%
Once a month	31%	31%	33%
Once every two weeks	16%	13%	23%
Once a week or more	12%	11%	13%

Note. The grade distribution columns only represent those students who gave consent to correlate their responses with their grades.

Also of interest was the relationship between lecture capture use and attendance. Students with the greatest number of missed classes had a tendency to view the lecture capture recordings more frequently than those who attended the classes on a regular basis.

For those missing class, the principal reasons cited for watching the recorded videos were related to work or family reasons, or that the students felt they could learn as easily from the lecture capture recordings as they could from coming to class in person. When digging deeper into this last finding, students who tended to replace face-to-face classes with lecture capture recordings remarked that this depended entirely on the nature of the class. If they perceived that attending class added value to their understanding of the content and helped them with their assignments and evaluations, the students were more likely to attend the live lectures in class. Elements of the class that added value, as stated by the students, included the enthusiasm and engagement of the

instructor, relevant active learning activities, and a heightened sense of community in the classroom. These findings clearly echo those of Chang (2007) and Davis et al. (2009).

The data seem to show that, while absenteeism remains the same, students who are absent view more videos produced through lecture capture. Thus, lecture capture does not necessarily cause absenteeism, but it does provide an additional avenue to enhance the learning experience for those students who tend to miss class, as shown by the data confirming that students expressed a high level of satisfaction toward this tool. In the next section, these findings are related to student achievement.

Student Achievement

Three main measures were examined to represent student achievement: student perceptions of their learning gain, students' perceptions of their grades, and students' actual grades. 75% of students reported that lecture capture was positive for their learning. Only 13% of students responded "rarely" or "almost never" (7% and 6%, respectively). 12% of students indicated "about half the time". Students held similarly favourable views regarding the impact of lecture capture on their grades. 68% of students indicated that lecture capture helped them to achieve better grades in a significant or moderate way, 26% of students were not sure, and 7% of students felt that lecture capture did not help improve their course grades. These findings are consistent with those of Gosper et al. (2010).

Since there was no control group for this study, it is difficult to assess the real impact of lecture capture on student achievement. However, indirect data and comments from students and professors can help inform a partial response to this question. When examining the relationship between the frequency of video views and students' marks in a given course, a trend clearly emerged. Students with lower course marks appear to access the recordings more frequently than those with higher marks. No significant differences were noted in viewing patterns between higher and lower achieving students or across gender or age.

While at first glance this seems counterintuitive, students' viewing patterns and open-ended comments from the student questionnaire suggest non-significant differences as to the utilization of lecture capture recordings between students with lower marks (F-C+) and those with higher marks (B-A+). For instance, students with lower marks had a tendency to view several weeks of recordings at one time (Table 3), they used lecture capture to take comprehensive notes, and they used lecture capture to work through the material at their own pace (Table 1). Students with higher marks had less sporadic use over the semester. Both Owston et al. (2011) and Vajoczki et al. (2011) observed similar results when examining the use of lecture capture recordings. Owston et al. (2011) suggested that "it may be that as students gain success in a course—and build the confidence that may come with this success—they will feel less need to review material in the lecture recordings" (p. 267).

While there is no control variable to provide sufficient evidence that, had a subset of students made use of lecture capture recordings, they were more likely to achieve a higher grade, the instructor interviews and comments shared by students via the survey and the focus groups suggested that lecture capture recordings appear to be of greater benefit to students with lower marks by providing these students with an additional resource to guide them toward success. Course instructors shared that they felt that lower achieving students who used the recordings appeared more confident and seemed to be achieving marginally better grades. As one instructor stated, "It is as if the left end of the course grade distribution curve is translating slightly to the

right.” It should also be noted that several course instructors mentioned that courses, which featured lecture capture generally, had greater overall averages as compared to previous iterations of the same courses without the recordings. Each instructor expressed that they thought the recordings had a positive effect on student learning, and one instructor shared that a 2-3% increase was observed in the overall average of the class compared to previous iterations of the same course.

Supporting these findings, Owston et al. (2011) offered the following explanation:

Higher achievers bring to their studies well-developed and successful learning strategies. Therefore, lecture capture provides minimal added value for them if they attend class, take notes, or study the course content in other ways. Lower achievers are not as likely to have developed these successful strategies and depend more on viewing recordings multiple times in an attempt to make the subject matter sink. (p. 267)

The following statement from an instructor in the study represents a reoccurring theme in the findings: “The best students don’t really need help, they are already strong. On the other extreme, [low achieving] students often don’t improve, no matter how much you help them. The impact of the videos affects the middle group.” Adding to the view that the technology has less of an impact on lower achieving students, an instructor expressed the concern that students may see the videos as an incentive to procrastinate, and “students might get a false sense of security and depend too much on the availability of videos.” This view was also expressed in the literature, highlighting the importance of having regular discussions with students about study strategies, as a way of discouraging this outlook and approach to using the technology.

Pointing to the remedial benefits of the videos, one instructor said that the recordings really helped those students who did not have a strong background in the subject area at the beginning of the course, and those students who were not well prepared before entering the program.

Study Habits

An emerging theme mentioned in the interviews with instructors related to the use of lecture capture as a tool to be used in one’s arsenal of study habits. It was noted that when discussing the tool with students and expressing the different ways in which the recordings would be used in the course, instructors had the opportunity to discuss study habits with students. In discussing how recordings could be used to come prepared for class or how they could be used to review after class or for an exam, several instructors expressed an interest in talking about quality over quantity of study time with students and shared a few strategies about how the videos could be best used in different contexts.

Conclusions

While additional research could further inform the benefits and limitations of lecture capture technology and how it can best support student learning, the findings emerging from this study confirm that when made available, a strong majority of students use lecture capture recordings as a tool to help scaffold their learning and improve their educational experience. Certain viewing patterns appear to affect academic performance, which for some students have led to tangible improvements in their learning. Given the implication of these findings, coupled with recent literature in this area, the planned and supported use and expansion of lecture capture technology in higher education should be encouraged.

Notable benefits of using lecture capture were identified by participants in this study. Among these, increased learning opportunities and flexibility were highlighted. Reflecting on both students' reported rationales for using lecture capture and also students' viewing patterns (i.e., when they used the tool, and for what purpose), it is clear that many students appreciated being able to review material they might otherwise have missed (e.g., as a result of illness, a missed class, misunderstanding in class, etc.). Many students reported being satisfied with the course and 800 out of 1063 students (75%) noted that lecture capture made it easier for them to learn either in a moderate or significant way.

The study provided no evidence that lecture capture hinders students' learning experiences. Moreover, lecture capture does appear to benefit certain sub-groups of students in significant ways (i.e., students with challenging schedules, students requiring accommodations, students studying in their non-dominant language, etc.).

Lecture capture can also facilitate and increase opportunities for providing students with accommodations to support their learning. More research would be needed to better understand how this tool can be used to support a range of learning needs and also disabilities or exceptionalities. However, the ways in which lecture capture can be customized, and the level of personal engagement and decision-making about use and preferences that participants in this study shared, indicate the strong potential for this tool to meet a range of students' needs that can support and enhance students' learning experiences.

Lastly, with lecture capture, there is an opportunity for metacognitive learning and the improvement of students' study habits. Reflecting on one's learning experiences is an essential part of higher education and can help students become more productive learners who engage in meaningful activities. Lecture capture can serve as a strategic tool in a student's arsenal of study habits. Instructors may wish to discuss how its use can be made most effective.

The study also revealed some limitations of lecture capture. This tool is not well-suited for highly interactive classes that have a lot of group work or peer interaction, since these instances and exchanges are not easily or well-captured through video recordings. When students are interacting with one another, as in group work, an instructor can either choose to leave the video unedited and post the full class, or edit out these excerpts, which can be time consuming and leave students wondering what they have missed. In either case, students not actively participating in the class will not have a parallel meaningful experience simply by watching that part of the class. In a class with a lot of engagement, including questions and group discussions, much of these exchanges are not properly recorded, since it is only the instructor who is wearing a personal microphone.

Instructors who participated in the study also agreed that lecture capture must be fully integrated into the course design to optimize its potential and capacity to support and enhance

student learning. Lecture capture provides an interesting array of possibilities, but preparation time is required on the part of instructors to effectively design their course curricula and online content, as well as reconsider what can transpire during class time to complement and further expand on any additional materials that were provided through online recordings. When used properly, the opportunity for a fully integrated use of the tool becomes one of lecture capture's greatest strengths.

Lecture capture raises many technical issues and concerns. Some of these issues can be easily solved, such as having spare batteries for the microphones ready on hand or a back-up microphone set up as a replacement. Technical issues also included the capacity to have an interface that can be viewed and/or listened to on multiple devices. Also, some instructors do not understand what is and what is not being captured by the tool (i.e., considering the use of projectors, laser pointers, and slides, in light of the recording).

Despite these challenges and limitations, lecture capture offers many innovative opportunities for both teaching and learning. Lecture capture technology allows an instructor to highlight or showcase information outside of class time, so that in-class time can be used differently (i.e., increased peer to peer interaction, more discussion, hands-on or interactive learning, the use of materials to support lessons that may be harder to access otherwise, i.e. demonstrations, speakers, etc.).

Overall, the results of this study have shown that a strong majority of students indicated that lecture capture facilitated their learning, that no difference in class attendance was observed for courses using lecture capture, and that students with the greatest number of missed classes viewed the recordings more frequently. As per impact on academic achievement, students with lower course marks accessed the recordings more frequently than those with higher marks leading to the belief that lecture capture predominately helped average to below average students achieve slightly better marks, but had less of an impact on the grades for particularly low and high achieving students. These results add to the continued growth of literature on the use and impact of lecture capture recordings on student learning, and reveal further opportunities for future examination of how this tool can best support learners in higher education.

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