

12-31-2013

## Use of Lecture Capture in Undergraduate Biological Science Education

Candace Wiese

*University of Guelph Humber*, cwiese01@guelphhumber.ca

Genevieve Newton

*University of Guelph*, newton@uoguelph.ca

Follow this and additional works at: [http://ir.lib.uwo.ca/cjsotl\\_rcacea](http://ir.lib.uwo.ca/cjsotl_rcacea)  
<http://dx.doi.org/10.5206/cjsotl-rcacea.2013.2.4>

---

### Recommended Citation

Wiese, Candace and Newton, Genevieve (2013) "Use of Lecture Capture in Undergraduate Biological Science Education," *The Canadian Journal for the Scholarship of Teaching and Learning*: Vol. 4: Iss. 2, Article 4.

DOI: <http://dx.doi.org/10.5206/cjsotl-rcacea.2013.2.4>

Available at: [http://ir.lib.uwo.ca/cjsotl\\_rcacea/vol4/iss2/4](http://ir.lib.uwo.ca/cjsotl_rcacea/vol4/iss2/4)

---

# Use of Lecture Capture in Undergraduate Biological Science Education

## Abstract

This study examined the use of lecture capture in students in a large 3<sup>rd</sup> year undergraduate biological science course at the University of Guelph. Data regarding viewing behaviour, academic performance, and attendance were analyzed in relation to student learning approach (as assessed by the R-SPQ-2F), gender, and year of post-secondary education. It was found that relative to historic controls, students provided lecture capture videos increased their final exam grade by approximately 5%. It was also found that learning approach was significantly related to video viewing behaviour, final exam performance, and attendance, with a deep learning approach being associated with more video views, better performance, and a greater tendency to watch videos to master and review material. A surface approach showed contrasting associations. Moreover, a higher deep approach score was related to fewer absences, while a higher surface approach score was related to more absences and increased the likelihood of a student missing a class. Gender also influenced viewing behaviour, with females being more likely than males to watch videos to generate notes and to review material. This research demonstrates that learning approach and gender are significant predictors of lecture capture behaviour, performance, and/or attendance in biological science education, and provides support for the use of lecture capture as a tool to improve academic performance.

Cette étude examine l'utilisation de la capture de cours dans une grande classe d'étudiants de premier cycle inscrits à un cours de sciences biologiques de troisième année. Les données relatives au comportement de visionnement des vidéos, aux résultats académiques et à l'assiduité ont été analysées en relation avec l'approche d'apprentissage des étudiants (telle que mesurée par le R-SPQ-2F), le sexe et l'année d'études post-secondaires. Cette étude a montré que, comparativement aux contrôles historiques, les notes obtenues aux examens finals par les étudiants exposés à des vidéos académiques étaient de 5 % supérieures. L'étude a également indiqué que l'approche d'apprentissage était liée de façon significative au comportement de visionnement, aux résultats obtenus aux examens finals et à l'assiduité, et que l'approche en profondeur était liée à un nombre supérieur de visionnements des vidéos, à de meilleurs résultats et à une tendance accrue à regarder les vidéos afin de maîtriser et de réviser la matière. L'approche en surface a indiqué des associations contrastées. De plus, un score supérieur d'approche en profondeur était lié à un nombre moins élevé d'absences alors que l'approche en surface était liée à davantage d'absences et qu'elle augmentait les possibilités que les étudiants soient absents en classe. Le sexe avait également une incidence sur le comportement de visionnement, les femmes ayant davantage tendance à regarder les vidéos afin de prendre des notes et de réviser la matière que les hommes. Cette recherche a montré que l'approche d'apprentissage et le sexe sont des indicateurs importants de comportement en ce qui concerne la capture de cours, la performance et/ou l'assiduité dans le domaine des sciences biologiques et qu'elle offre un soutien efficace pour l'utilisation de la capture de cours en tant qu'outil pour améliorer la performance académique.

## Keywords

Lecture capture, podcasts, vodcasts

## Cover Page Footnote

This work was funded in part by a General Research Grant from the University of Guelph Humber. The authors would like to thank Michelle Edwards at the University of Guelph for her valuable assistance with statistical analysis.

Lecture capture can be generally defined as concurrent capturing of non-persistent information (such as speech) with persistent information (such as presentation slides) that can be made available for access at a later time (Brotherton & Abowd, 2004). Files can take the form of either audio only or audio combined with video, with research showing that students prefer the latter (Embi, Biddinger, Goldenhar, Schick, Kaya & Held, 2006). Lecture capture describes the multimedia capturing of live lectures before an audience of students in higher education, and while this phrase is sometimes used synonymously with other terms including podcasting and vodcasting (for examples of the use of these terms, see Shaw & Molnar, 2011; Vajoczki, Watt, Marquis, & Holshausen, 2010). According to Cambridge Dictionaries Online, a podcast is more accurately defined as an audio-only recording (“Podcast”, n.d.) while a vodcast is a video recording (“Vodcast”, n.d.). While lecture capture files may be downloadable over the Internet, they may also be streamed live, such as through YouTube or an institute of higher education’s streaming server. Since lecture capture and podcasts are terms that are sometimes used interchangeably but really describe different elements of the lecture being captured (such as instructor audio and video) (see Holbrook & Dupont, 2009; Owston, Lupshenyuk, & Wideman, 2011), it is important to outline the difference. We use the term lecture capture to refer to the synchronous capture of the instructor’s speech with their PowerPoint slides, which were provided to students within 24 hours of the lecture through the digital streaming service of the home institution.

Lecture capture is increasingly used at institutions both within Canada and internationally (Green, 2011). The continuous nature of the delivery of lecture content makes it difficult for students to attend to all points of discussion when concurrently taking notes, and it is impossible for students to have comprehensive access to lecture content (such as instructor speech) if they are absent from class. Frankel recently reported that post-secondary institutions worldwide spent \$60 to \$70 million on lecture capture in 2011 (as cited in Frankel, 2012). Greenberg has stated that spending on lecture capture has increased by approximately 19 percent over the last few years, with an anticipated increase in global spending to 25 percent within 5 years (as cited in Frankel, 2012). However, while spending is increasing, overall use remains quite low. The 2011 Campus Computing Survey reported that only 8.3 percent of public and 3.9 percent of private universities were using lecture capture technology, although research shows that there has been a consistent increase in the use of this technology across a range of institutes of higher education (Green, 2011). Consequently, Wainhouse Research recently described lecture capture technology as “one of the hottest campus technologies for higher education”, both at present and in the years to come” (Greenberg & Nilssen, 2011, pg.5).

Reports have indicated several benefits of lecture capture use including increased student satisfaction (Bryans Bongey, Cizadlo & Kalnbach, 2006; Vajoczki et al., 2010; Traphagan, Kuscera & Kishi, 2010), enhanced understanding of content and clarification of difficult topics (Bryans Bongey, Cizadlo & Kalnbach, 2006; Luna & Cullen, 2011; Scutter, Stupans, Sawyer, & King, 2010; Vajoczki et al., 2010; Vajoczki, Watt, Marquis, Liao, & Vine, 2011), improved generation of course notes (Brotherton & Abowd, 2004; Evans, 2008; Luna & Cullen, 2011; McKinney, Dyck, & Luber, 2009; Babb & Ross, 2009), increased accessibility to students with disabilities and non-native English speakers (Scutter et al., 2010; Vajoczki et al., 2011; Vajoczki et al., 2010;), and for the instructor, decreased requests for content clarification (Harpp et al., 2004; Taylor, 2009; Vajoczki et al., 2010). There is also evidence that the use of lecture capture is associated with improved course performance (Bollmeier, Wenger, & Forinash, 2010; Cramer, Collins, Snider, & Fawcett, 2007; Francom, Ryan, & Kariuki, 2011; Harrigan, 1995; Vajoczki

et.al, 2010), although the research findings in this area are equivocal, with other studies noting no relationship between lecture capture use and course grades (Bassili, 2006; Jensen, 2011; O'Bannon, Lubke, Beard, & Britt, 2011). Despite these reported benefits, there is concern that provision of lecture capture will discourage attendance, which has been shown to be a predictor of student grades (source). Research in this area has again yielded inconclusive results, with both negative (Holbrook & Dupont 2011; Traphagan, Kucsera & Kishi, 2010; Vajoczki et al. 2011) and neutral (Bollmeier, Wenger & Forinash, 2010; Brotherton & Abowd, 2004; Bryans Bongey, Cizaldo & Kalnbach, 2006; McElroy & Blount, 2006;; Pham, 2010) relationships observed. These inconsistencies are likely related to several factors, including user characteristics, as differences in lecture capture use were recently shown between deep and surface learners (Vajoczki et al., 2011), between males and females (Pham, 2010), and between students across different academic levels (Gosper, Green, McNeil, Phillips, Preston & Woo, 2007; Holbrook & Dupont, 2011). These findings related to learning approach, gender, and academic level are relevant since they imply that differences in student characteristics may influence outcomes such as viewing behaviour, performance and attendance. The current body of literature suggests that additional research is warranted to investigate the relationships between lecture capture use and academic performance and attendance, and that the characteristics of lecture capture users should be further explored. This gap is addressed in the present study, the purpose of which was to examine the use of lecture capture in undergraduate students in biological science education by measuring the relationships between viewing behaviour, academic performance, and attendance in relation to student learning approach (as assessed by the R-SPQ-2F), gender, and year of post-secondary education.

### **Context**

The relationship between lecture capture use and academic performance has been the subject of considerable investigation, with research showing positive, neutral, and negative associations. Clarification of the relationship between lecture capture use and performance is an important pedagogical consideration, as it seems plausible that lecture capture – which provides students with access to lecture content outside of class, and can be used for reviewing material, clarifying difficult topics, and studying for exams – could be a valuable learning resource. Several studies suggest that the availability of lecture capture is positively correlated with student grades, raising them slightly (Bollmeier, Wenger & Forinash, 2010; Vajoczki et.al, 2010; Francom, Ryan & Kariuki, 2011; Harrigan, 1995). For example, grades were 9.9% higher in a hybrid course that reduced in-class lectures and provided lecture capture videos as compared to a traditional lecture based class (McFarlin, 2008). Performance has been linearly associated with use of lecture capture, with midterm exam scores increasing as the number of lecture capture accesses increased (Cramer et al., 2007). Here, use of lecture capture for 100 minutes was associated with a grade increase of 15% (Cramer et al., 2007). However, the finding of improved performance with the use of lecture capture is not equivocal, with several studies noting little to no effect on student grades (Abt & Barry, 2007; Brotherton & Abowd, 2004; Powell & Barton, 2010). For example, when lecture capture was used to make more time in class for active learning activities such as discussion and student questions, there was no noted improvement in performance (Jensen, 2011; O'Bannon et al., 2011). It has been observed that students who both attended class and watched online lecture capture videos had lower exam marks than students who did not watch the videos (Joordens, Le, Grinnell, & Chrysostomou, 2009). Clearly, the

relationship between performance and use of lecture capture is not well defined and should be subject to further investigation.

The relationship between lecture capture use and attendance has also been subject to considerable investigation, with research again yielding inconsistent findings. There is ongoing concern that lecture capture discourages attendance, which is known to be an important predictor of student grades (Chen & Lin, 2008; Gump, 2005), although this relationship was identified in studies where an alternative to physical attendance was not provided, and evidence does not necessarily support a negative effect on performance with reduced attendance when lecture capture resources are offered to students. Several recent studies show that the availability of lecture capture has little to no relationship with attendance (Bollmeier, Wenger, & Forinash, 2010; Brotherton & Abowd, 2004; Bryans Bongey, Cizaldo & Kalnbach 2006; McElroy & Blount, 2006; Pham 2010). A neutral relationship has also been observed between the number of times a lecture capture video was viewed and class attendance (Bollmeier, Wenger, & Forinash, 2010; Pham 2010). Students indicate many reasons for not changing their attendance patterns, including the need for regular routine, teacher and classmate interaction, and a greater ability to focus with a live presentation (Copley, 2007). In a study looking at the motivation of medical students to attend lecture, students reported that the decision was more based on the qualities of the lecturer, not on the availability of electronic material (Billings-Gagliardi & Mazor, 2007). However, there is also evidence that the availability of lecture capture does have a negative impact on classroom attendance. A recent study noted that for students who missed more than six classes, availability of lecture capture was the main reason (Holbrook & Dupont, 2011). Similarly, class attendance was found to be 9% lower in the lecture capture viewing section of a course relative to a section with no lecture capture videos, and 36% of these students reported often replacing class lectures with the videos; students in this study self-selected the section of the course that they enrolled in without prior knowledge of the availability of lecture videos in only one section (Traphagan, Kucsera & Kishi, 2010). Recent research shows that while the majority of students use lecture capture videos for reviewing for tests, a minority (21%) use them in place of attending class (Vajoczki et al., 2011). Yet even when the relationship between lecture capture use and attendance is negative, it is important to note that students are not only missing class because the information is readily available to them, but instead report that they are skipping because of other academic and employment responsibilities (Silverstein, 2006). Many students feel that lecture capture is a valuable asset because when class must be missed for reasons such as medical, employment, family, etc., they had the necessary information available to them to keep up with the course (Scutter et al., 2010). It is also important to note that a decline in attendance in association with provision of lecture capture can only be construed negatively when the same learning outcomes are not achieved. More research is clearly warranted to further elucidate the relationship between using lecture capture and attendance.

Recently, research has identified student learning approach, gender, and academic level as being related to outcomes such as lecture capture behaviour, academic performance and attendance. Student approach to learning, or learning approach, was first articulated by Marton and Säljö (1976), who observed two main approaches to the process and cognitive intention in taking up a learning task, surface and deep. The deep approach is associated with internalization of content, making learning meaningful, and personal growth (high-level engagement), while the surface approach is associated with rote memorization and reproducing facts (low-level engagement) (Marton & Säljö, 1976). These terms have been widely adopted in research pedagogy since then and have been described as functions of the students' awareness of specific

contexts influencing their learning environment (Gibbs, Morgan, & Taylor, 1982; Prat-Sala & Redford, 2010). Student approach to learning is commonly measured by the Revised Student Process Questionnaire 2-Factor (R-SPQ-2F) (Biggs, Kember & Leung, 2001), a modified version of the Student Process Questionnaire (SPQ) (Biggs, 1987), that has been validated as a research tool with which to measure learning approach using the deep and surface scales (Justicia, Pichardo, Cano, Berben, & De la Fuente, 2008). Learning approach has been found to be a relevant characteristic of lecture capture users, as students with higher deep learning approach scores (as measured by the R-SPQ-2F) use lecture capture to supplement attendance, while students with higher surface learning approach scores use lecture capture to replace attendance (Vajoczki et al., 2011). Gender has also been found to be a relevant characteristic of lecture capture users, with females listening to significantly more hours per week than males (Pham, 2010). Similarly, academic level has been found to affect factors related to lecture capture use, including student satisfaction, viewing behaviour, and attendance. For example, upper year students ranked lecture capture that included video and audio more positively than lower year students (Copley, 2007). Also, watching selected material as opposed to viewing lecture capture videos in their entirety may differ with age, as it has been found that younger students are more likely to watch selected material while older students are more likely to view the entire video (Gosper et al., 2007). And, older students may show different relationships between lecture capture and attendance, as students in upper years have been found to use lecture capture as learning tools, not as opportunities to miss class, whereas students in first year have been found to use them in place of attending lecture (Holbrook & Dupont, 2011). Together, these findings suggest that characteristics of lecture capture users, such as learning approach, gender, and academic level, appear to be important predictors of frequency and motivation for use of lecture capture, although future research is needed to better understand these relationships.

### **Research Questions**

As outlined above, there are several issues regarding the use of lecture capture that are unresolved and warrant further investigation. In an attempt to address some of these issues, we identified viewing behaviour, performance, and attendance as dependent variables that could be investigated experimentally in relation to independent variables including learning approach, gender, and years of post-secondary education. Following this, the research questions to be investigated in this study were:

1. Are there relationships between viewing behaviour (including number of views, how videos were viewed, and why videos were viewed) and learning approach, gender and/or year of post-secondary education?
2. How does use of lecture capture impact self-reported attendance, and is attendance related to learning approach, gender and/or year of post-secondary education?
3. How does use of lecture capture impact performance as assessed by comparison with historic controls?

## Methods

### Participants

Students were enrolled in NUTR 3210 (Fundamentals of Nutrition) at the University of Guelph in either Fall 2011, Winter 2011, or Winter 2012. This is a foundation course for the study of nutrition, which looks at the occurrence, uptake and metabolic role of nutrients in relation to growth, reproduction and longevity in human subjects, domestic animals and other species. Students in Winter 2012 (n=597) were provided with lecture capture and were invited to complete a survey regarding their use of the videos. Students in Fall 2011 (n=288) and Winter 2011 (n=602) were used as historical controls. Comprehensive demographic data was not available for the control groups. While findings from the two Winter cohorts were expected to be similar, there are known differences between the Winter and Fall groups. The Winter classes consist primarily of students in three programs: Biomedical Sciences, Human Kinetics, and Nutrition and Nutraceutical Sciences. NUTR 3210 is in the calendar for these programs in the fourth semester; therefore, the majority of the students in the two Winter classes would have been in their second year of undergraduate studies. The Fall class is known to consist primarily of Biological Science majors, as NUTR 3210 is in the calendar for this program in the fifth semester; therefore, the majority of students in the Fall class would have been in their third year of undergraduate studies. Although the entrance GPA of students in the three classes is not known, it is expected that the GPA of the Winter classes might have been higher due to the inclusion of the Biomedical Science students, who were required to maintain a minimum GPA of 75% in their first year of studies. The same instructor taught the second seven weeks of the three courses, with lecture capture being provided in Winter 2012. A second instructor taught the first five weeks the two Winter classes, and a third instructor taught the first part of the class in Fall 2011. The course content was identical across the second seven weeks of each of the three classes, and content in the first five weeks of the course was nearly identical across the three classes, as course materials are shared in part between the two instructors. Assessment of students was the same across all three classes, and consisted of one midterm and one final exam (all multiple-choice questions). All students (n=597) in the winter 2012 NUTR 3210 class were invited to complete survey after the submission of the final course grades. A total of 308 students responded. As an incentive for completing the survey, students had their names entered into a draw to win one of 10 Kindle Touch eReaders as approved by the Research Ethics Board at the University of Guelph. The demographics of each group are summarized in table 1.

Table 1  
*Demographics of Participant Groups*

Group	N	Programs(s) of Study	Semester of Study
Winter 2012	597*	Mainly Biomedical Sciences, Human Kinetics, and Nutrition & Nutraceutical Sciences	Mainly 4 <sup>th</sup>
Fall 2012	288	Mainly Biological Sciences	Mainly 5 <sup>th</sup>
Winter 2011	602	Mainly Biomedical Sciences, Human Kinetics, and Nutrition & Nutraceutical Sciences	Mainly 4 <sup>th</sup>

\*Note that 597 students were used for performance analysis, while 308 students completed the R-SPQ-2F and lecture capture survey.

## Measures

**Lecture capture.** Live lectures were captured using the I Show U software for Mac (version 2.0, 2011 Shiny White Box, New Zealand) and a Revolabs xTag USB wireless microphone (Model 02-DSKSYS-D, Revolabs, U.S.A). These tools were used for synchronous audio/PowerPoint slide capture. The captured lectures were then streamed directly through the Guelph's library server; however they could not be downloaded. The link to the videos was available through the course management site, which required a username and password. Videos were not made available to students for download for several reasons: first, the home institution strongly discourages posting video files in the course management site due to their large size (each video was approximately 20MB); second, hosting the files on the institutional server enables the institution's Copyright Officer to ensure that videos comply with copyright laws; and third, providing trackable links to videos through the course management site allowed each video access to be monitored. A total of 11 lecture capture videos were available for viewing throughout each semester. Videos were made available to students within 24 hours of the in-class lecture. Videos were not captioned or transcribed, as it was not official institution policy to require these features at the time of this research unless specifically requested by a student. It is not known what proportion of students had high-speed internet access off campus.

**Surveys.** *Revised Two-Factor Study Process Questionnaire 2 (R-SPQ-2F).* The R-SPQ-2F questionnaire is designed to measure whether students take a deep or surface approach to learning. Initially devised as the Study Process Questionnaire, this revised version consists of 20 questions, with 10 items representing each approach, and it has four subscales that describe motive and strategy (Biggs, Kember & Leung, 2001). The R-SPQ-2F has recently been shown to best describe the two factors of deep and surface as measured by their 10 corresponding items (Justicia et al., 2008), so these are the only variables that will be considered in this investigation.

*Lecture capture survey.* Table 2 lists the questions included in the survey along with the 20 questions revised from the R-SPQ-2F. The response options are indicated in brackets. Vajoczki et al. (2011) was used in part to develop the lecture capture survey questions.

Table 2

*Lecture Capture Survey Questions*

- 
1. Did you watch any of the NUTR 3210 lecture videos? (Yes or No)
  2. Of the 11 lectures for which videos were available, approximately how many did you watch? (None, 1-3, 4-7, 8-11)
  3. Have other courses made lecture videos available? If “yes” please state the name of the course. (Yes or No)
  4. Have you missed a NUTR 3210 class (not due to illness) because you knew it would be available on video? (Yes or No)
  5. Compared to your other courses, how would you describe your attendance in NUTR 3210? (Approximately equal, A little bit less/around 5% decrease, Somewhat less/around 10% decrease, Quite a bit less/around 25% decrease, A lot less/around 50% decrease, I didn’t bother attending NUTR 3210)
  6. Do the following statements describe how you viewed the lecture videos? If you viewed videos differently, you may answer yes to both questions. (Yes or no).
    - a) I watched them from beginning to end
    - b) I watched selected material.
  7. Do the following statements describe why you viewed the lecture videos? (Yes or No)
    - a) To catch up on lectures I was absent from
    - b) To help with difficult material I did not understand
    - c) To master material I already understood
    - d) To casually review the lecture.
    - e) To generate more complete course notes
    - f) To review for the final exam
  8. How well do you agree with this statement: Having lecture videos available improved my learning in this course? (Definitely agree, agree somewhat, neutral, disagree somewhat, definitely disagree)
  9. What is your gender? (Male or Female)
  10. What is your cumulative GPA? (<60, 60-69, 70-79, 80-89, 90-100)
  11. How old are you (in years)? (text response)
  12. What is your career goal? (text response)
  13. How many years of post-secondary education do you have? (text response)
- 

**Performance.** Assessment in this course was entirely through multiple-choice exams (midterm and final); since this was a very high enrolment course without the support of any teaching assistants, exam-only, multiple-choice delivery was the sole feasible option. The midterm exam was held at the mid-point of the semester and since lecture capture videos were only provided for the latter seven weeks of the course, performance on the midterm was not relevant to the present study. The final exam was weighted to consist of approximately 80% of material from the latter seven weeks of the semester; therefore, the final exam was largely

representative of the material that was lecture captured, and was used to evaluate performance in this study. It is important to note that the final exam did include questions that were not covered in the lecture videos. While this does represent a confounding variable, the questions asked between semesters were comparable and covered largely the same topics, with only minor differences between the classes. The potential relationship between lecture capture and performance was assessed by comparison of final exam grades with historic controls, which was data obtained from the same course run in the Fall and Winter 2011 semesters.

## **Procedure**

NUTR 3210 was held each of the three semesters (Fall 2011, Winter 2011, Winter 2012). The Winter 2012 class was informed at the start of the course that lecture capture videos would be provided to them for the classes being taught by the researcher, and that at the end of the semester, once the final grades had been submitted, they would be invited to participate in a survey that asked them questions regarding their use of the lecture capture videos. During the last class, students were again told that a survey invitation would be sent to them after submission of the final grades. After submission of the final grades, all students (n=597) were invited to participate in the research study and were provided with a link to the survey described above. The survey was hosted by FluidSurveys. Two more emails reminding students about the invitation to participate in the research study were sent to the class before the survey was closed. In total, the survey was open for a period of one week. Although the survey asked students to provide their name, when survey data was exported for data analysis, each student was assigned a unique identifier to ensure confidentiality of information. The pattern of video accesses was provided by the home institution as the cumulative number of views on each day.

## **Statistical Analysis**

Linear regression was conducted to investigate the relationships between: (a) learning approach and number of views, (b) year post-secondary education and number of views, (c) learning approach and exam grade, and (d) year post-secondary education and exam grade. The Pearson correlation coefficient ( $r$ ) was calculated for each association. The  $r$  value is considered to be the preferred index in a correlational design (Durlak, 2009), with  $r$  being widely used to represent effect size in terms of the magnitude and direction of the relationship between the variables (Rosnow, Rosenthal, & Rubin, 2000). The  $R^2$  values and the unstandardized coefficients for the y-intercept and learning approach score were also calculated. Logistic regression was conducted to investigate the relationship between: (a) learning approach and how videos were used, (b) learning approach and why videos were used, (c) year post-secondary education and how and why videos were used, (d) learning approach and whether students missed a class because videos were available, (e) gender and attendance comparison categories, and (f) year post-secondary education and whether students missed a class because videos were available. This statistical approach is consistent with methods used to analyze categorical data (Agresti, 1996), and determines the odds ratio (OR), which represents an index of effect, or effect size (Durlak, 2009); the values presented here are as standardized coefficients. Chi-squared tests were used to investigate the relationships between: (a) gender and how videos were used, (b) gender and why videos were used, and (c) gender and whether students missed a class because videos were available. Effect size for the chi-squared analysis was determined by

calculating the Phi coefficient. T-tests were conducted to investigate the relationship between: (a) gender and final exam grade, and (b) gender and number of views. Analysis of variance (ANOVA) was conducted to investigate the relationships between: (a) final exam grades in fall 2011, winter 2011, and winter 2012, (b) learning approach and attendance comparison categories, and (c) year post-secondary education and attendance comparison categories, and (d) year post-secondary education and final exam grade. For the analysis of year of post-secondary education performance, students were grouped into three categories: year 2, year 3, or year 4 or above. Significant effects were investigated further with Tukey's post-hoc tests. All analysis was done with SPSS version 19 and the  $p$  value was set at less than 0.05.

## Results

### Viewing Behaviour

Significant relationships were observed between viewing behaviour and learning approach as assessed by linear regression. As the score reflecting a deep approach increased, the number of views increased ( $p < 0.01$ ,  $r = 0.22$ ). As the score reflecting a surface approach increased, the number of views decreased ( $p < 0.1$ ,  $r = -0.12$ ). As deep approach score increased, students were more likely to watch videos to master material ( $p \leq 0.001$ , OR 1.1), and more likely to watch videos to review material ( $p = 0.04$ , OR 1.04). As surface approach score increased, students were less likely to watch videos beginning to end ( $p \leq 0.01$ , OR 0.93), less likely to watch videos to master material ( $p \leq 0.001$ , OR 0.92), and less likely to watch videos to generate notes ( $p \leq 0.001$ , OR 0.92). As the surface approach score increased, there was trend towards students being less likely to watch videos to review material ( $p = 0.08$ , OR 0.96), and as deep approach score increased, there was a trend towards students being more likely to watch videos from beginning to end ( $p = 0.08$ , OR 1.04).

Significant relationships were also observed between viewing behaviour and gender as assessed by chi-squared tests. There was a significant difference between males and females in watching videos to generate notes, with females being more likely to generate notes than males ( $p < 0.01$ ). There was also a non-significant trend ( $p = 0.08$ ) towards a difference in gender and watching videos to review material, with females being more likely to review material than males.

Figure 1 represents the number of video views per day throughout the time the videos were available. These results indicate that there was a steady viewing rate throughout 02/28/2012 and 03/29/2012 a large increase in views before the final exam.

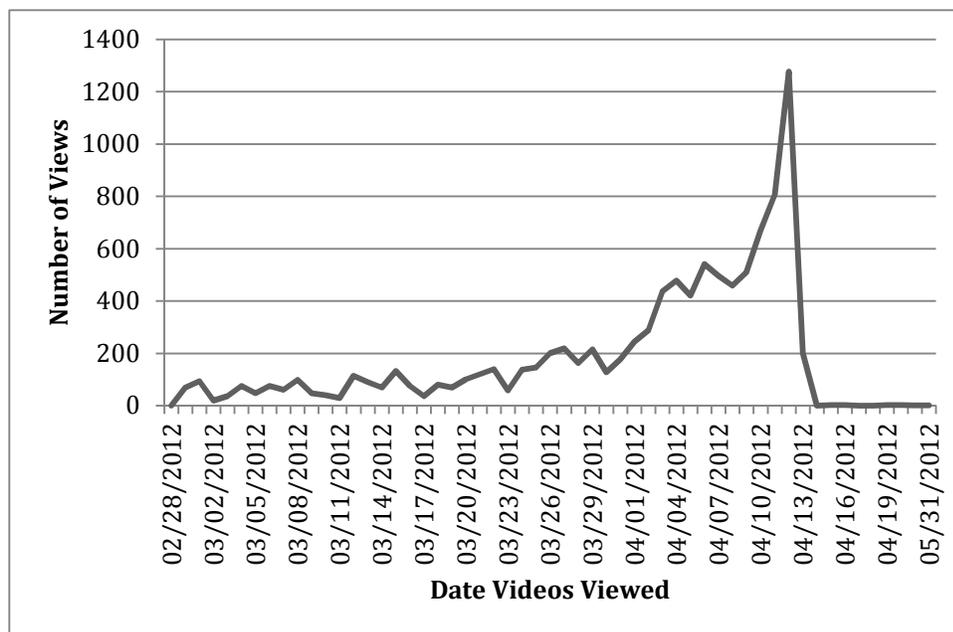


Figure 1. Number of video views per day.

Tables 3 and 4 show the pattern of viewing behaviour across the total number of survey respondents. Table 1 shows that the majority of students used both viewing strategies of watching videos in their entirety as well as watching selected material. Table 2 shows that between 50% and 75% of students used the lecture videos to review/watch/view lectures from days on which they were absent, to master material, to casually review material, and to generate more complex lecture notes. Over 80% of students used the videos to help with difficult material and to study for exams.

Table 3  
*Distribution of How Students Used Lecture Capture*

	%		
	Yes	No	No Response
Students who viewed lecture from the beginning to the end.	73	25	3
Students who watched selected material.	63	33	4

Table 4  
*Distribution of Why Students Used Lecture Capture*

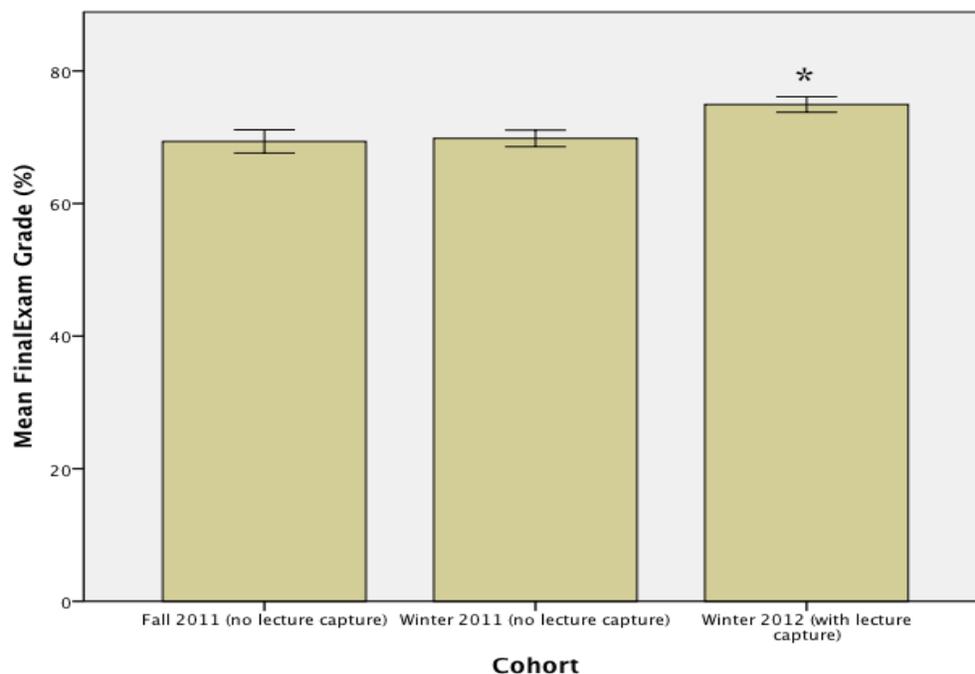
	%		
	Yes	No	No Response
To catch up on lectures I was absent from.	52	50	0
To help with difficult material I did not understand.	90	7	3
To master material I already understand.	57	39	4
To casually review the lecture.	52	44	4
To generate more complex lecture notes.	75	22	3
To study for the final exam.	81	16	3

## Performance

The final exam average of the aggregated class data was 69.3% in Fall 2011 (n=288), 69.9% in Winter 2011 (n=602), and 74.9% in Winter 2012 (n=597). The final exam average of survey respondents, at 79% (n=308), was higher than the aggregated class, which demonstrates a survey response bias. However, the statistical analysis of performance relative to historic controls was done using the aggregated data. Relative to historic controls, analysis of aggregated course performance data revealed a highly significant ( $p < 0.001$ ) difference in final exam grade for the W12 semester (provided lecture capture) compared to F11 (no lecture capture) and W11 (no lecture capture), as shown in Figure 2. Tukey's post-hoc tests revealed significant differences between W12 and W11, and between W12 and F11.

Significant relationships were also observed between final exam performance and learning approach as assessed by linear regression. As deep approach increased, the exam score increased ( $p < 0.001$ ,  $r = 0.24$ ) as represented in Figure 3. As surface approach increased, the exam score decreases ( $p < 0.001$ ,  $r = -0.26$ ) as represented in Figure 4.

An additional significant finding was that students in their 2nd year of post-secondary education performed significantly better than students in their 3rd year ( $p < 0.05$ ).



*Figure 2.* Final exam performance between the Winter 2012 class provided lecture capture and the Fall 2011 and Winter 2011 without lecture capture. The mean final exam grade in Winter 2012 was significantly higher ( $p < 0.001$ ) than in the other two classes. Error bars represent +/- SEM.

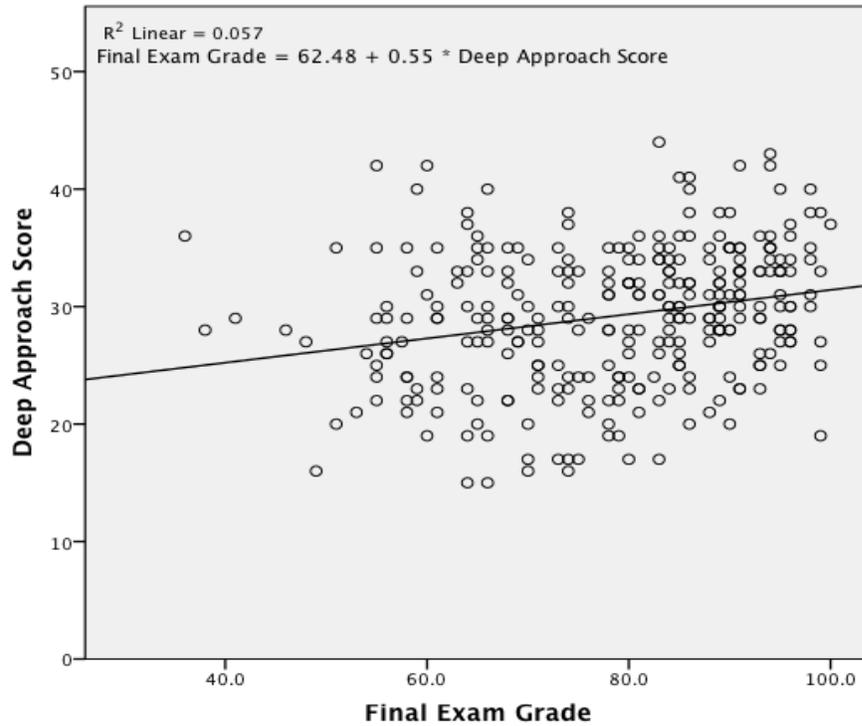


Figure 3. Deep approach score (as measured by the R-SPQ-2F) relative to final exam grade.

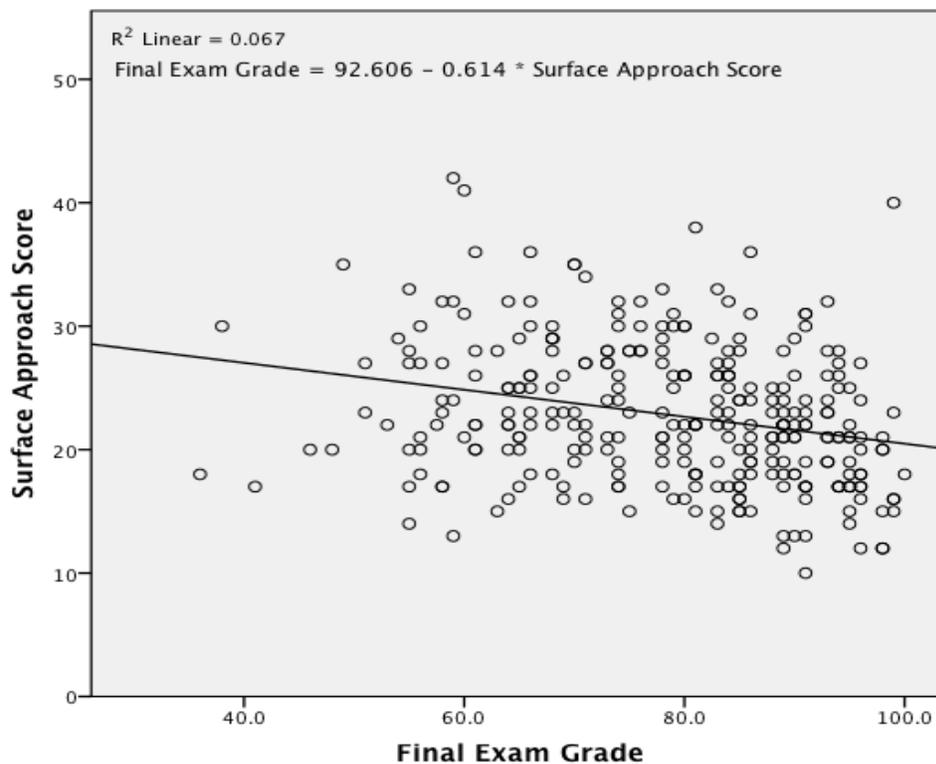


Figure 4. Surface approach score (as measured by the R-SPQ-2F) relative to final exam grade.

## Attendance

Figure 5 illustrates the reported differences in attendance in NUTR 3210 relative to classes in which lecture videos were not available across the total number of survey respondents. This figure shows that 84% of students reported no change in attendance, 6% reported an approximate 5% decrease in attendance, 5% reported an approximate 10% decrease in attendance, 2% reported an approximate 25% decrease in attendance, 1% reported an approximate 50% decrease in attendance, and 2% reported not attending NUTR 3210 at all. Significant relationships were observed between attendance and learning approach. An increase in surface approach score was related to an increased likelihood of a positive response to the question “did you miss a NUTR 3210 class because lecture capture videos were available?” as measured by logistic regression ( $p=0.01$ , OR 1.06). After dividing students into categories based on their different attendance patterns in NUTR 3210 relative to classes in which lecture videos were not available (category 1 = no change in attendance, category 2 = 5% decrease in attendance, category 3 = 10% decrease in attendance, category 4 = 25% or greater decrease in attendance), there was a significant relationship between deep approach score and attendance as represented in Figure 6 ( $p<0.001$ ,  $r= -0.20$ ,  $R^2=0.037$ ). This relationship is represented by the equation: Attendance Comparison Category =  $31.03 - 1.341 * \text{Deep Approach Score}$ . There was also a significant relationship between surface approach scores and attendance as shown in Figure 7 ( $p=0.001$ ,  $r=0.20$ ,  $R^2=0.048$ ). This relationship is represented by the equation: Attendance Comparison Category =  $0.605 + 0.032 * \text{Surface Approach Score}$ . Relationships between learning approach and the differences in attendance were measured by linear regression, which is an appropriate analysis because the categories of attendance changes – although ordinal – are arranged continuously and thus were treated as continuous variables. Figures 6 and 7 illustrate the relationships as box and whisker plots; the line in the box represents the median while the top and bottom of the box represent the 75<sup>th</sup> percentile and 25<sup>th</sup> percentile respectively. The ends of the whiskers represent the minimum and maximum of the data. It can be seen that the mean deep approach scores of students in the categories that showed the least change in attendance were higher than those in the categories showing a greater change in attendance, while the mean surface approach scores of students in the categories showing the least change in attendance were lower than those in the categories showing a greater change in attendance.

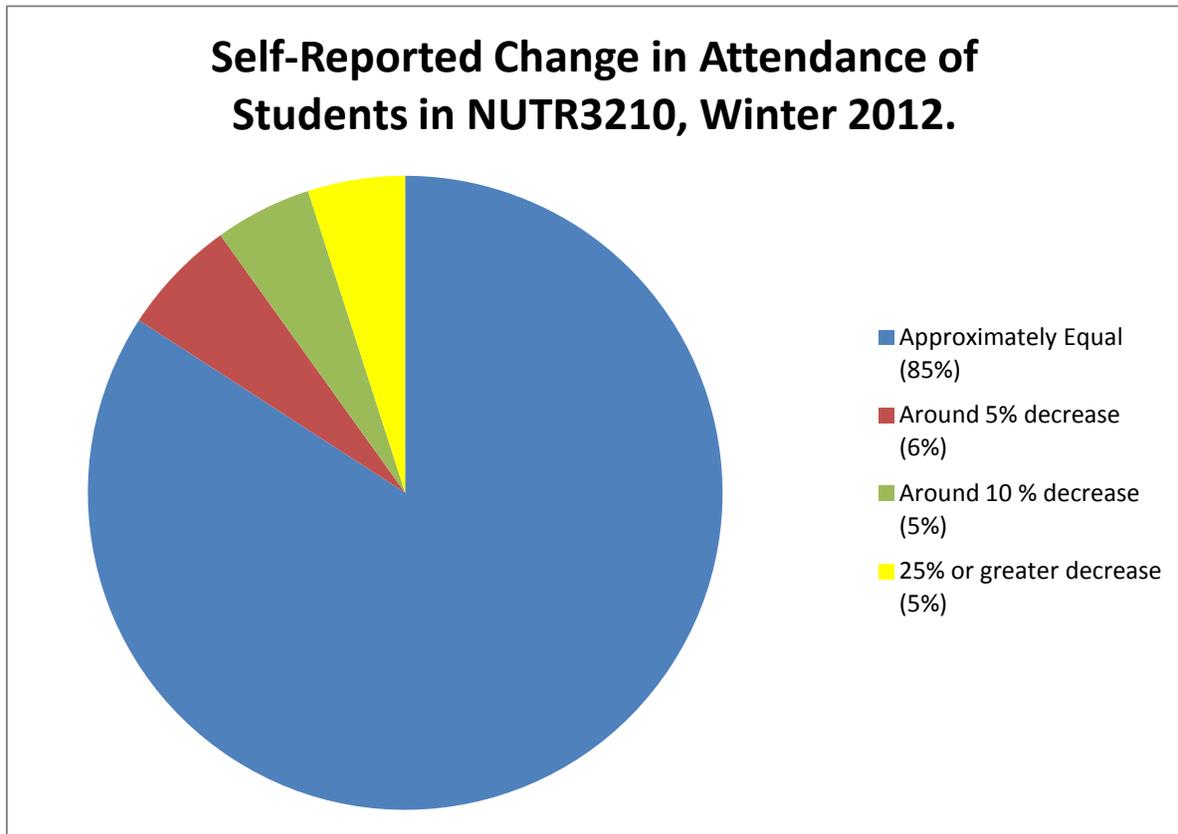


Figure 5. Student reported differences in attendance patterns in NUTR 3210 compared to classes in which lecture capture was not available.

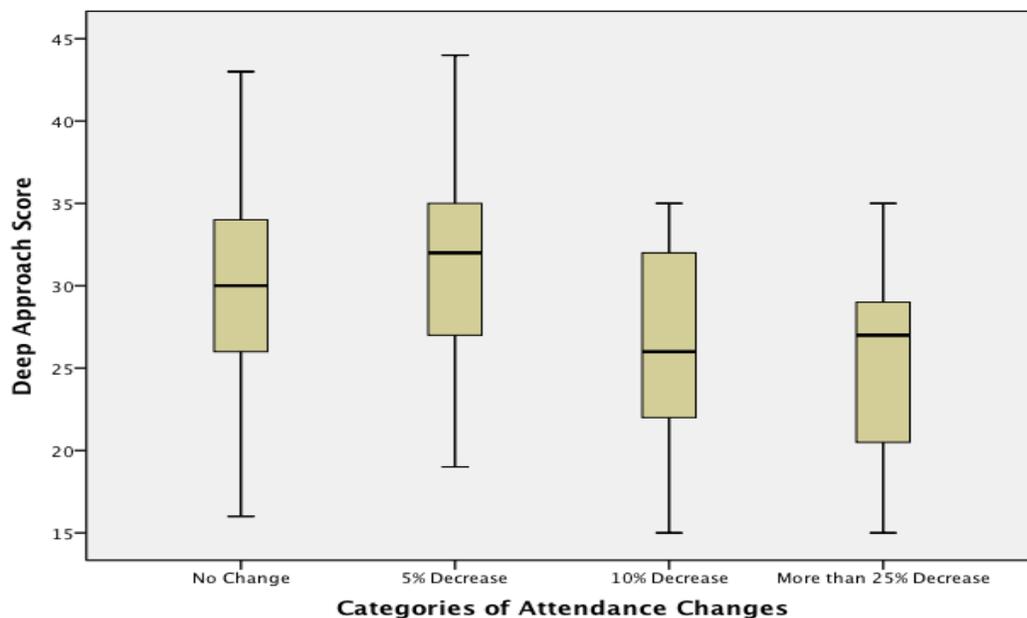


Figure 6. Distribution of deep approach scores (as measured by the R-SPQ-2F) across the categories of attendance changes.

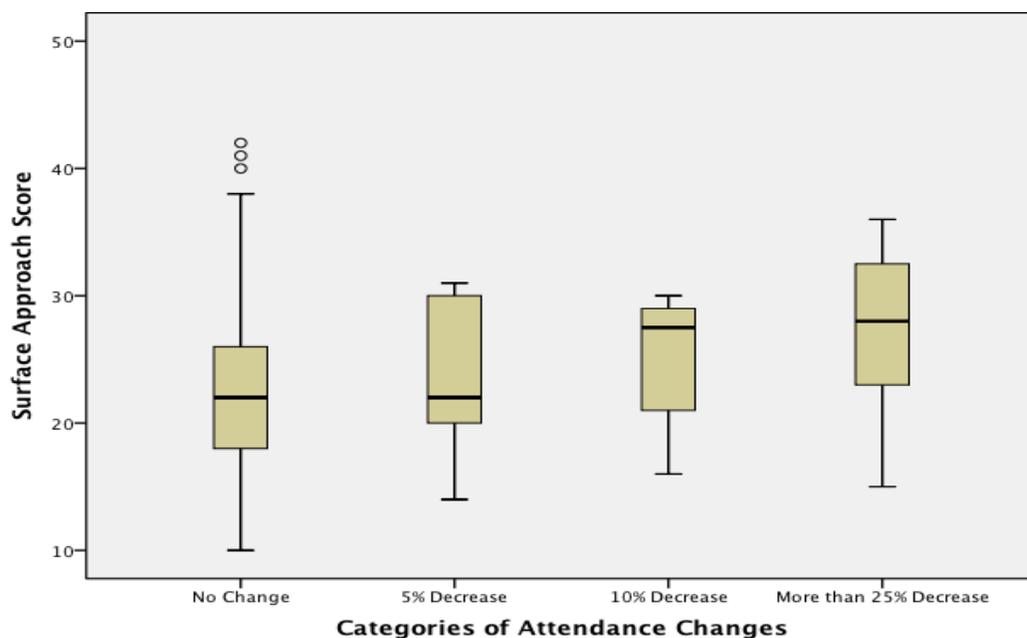


Figure 7. Distribution of surface approach scores (as measured by the R-SPQ-2F) across the categories of attendance changes.

## **Discussion**

This study examined the use of lecture capture in students in a large 3<sup>rd</sup> year undergraduate course. Data regarding viewing behaviour, academic performance, and attendance were analyzed in relation to student learning approach (as assessed by the R-SPQ-2F), gender, and year of post-secondary education. Performance was measured by grade on the final exam and was compared to historical controls.

### **Viewing Behaviour**

Several aspects of viewing behaviour were found to be significantly associated with learning approach. Higher deep learning scores were positively associated with viewing more videos, and watching videos specifically to master and review the material. In contrast, higher surface learning scores were negatively associated with watching videos from beginning to end, to master the material and to generate notes. This is consistent with previous research which indicated that deep learners will make more use of lecture capture, especially for exam review, spending more time on school work overall (Vajoczki et al., 2011). As previously described, the approach to learning describes how students arrive at different understandings of a course, with the deep approach being associated with internalization of content, making learning meaningful, and personal growth (high-level engagement), and the surface approach being associated with rote memorization and reproducing facts (low-level engagement) (Marton & Säljö, 1976). These motivational differences may explain the differences in viewing frequency of the videos, as well as differences in motivation for use.

Viewing behaviour was also found to be significantly associated with gender. In this study, females were shown to be more apt to use the lecture capture videos to generate notes and to review material. The effect of gender is not likely associated with learning approach, as analysis of deep and surface approach scores did not reveal significant differences between the two groups. This is in contrast to Vajoczki et al. (2011), who found that more females were identified as ‘deep learners’. In our analysis, however, we used the spectrum of R-SPQ-2F responses, rather than a cut-off score that designated students as surface or deep learners, which makes drawing comparisons between the two studies difficult. There was also no difference in final exam grades between males and females, which suggests that the use of lecture videos to generate notes and review material did not translate into a performance effect. Previous research has shown that females accessed more lecture capture videos per week than males (Pham, 2010), although we did not observe the same phenomenon. Females have been shown to engage in more note-taking than males (Kay & Lauricella, 2011), which may explain the observed difference in this behaviour between males and females in this study.

### **Performance**

We observed a significant difference between final exam grades between the Winter 2012 class provided lecture capture and the two classes used as historical controls. Students in the Winter 2012 cohort showed an almost 5% increase in final exam grade relative to two previous cohorts who were not provided with the same resource. Importantly, the only notable difference between these three cohorts was the provision of lecture capture: all other course material, including lecture notes, were very similar between the three classes. Moreover, the material

covered by exam questions differed minimally between semesters. Nonetheless, as subsequently described, there are demographic differences between the three groups that limits the interpretation of these findings; as well, the interpretation is somewhat confounded by the difference between instructors teaching the first part of each course (two instructors across the three courses), and by the inclusion of some content not covered by lecture capture on the final exam. As discussed in a later section, the vast majority of students in this study either did not reduce their attendance, or reduced it only marginally. So, the lecture videos in this instance can primarily be viewed as supplements – rather than replacements – to lectures, although this may be influenced by learning approach, as discussed below. While some previous research has shown positive relationships between lecture capture and performance (Bollmeier, Wenger, & Forinash, 2010; Francom, Ryan & Kariuki, 2011; Harrigan, 1995; McFarlin, 2008; Vajoczki et.al, 2010;), null relationships have also been observed (Abt & Barry, 2007; Brotherton & Abowd, 2004; Joordens et al., 2009; Powell & Barton, 2010;). This study therefore lends support to the finding that at least in certain contexts, provision of lecture capture to students as an additional course resource is positively associated with an increase in performance. Consistent with previous research related to learning approach and performance (e.g., Vajoczki et al., 2011), we observed significant relationships between student performance and learning approach.

The results of this study suggest that there is a relationship between a student's year of post-secondary education and performance, with students in second year showing better performance than students in third year. However, this is not likely due to a true effect of year of study but rather to characteristics of students that take this particular course in third year, rather than in second year. As previously described, NUTR 3210 is scheduled to be taken in year two (semester four) by students in the Biomedical Sciences program, which requires a GPA of 75% minimum in their first year of study. Also, there could be some students taking the course in their third year because they have either failed the course the previous year or another course in their program, and are now out of sync with their regular schedule of studies. Thus, these students may not be representative of a random sampling of students in third year. Therefore, this finding is not necessarily an accurate reflection of the relationship between years of post-secondary education and performance.

## Attendance

Consistent with previous research by Vajoczki et al. (2011), learning approach in this study was found to be significantly associated with student attendance. We observed that as deep approach score increased, students were less likely to decrease attendance. The opposite was observed with surface learners, whereby as surface approach score increased, students were more likely to decrease attendance. Vajoczki et al. (2011) similarly found that in contrast to deep learners, surface learners would use the lecture videos to replace attendance. In contrast to Vajoczki et al, who designated students as *either* deep or surface learners, we analyzed attendance using the range of R-SPQ-2F scores, and so were able to demonstrate a significant linear relationship between learning approach and attendance. This finding therefore not only confirms the relationship between learning approach and the use of lecture capture in relation to attendance, it demonstrates that students with higher scores at the end of either spectrum show a greater response. Again, this is likely attributable to the characteristics of a deep learner. Since lecture capture videos were not provided during the first part of the semester, there is a possibility that student attendance pattern differences occurred before the onset of lecture capture

provision; however, it is nonetheless plausible that students with higher deep approach scores may be more likely to use the videos as a supplement to lectures, while those with higher surface approach scores may be more likely to use them as replacements to lectures.

Interestingly, 85% of students in this study indicated that their attendance did not change with the availability of the lecture capture videos, with another 6% indicating that their attendance decreased by only around 5%. Therefore, for over 90% of students, there was no more than a minimal difference in attendance patterns in response to provision of lecture capture. As with the research related to lecture capture and academic performance, studies that have looked at the association between lecture capture and attendance have been mixed. While a number have shown that the availability of lecture capture showed little to no relationship with attendance (Brotherton & Abowd, 2004; Bryans Bongey, Cizaldo & Kalnbach, 2006; McElroy & Blount, 2006; Pham, 2010), several others (Bollmeier, Wenger & Forinash, 2010; Holbrook & Dupont, 2011; Owston, Lupshenyuk, & Wideman, 2011; Traphagan, Kucsera & Kishi, 2010; Vajoczki et al., 2011) have shown a negative relationship. The students in NUTR 3210 were all enrolled in a Bachelor of Science program, with the majority in the Bio-Medical Sciences, Human Kinetics, Biological Science, or Nutrition and Nutraceutical Sciences major. Program of study may be a factor to consider as influencing the relationship between lecture capture and attendance, with these findings not necessarily generalizing across non-health science disciplines. Previous research investigating the relationship between lecture capture and attendance has been conducted across a variety of different disciplines, which may influence the results and should be considered when interpreting the findings of the present study. For example, Bollmeier, Wenger & Forinash (2010) reported in their study of professional therapeutics students that 72% of students reported no change in attendance in response to provision of lecture capture, while Bryans Bongey, Cizaldo & Kalnbach (2006) reported in their study of college biology students that 95% of students indicated that they did not attend class less often when provided with lecture capture resources. This illustrates that there may be differences in attendance changes across disciplines, although other factors – such as timing – may also be important; for example, attendance is known to be influenced by class schedules (including day of the week, the number of classes on a given day, and the time of day the class is held) (Student Affairs, 1996). From a disciplinary perspective, this study, which looked at lecture capture use in a second year undergraduate course taken by students in health and biological science programs, can be compared to studies by Owston, Lupshenyuk, & Wideman (2011), who looked at use of lecture capture in freshman classes in a faculty of health, and Holbrook and Dupont (2009), who looked at lecture capture use in introductory genetics and advanced virology. In contrast to Owston, Lupshenyuk, & Wideman (2011), who observed that 10% of students stopped attending class altogether, we found that only 2% of students in the present study reported not attending NUTR 3210; however, our population included second and third year students, which as suggested by Holbrook & Dupont (2009), show a lesser change in attendance following provision of lecture capture. In their study, thirty seven percent of students in the introductory genetics class reported changing their attendance with around 16% reporting missing “a lot more classes than normal”, while 10% of students in an advanced virology course reported a change in attendance although none reported a significant change (Holbrook & Dupont, 2009). This shows that attendance changes in response to lecture capture may vary across academic levels, and that students in upper years may use the videos as learning tools, whereas introductory students in first year may use the videos in place of attending lecture (Holbrook & Dupont, 2011). In this study, we observed that approximately 15% of students changed their attendance patterns, with

around 5% changing them drastically (a 25% or greater difference in attendance). This finding could be viewed as consistent with the findings of Holbrook & Dupont, as our population of second and third year students would be between their introductory and advanced subject populations. We did not find differences in attendance between students at different academic levels, but our sample did not include first year students, and our population in fourth year or beyond was too small to be reliable. A final factor that has been shown to influence the relationship between lecture capture and attendance is student perception of lecture quality, with students reporting that their decision to attend lectures was more based on the qualities of the lecturer rather than on the availability of lecture videos (Billings-Gagliardi & Mazor, 2007). Student responses to end-of-semester course evaluations in the Winter 2012 NUTR 3210 course demonstrated an overall positive impression of lecturer quality, which may have had the effect of increasing their motivation to attend class. Clearly, many factors will contribute to a student's decision to use lecture videos to replace attendance, and elements including discipline, academic level, and student perception of lecturer quality should be considered as potential influences in the present study.

### **Limitations**

The major limitation to this study is the reliability of the performance comparison to historical data. Comprehensive demographic data was not available for the control groups, so it is not known whether they differed appreciably from the experimental group to which the performance comparison was made. However, general characteristics of the three classes in terms of program and year of study are known, and while there were differences between the Winter and Fall classes, the two Winter classes would have been comparable. It is also possible that the entrance GPA of the two Winter classes was higher than the Fall class due to the inclusion of Biomedical Science students; nonetheless, the two control groups showed nearly equivalent performance on the final exam, which was similar (although not identical) between the semesters. While every effort was made to ensure continuity between the courses, there were indeed differences between the groups that limit the interpretation of the performance improvement noted in this study. The performance comparison to historical data is also limited by the fact that the final exam grades included approximately 20% of questions from material that was not lecture captured, although as previously described, these questions covered nearly identical material and were comparable between each of the three classes, so their influence on performance is expected to be similar across the groups. A second limitation is that there was a biased response to the survey, as the final exam average was 79% for the survey respondents against a 75% average for the entire class. Therefore, the population sample for most of our analyses was biased towards higher performing students. However, it is important to note that the analysis of performance relative to historical controls – wherein we observed an almost 5% increase in final exam grade following provision of lecture capture – was based on aggregate data of the entire class, so this finding has not been positively skewed. This population may also have been biased towards lecture capture users, as 91% of responders reported using the lecture capture videos. A third limitation is that attendance in this study was self-reported, due to the difficulty of measuring physical attendance in large classes. The majority of studies that have looked at the relationship between lecture capture and attendance have used a similar self-reporting measure, so our methodology – while inherently biased towards subjectivity – is nonetheless consistent with the previous body of literature. A fourth limitation is that the

students in this course were all science majors, and did not include students across all academic levels, so these results may not be representative of students in other programs and at other points in their academic careers. A fifth limitation relates to the possibility of type 1 errors in the statistical analysis, due to multiple comparisons being made. And a final limitation relates to the possibility of equity issues related to accessibility of the videos, as it is not known how many students in this study had access to reliable, high speed internet access off campus. As already mentioned, 91% of survey responders reported accessing the videos, and video usage data showed that each video received an average of 818 views (data not shown), which suggests that the videos were heavily accessed. Nonetheless, videos may not have been equally available to all students, which could influence the study results and should be considered in the interpretation of the study data. Despite these limitations, the research findings in the present study are consistent a number of previous research studies, in particular, with Vajoczki, et.al. (2011), and confirm and strengthen several observed relationships, most notably those between lecture capture and attendance and lecture capture and performance, particularly in terms of student learning approach.

### **Conclusion**

This systematic inquiry into the teaching and learning process demonstrates that the use of lecture capture varies depending on user characteristics, including learning approach and gender. The relationships that were observed between learning approach and behaviour such as viewing videos to master and review material are consistent with the known characteristics of deep and surface learners, and the contribution of learning approach to changes in viewing behaviour was quite significant. In contrast, the gender effects in this study were small, and suggest that while some differences in lecture capture use may exist between males and females, gender likely exerts only a minor influence on viewing behaviour. This study also demonstrates that performance may be significantly improved following provision of lecture capture as an additional course resource, and that concerns about a large decrease in attendance may be unfounded, with students using lectures more often to supplement – rather than to replace – attending lectures. Year of study was not found to be significantly associated with any measured variables except performance, although as previously discussed, the study design may not have adequately allowed for this investigation. While these findings are consistent with many previous studies related to lecture capture, they conflict with others, which seems to suggest the importance of considering the context in which lecture capture is being provided as an important factor. A primary objective of evidence-based investigations such as this one is to demonstrate strategies and tools with which to improve student learning; it is our belief that this goal has been accomplished in the present study, which highlights lecture capture as a tool that can be used to improve student performance, at least in the context of this research, and which clarifies characteristics of lecture capture users that influence how lecture capture is utilized. Due to the limitations associated with self-reported attendance, future research should focus on obtaining an objective measurement of attendance so as to more accurately determine the relationship between lecture capture and this variable, and on characterizing the differences in lecture capture use between disciplines and across academic levels. However, the present research clearly supports the use of lecture capture as a tool to improve academic performance without significantly compromising class attendance.

## References

- Agresti, A. (1996). *An introduction to categorical data analysis*. New York: Wiley.
- Abt, G., & Barry, T. (2007). The quantitative effect of students using podcasts in a first year undergraduate exercise physiology module. *Bioscience Education e-Journal*, 10, 9. <http://dx.doi.org/10.3108/beej.10.8>
- Babb, K. A., & Ross, C. (2009). The timing of online lecture slide availability and its effect on attendance, participation, and exam performance. *Computers & Education*, 52(4), 868-881. <http://dx.doi.org/10.1016/j.compedu.2008.12.009>
- Bassili, J. N. (2006). Promotion and prevention orientations in the choice to attend lectures or watch them online. *Journal of Computer Assisted Learning*, 22(6), 444-455. <http://dx.doi.org/10.1111/j.1365-2729.2006.00192.x>
- Biggs, J. B. (1987). *Study Process Questionnaire Manual*. Melbourne: Australian Council for Educational Research.
- Biggs, J., Kember, D., & Leung, D. (2001). The revised two-factor study process questionnaire: R-SPQ-2F. *British Journal of Educational Psychology*, 71, 133-149. <http://dx.doi.org/10.1348/000709901158433>
- Billings-Gagliardi, S., & Mazor, K. M. (2007). Student decisions about lecture attendance: do electronic course materials matter? *Journal of the Association of American Medical Colleges*, 82(10), S73-S76.
- Bollmeier, S. G., Wenger, P. J., & Forinash, A. B. (2010). Impact of online lecture-capture on student outcomes in a therapeutics course. *American Journal of Pharmaceutical Education*, 74(7), 127. <http://dx.doi.org/10.5688/aj7407127>
- Brotheron, J. A., & Abowd, G. D. (2004). Lessons learned from eClass: Assessing automated capture and access in the classroom. *ACM Transactions on Computer-Human Interaction*, 11(2), 121-155. <http://dx.doi.org/10.1145/1005361.1005362>
- Bryans Bongey, S. B., Cizaldo, G., & Kalnbach, L. (2006). Explorations in course-casting: podcasts in higher education. *Campus-Wide Information Systems*, 23(5), 350-367. <http://dx.doi.org/10.1108/10650740610714107>
- Chen, J. & Lin, T.F. Class attendance and exam performance: a randomized experiment. *Journal of Economic Education*, 39(3), 213-227. <http://dx.doi.org/10.3200/JECE.39.3.213-227>
- Copley, J. (2007). Audio and video podcasts of lectures for campus-based students: production and evaluation of student use. *Innovations in Education and Teaching International*, 44(4), 387-399. <http://dx.doi.org/10.1080/14703290701602805>
- Cramer, K. M., Collins, K. R., Snider, D., & Fawcett, G. (2007). The virtual lecture hall: Utilisation, effectiveness and student perceptions. *British Journal of Educational Technology*, 38(1), 106-115. <http://dx.doi.org/10.1111/j.1467-8535.2006.00598.x>
- Durlak, J. A. (2009). How to select, calculate, and interpret effect sizes. *Journal of Pediatric Psychology*, 34(9), 917-928. <http://dx.doi.org/10.1093/jpepsy/jsp004>
- Embi, P. J., Biddinger, P. W., Goldenhar, L. M., Schick, L. C., Kaya, B., & Held, J. D. (2006). Preferences regarding the computerized delivery of lecture content: a survey of medical students. *AMIA Annual Symposium Proceedings*, 916.
- Evans, C. (2008). The effectiveness of m-learning in the form of podcast revision lectures in higher education. *Computers & Education*, 50(2), 491-498. <http://dx.doi.org/10.1016/j.compedu.2007.09.016>

- Francom, J., Ryan, T. G., & Kariuki, M. (2011). The effects of podcasting on college student achievement and attitude. *Journal of the Research Center for Educational Technology*, 7(1), 39-53.
- Frankel, K. A. (2012, January 5). Echo 360 pushes 'lecture capture' tech into classrooms from Qatar to the US. *Bloomberg*. Retrieved from <http://www.bloomberg.com/news/2012-01-05/echo360-pushes-lecture-capture-tech-into-classrooms-from-qatar-to-the-u-s-.html>.
- Gibbs, G., Morgan, A., & Taylor, E. (1982). A review of the research of Ference Marton and the Goteborg group: a phenomenological research perspective on learning. *Higher Education*, 11, 123-145. <http://dx.doi.org/10.1007/BF00139684>
- Green, K. C. (2011). *The Campus Computing Project*. Retrieved from <http://www.campuscomputing.net/sites/www.campuscomputing.net/files/Green-CampusComputing2011.pdf>.
- Greenberg, A. D., & Nilssen, A. (2011). *Wainhouse research paper: Lecture capture deployment models*. Retrieved from <http://www.wainhouse.com/files/papers/wr-lecture-capture-deploy.pdf>
- Gosper, M., Green, D., McNeil, M., Phillips, R., Preston, G., & Woo, K. (2008). *The impact of web-based lecture technologies on current and future practices in learning and teaching*. Australian Teaching and Learning Council. Retrieved from <https://www.mq.edu.au/ltc/altc/wblt/research/report.html>
- Gump, S.E. (2005) The cost of cutting class: attendance as a predictor of student success. *College Teaching*, 53, 21-26. <http://dx.doi.org/10.3200/CTCH.53.1.21-26>
- Harrigan, K. (1995). The SPECIAL system: Self-paced education with compressed interactive audio learning. *Journal of Research on Computing in Education*, 27(3), 361-370.
- Harpp, D. N., Fenster, A. E., Schwarcz, J. A., Zorychta, E., Goodyer, N., Hsiao, W., & Parente, J. (2004). Lecture retrieval via the web: Better than being there? *Journal of Chemical Education*, 81(5), 688-690. <http://dx.doi.org/10.1021/ed081p688>
- Holbrook, J., & Dupont, C. (2009). Profcasts and class attendance – does year in program matter? *Bioscience Education*, 13, c2. <http://dx.doi.org/10.3108/beej.13.c2>
- Holbrook J., & Dupont, C. (2011). Podcasts and attendance – does year in program matter? *Bioscience Education*, 13.
- Jensen, S. A. (2011). In-class versus online video lectures: Similar learning outcomes, but a preference for in-class. *Teaching of Psychology*, 38(4), 298-302. <http://dx.doi.org/10.1177/0098628311421336>
- Joordens, S., Le, A., Grinnell, R., & Chrysostomou, S. (2009). Eating your lectures and having them too: Is online lecture availability especially helpful in “skills-based” courses? *Electronic Journal of e-Learning*, 7(3), 281-288.
- Justicia, F., Pichardo, M., Cano, F., Berben, A., & De la Fuente, J. (2008). The revised two-factor study process questionnaire (R-SPQ-2F): exploratory and confirmatory factor analyses at item level. *European Journal of Psychology and Education*, 23, 355-372. <http://dx.doi.org/10.1007/BF03173004>
- Kay, R. H., & Lauricella, S. (2011). Gender differences in the use of laptops in higher education: a formative analysis. *Journal of Educational Computing Research*, 44(3), 361-380. <http://dx.doi.org/10.2190/EC.44.3.f>
- Luna, G., & Cullen, D. (2011). Podcasting as complement to graduate teaching: Does it accommodate adult learning theories? *International Journal of Teaching and Learning in Higher Education*, 23(1), 40-47.

- Marton, F., & Säljö, R. (1976). On qualitative differences in learning – I: Outcome and process. *British Journal of Educational Psychology*, 46, 4-11. <http://dx.doi.org/10.1111/j.2044-8279.1976.tb02980.x>
- McElroy, J., & Blount, J. (2006). You, me and iLecture. In L. Markauskaite, P. Goodyear, & P. Reimann (Eds), *Proceedings of the 23rd Annual Ascilite Conference: Who's Learning? Whose Technology?* 549-559. Retrieved from [http://www.ascilite.org.au/conferences/sydney06/proceeding/pdf\\_papers/p87.pdf](http://www.ascilite.org.au/conferences/sydney06/proceeding/pdf_papers/p87.pdf)
- McFarlin, B. K. (2008). Hybrid lecture-online format increases student grades in an undergraduate exercise physiology course at a large urban university. *Advances in Physiology Education*, 32(1), 86-91. <http://dx.doi.org/10.1152/advan.00066.2007>
- McKinney, D., Dyck, J. L., & Luber, E. S. (2009). iTunes university and the classroom: Can podcasts replace professors? *Computers & Education*, 52(3), 617-623. <http://dx.doi.org/10.1016/j.compedu.2008.11.004>
- O'Bannon, B. W., Lubke, J. K., Beard, J. L., & Britt, V. G. (2011). Using podcasts to replace lecture: Effects on student achievement. *Computers & Education*, 57(3), 1885-1892. <http://dx.doi.org/10.1016/j.compedu.2011.04.001>
- Owston, R., Lupshenyuk, D., & Wideman, H. (2011). Lecture capture in large undergraduate classes: Student perceptions and academic performance. *Internet and Higher Education*, 14(4), 262-268. <http://dx.doi.org/10.1016/j.iheduc.2011.05.006>
- Pham, J. (2010). *A case study of classroom podcast in ohlone community college*. (3417168, Alliant International University, San Francisco Bay). *ProQuest Dissertations and Theses*, 162. Retrieved from <http://search.proquest.com/docview/744398076?accountid=11233>. (744398076).
- Podcast. (n.d.) In *Cambridge Dictionaries Online*. Retrieved from <http://dictionary.cambridge.org/dictionary/british/podcast>.
- Powell, M. C. B. (2010). *Podcast effectiveness as scaffolding support for students enrolled in first-semester general chemistry laboratories*. (3436570, University of North Texas). *ProQuest Dissertations and Theses*, 219. Retrieved from <http://search.proquest.com/docview/822234303?accountid=11233>. (822234303).
- Prat-Sala, M., & Redford, P. (2010). The interplay between motivation, self-efficacy, and approaches to studying. *British Journal of Educational Psychology*, 80, 283-305. <http://dx.doi.org/10.1348/000709909X480563>
- Rosnow, R. L., Rosenthal, R., & Rubin, D. B. (2000). Contrasts and correlations in effect size determination. *Psychological Science*, 11(6), 446-453. <http://dx.doi.org/10.1111/1467-9280.00287>
- Scutter, S., Stupans, I., Sawyer, T., & King, S. (2010). How do students use podcasts to support learning? *Australasian Journal of Educational Technology*, 26(2), 180-191.
- Shaw, G. P., & Molnar, D. (2011). Non-native English language speakers benefit most from the use of lecture capture in medical school. *Biochemistry and Molecular Biology Education*, 39(6), 416-420. <http://dx.doi.org/10.1002/bmb.20552>
- Silverstein, S. (2006, January 17). The iPod took my seat. *Los Angeles Times*, pp. 1, 2. Retrieved from <http://articles.latimes.com/2006/jan/17/local/me-noshow17>
- Student Affairs (1996). *Class attendance*. Penn State University. Retrieved from <http://studentaffairs.psu.edu/assessment/pdf/24.pdf>

- Taylor, M. Z. (2009). Podcast lectures as a primary teaching technology: Results of a one-year trial. *Journal of Political Science Education, 5*(2), 119-137.  
<http://dx.doi.org/10.1080/15512160902816249>
- Traphagan, T., Kucsera, J. V., & Kishi, K. (2010). Impact of class lecture webcasting on attendance and learning. *Educational Technology Research and Development, 58*(1), 19-37. <http://dx.doi.org/10.1007/s11423-009-9128-7>
- Vajoczki, S., Watt, S., Marquis, N., & Holshausen, K. (2010). Podcasts: Are they an effective tool to enhance student learning? A case study from McMaster University, Hamilton Canada. *Journal of Educational Multimedia and Hypermedia, 19*(3), 349-362.
- Vajoczki, S., Watt, S., Marquis, N., Liao, R., & Vine, M. (2011). Students approach to learning and their use of lecture capture. *Journal of Educational Multimedia and Hypermedia, 20*(2), 195-214.
- Vodcast. (n.d.). In *Cambridge Dictionaries Online*. Retrieved from <http://dictionary.cambridge.org/dictionary/british/vodcast?q=vodcast>