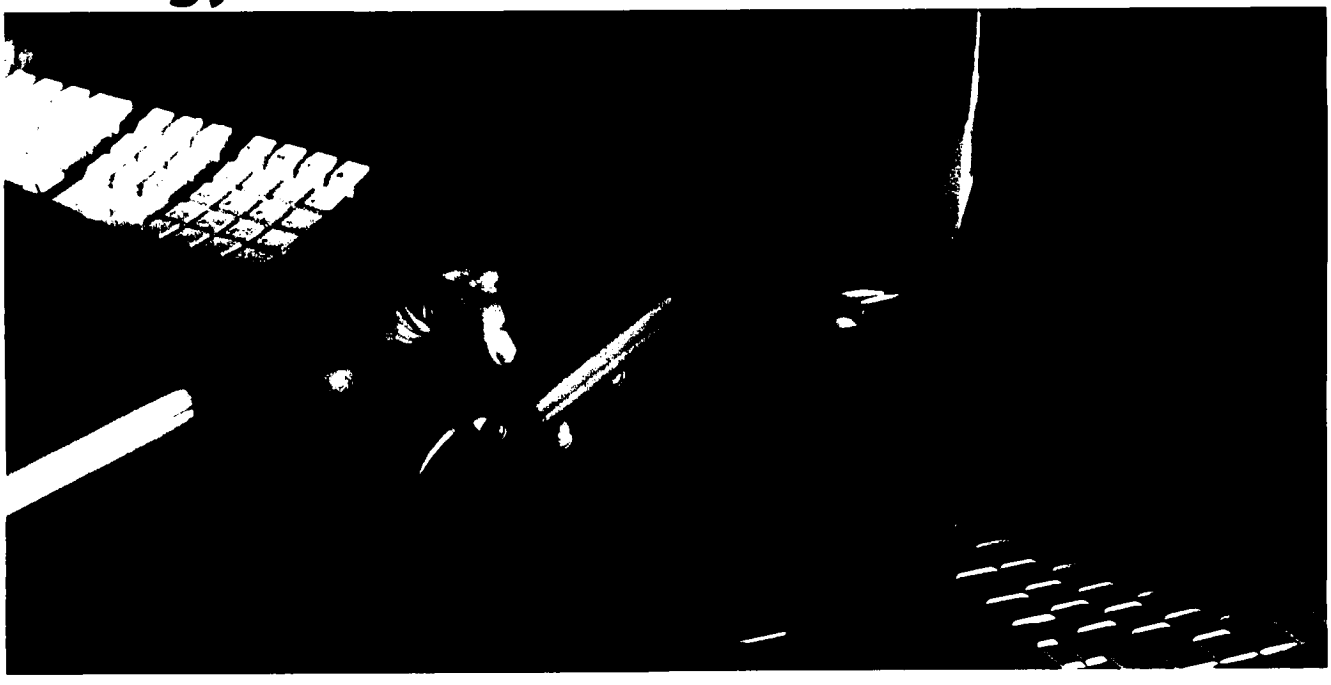
Analysis of Students' Downloading of Online Audio Lecture Recordings in a Large Biology Lecture Course



By Brian T. White

An analysis of students' podcast downloads in a large lecture course suggests that podcasts are primarily used for exam preparation and do not reduce lecture attendance.

Students in large lecture courses have been making audio recordings of lectures for many years. Recently, it has become possible to record lectures digitally and post the resulting files on the web for easy download by all students. Because these files can be easily downloaded to personal MP3 players like the iPod, these are often called "podcasts." Many educators have advocated the use of podcasts at the university level. For example, Duke University has begun a program in which all entering freshmen have an iPod (Duke University 2005).

Podcasts take many forms, from podcasting of lecture audio only (French 2006; Kadel 2006; Read 2007) to audio and video podcasts (McGrann 2006) and even courses where the lectures have been entirely replaced by podcasts (Smeaton and Keogh 1999). Although many articles encourage the use of podcasting, there has been very little formal research on the effects of this technology on students and the classroom. French (2006) cites dual encoding theory and studies of multimedia software to suggest that listening to lecture podcasts "while watching TV, conversing, or browsing the web" may not be an effective learning strategy and calls for more research into "how podcasting can be used to increase learning" (p. 59). While generally supportive of podcasting, Kadel (2006) suggests a series of research questions that need to be addressed. These include how podcasting is used by professors and students, whether podcasting decreases lecture attendance, and if particular podcasting options are

effective teaching tools. This paper addresses three questions apropos of those posed by Kadel in the context of a large introductory-level undergraduate science lecture course. It begins by exploring which students download the podcasts and when. Next, it examines the temporal pattern of downloads and what this suggests about how students use the podcasts. Finally, it examines whether the availability of podcasts reduces lecture attendance.

Subjects and data collection

General Biology II (Bio 112) is the second-semester introductory course for biology majors. It consists of three 50-minute lectures and one three-hour lab per week. There are three in-lecture exams and one final exam each semester. Typically, there are 150–200 students enrolled; most of these are biology majors, some are postbaccalaureate premedical students, and a few are majors in other departments. In spring 2007, when this study was conducted, there were 185 students enrolled in the course.

I have made lecture audio podcasts available on the course website since spring 2005. Each of the 39 lectures is recorded live on an MP3 recorder and posted on the course website immediately following lecture. Lectures from the previous spring semester are available until they are replaced by lectures from the current semester. As a result, students can use the lecture audio either to prepare for upcoming lectures or review past lectures. The lecture audio files are not part of a subscription service that distributes them automatically as they become available, as with a true podcast; students must download them individually as they need them. Accessing the audio files requires a password that I provide to all students and a small number of other users. The web server keeps a log of each file downloaded, the time of the download, and the internet protocol (IP) address of the downloading computer. In spring 2007 I began collecting log files at the start of the 4th week of the 17-week semester. Log files were not collected for the first three weeks due to a server configuration error. I only included log entries that recorded complete transfer of an audio file; interrupted or partial transfers were not included in the analysis. Students were not aware that I would be analyzing these log files. Using these log files, I have been able to construct a picture of who uses these files, for what purposes, and if this has any impact on attendance in lectures. The UMass Boston Institutional Review Board ruled that this project did not require human subjects research review.

Analysis and conclusions

The log files provide a record of IP addresses (a unique identifier for each particular client computer) and downloads (files successfully transferred over the network). For the purposes of this paper, I will make two simplifying assumptions. First, since each student has his or her own computer, I will assume that each different IP address corresponds to a different student. This introduces some error as it is likely that more than one student may use the same computer, a student may download from more than one computer, and students may give out the password to individuals who are not in the class. Second, since students download audio files as they need them, I will further assume that each download corresponds to a single listening event. The error arises here because a file, once downloaded, can be listened to one time, several times, or not at all. Keeping these assumptions in mind, it is possible to draw some tentative conclusions from the data I have collected.

The results section is organized around three questions relevant to educators considering whether or not to podcast their lectures:

1. How many students access the podcasts and how often?

Over the 14 weeks of the study, a total of 1,333 lecture audio files were downloaded, yielding an average of 13.3 per day and 7.2 per student enrolled in the course. These downloads originated from 228 different IP addresses, an average of 5.8 downloads per IP address. The number of distinct IP addresses that accessed the podcasts, 228, is somewhat higher than the 185 students enrolled in the class, indicating that the first assumption above is only approximately true. Figure 1 shows the

TABLE 1

Downloads during the week immediately preceding each exam.

Exam	Total downloads in preceding week	Relevant downloads in preceding week	% relevant downloads
Exam 1	91	69	76%
Exam 2	207	145	70%
Exam 3	210	207	98%
Final Exam	**303**	**303**	**100%**
Total	811	724	89%

Table showing number of lectures downloaded during the week preceding each exam. The number of lectures downloaded that are relevant to each exam are also shown.

frequency distribution of downloads by IP address. Computers with five different IP addresses downloaded more than 39 files—the total number of different lecture audio files on the website—indicating that these individuals downloaded the same files more than once. However, the majority of the downloads originated from IP addresses that downloaded four or fewer files, indicating that while most students used the podcasts, most only listened to a few lectures.

Smeaton and Keogh (1999) describe the analysis of web-server log files for a lecture course that was delivered entirely as podcasts. In that course, the average student downloaded 112 (94%) of the 119 available lecture files. This is significantly higher than the 7.2 (18%) out of a possible 39 downloads per student that I observed. This is likely because listening to the podcasts was optional in Bio 112.

Bull (2005) has suggested that one of the advantages of podcasting, as with other online content delivery systems, is that it supports "the long tail"—the large number of files that are accessed only very infrequently. Interestingly, the distribution of download rates for Bio 112 lectures shown in Figure 2 does not follow this pattern. Rather than being hyperbolic, the distribution of listening frequencies is roughly bell shaped and centered around the average value of 34.2 downloads per lecture. In our case, students listened to all the lectures at a roughly similar rate.

2. When do students access the podcasts and what does that suggest about what they use the podcasts for?

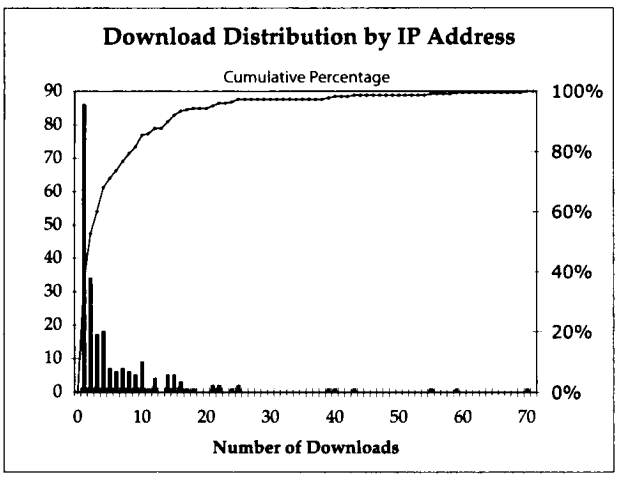
There are many possible uses for the lecture podcasts: preparing for an upcoming lecture, reviewing immediately after a lecture, reviewing lecture material before an exam, and so on. Occasional comments from students suggest that some do not expect to understand the lecture completely when they first hear it; these students expect to review the lecture at a later date to solidify their understanding. Others who have examined students' use of podcasts have found similar opinions—that students find the ability to pause, rewind, and listen to difficult material several times to be extremely valuable (Flanagan and Calandra 2005; Windham 2007).

To address this question, I began by determining if students listen to audio in advance of when the lecture was given, presumably to prepare for the lecture, or following the lecture to review. For each file downloaded, I calculated the difference between the time the lecture was given and the time the lecture audio file was downloaded. Figure 3 shows a graph of the frequency distribution of these differences. The overwhelming majority of downloads occur after the corresponding lecture was presented, with the average lecture being downloaded 18.3 days after it was given. This suggests that it may not be necessary to post audio files from previous years, because they are little used by students. Interestingly, many lectures are downloaded substantially after they were given, suggesting that students do not often use podcasts for immediate review of recent lectures.

Given that the downloads most frequently occurred some weeks after the corresponding lecture, I next examined when, over the course of the semester, these downloads occurred. Figure 4 shows a graph of downloads per day over the course of the semester. The graph shows large day-to-day fluctuations, with large peaks during the week before each of the exams. Based on these results, I suspected that students might be reviewing lectures specifically to prepare for the exams. To determine the extent to which this

FIGURE 1

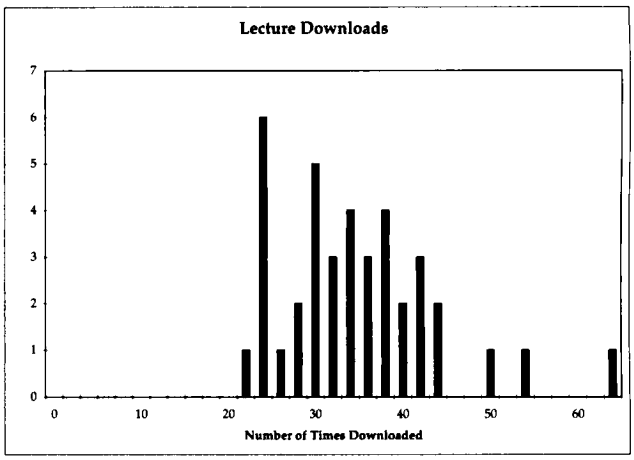
Frequency distribution of downloads by IP address.



Histogram showing number of IP addresses downloading different numbers of lecture podcasts. The cumulative percentage of all downloaded files is also shown.

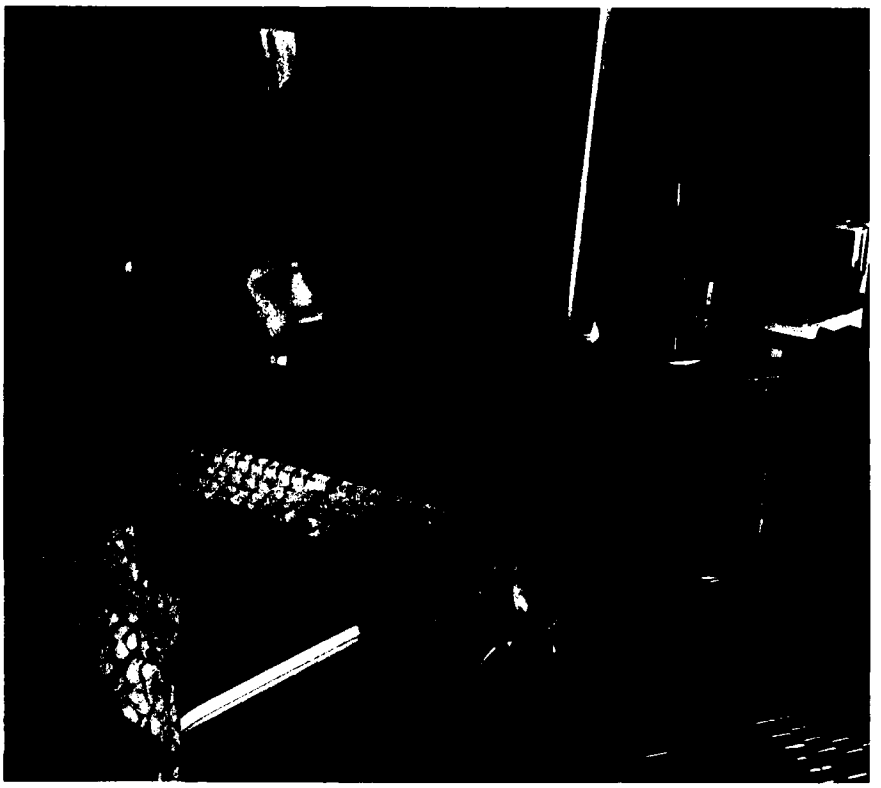
FIGURE 2

Frequency of lecture downloads.



Histogram showing number of lectures downloaded at different rates.

was the case, I counted the lectures downloaded during the week immediately preceding each lecture as well as the fraction of those downloads that corresponded to lectures covered on each exam. The results are shown in Table 1, which shows that in the four weeks preceding the four exams, which represent 4/14 (29%) of the weeks in the study, there were 811 downloads, representing 61% of the total podcasts downloaded. Furthermore, these data show that the overwhelming majority (89%) of the lectures downloaded in the week before each of the exams are relevant to the corresponding exam. These data strongly suggest that the majority of the lectures were listened to during the week before each exam, likely as part of students' preparation for each exam.



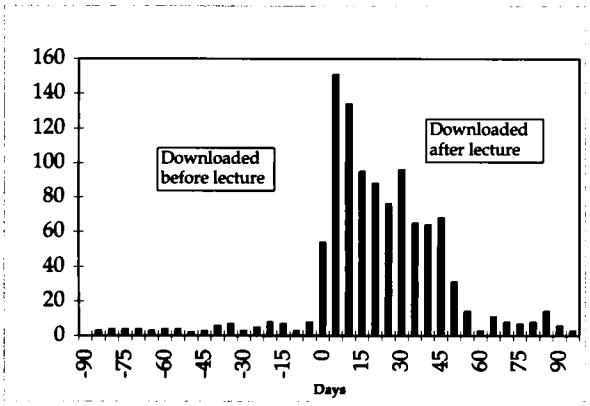
3. Does making podcasts available reduce lecture attendance?

Many educators are concerned that providing podcasts of lectures will reduce lecture attendance (for example: Kadel 2006; Lum 2006). I addressed this issue in two ways. First, by exploring the relationship, if any, between attendance at individual lectures and download frequency of each lecture. Second, I compared average lecture attendance rates in semesters where podcasts were available with those where it was not.

I am able to measure lecture attendance because students in my courses use the iClicker (*www.iClicker.com*) personal response system in my lectures. iClickers are individual, handheld radio transceivers carried by each student that allow him or her to transmit answers to a multiple-choice questions during lecture; students' answers are logged on a PC and displayed in a histogram for the class to see. Students earn points toward their final course grade for each iClicker question they answer; this small number of points encourages both the purchase of the iClicker and attendance in lecture. Of the 185

FIGURE 3

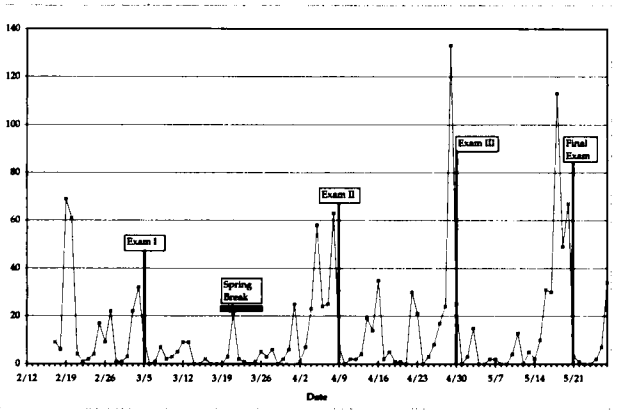
Difference between download and presentation times.



Histogram showing the number of podcasts downloaded at different times compared to when the corresponding lecture was given.

FIGURE 4

Downloads over the course of the semester.



Graph of total downloads on each day during the semester. The marked dates are Mondays.

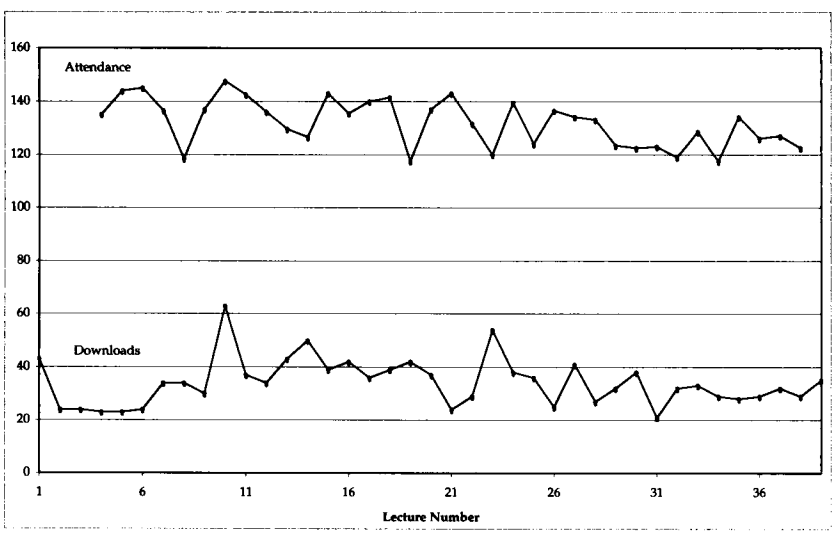
students in spring 2007, 184 purchased an iClicker. Figure 5 shows a graph of attendance at each lecture measured using response to iClicker questions along with the number of times that lecture's podcast was downloaded. Although both frequencies vary over the semester, there is no clear relationship between the lectures that are poorly attended and those that are frequently downloaded. Regression analysis of these data showed no significant association between attendance and download frequency. This suggests that students are not using the podcasts as a substitute for attending lectures.

As the second measure of the impact of podcasting on lecture attendance, I made use of a "historical experiment." Because I first made online lecture audio available in spring 2005, I was able to compare attendance rates using iClicker data before and after the introduction of podcasting in my courses. I pooled data from both of the courses I teach: General Biology I in the fall and General Biology II in the spring. Both courses have very similar structures and student populations. In all semesters, more than 95% of the students enrolled had purchased a "clicker" (in some semesters, I used iClickers; in others, I used different personal-response-system hardware). In fall 2003, before I introduced podcasting, the average attendance rate of students owning a clicker was 75.3%. Pooling five semesters of data from spring 2005 through spring 2007, when podcasts were available, the average attendance rate was 75.8%. The difference is not statistically significant. It is important to note that the points earned for answering clicker questions provide a strong incentive for students to attend lecture. However, this incentive is not sufficient to result in 100% lecture attendance. This suggests that there are other factors in addition to clicker points that influence students' decisions to attend lectures. Based on this, if the availability of lecture podcasts were a strong disincentive, I would expect to see a significant drop in attendance once they became available. Because this drop was not observed, access to lecture podcasts is probably not a significant disincentive to lecture attendance. It is not clear from these results how podcasting would affect attendance in a class without a personal response system.

Overall, these results suggest that a large fraction of students in the class are making use of the podcasts in an educationally sound way—to review lecture material in preparation for the exams. They further suggest that making these podcasts available does not reduce lecture attendance significantly. Further study of learning outcomes with and without podcasting will be required to answer Kadel's final question about their effectiveness as a learning tool. ■

FIGURE 5

Attendance and download rate for each lecture.



Graph of attendance and download frequency for each lecture.

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Brian T. White (brian.white@umb.edu) *is a professor in the biology department at the University of Massachusetts–Boston.*