

HOW WE TEACH | *Generalizable Education Research*

A survey of first-year biology student opinions regarding live lectures and recorded lectures as learning tools

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¹Department of Biomedicine, College of Public Health, Medicine, and Veterinary Science, James Cook University, Cairns, Queensland, Australia; ²Deviot Institute, Deviot, Tasmania, Australia; ³Institute of Food Science and Technology, College of Health, Massey University, Palmerston North, New Zealand; and ⁴Institute of Veterinary, Animal, and Biomedical Science, College of Science, Massey University, Palmerston North, New Zealand

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Simcock DC, Chua WH, Hekman M, Levin MT, Brown S. A survey of first-year biology student opinions regarding live lectures and recorded lectures as learning tools. *Adv Physiol Educ* 41: 69–76, 2017; doi:10.1152/advan.00117.2016.—A cohort of first-year biology students was surveyed regarding their opinions and viewing habits for live and recorded lectures. Most respondents (87%) attended live lectures as a rule (attenders), with 66% attending more than two-thirds of the lectures. In contrast, only 52% accessed recordings and only 13% viewed more than two-thirds of the available recordings. Respondents regarded lectures as efficient for information delivery (75%), and 89% enjoyed live lectures because they were useful for learning (89%), understanding coursework (94%), and keeping up with the subject (93%). Lecture enjoyment was driven less by entertainment (34%) or interaction with the lecturers (47%), although most students preferred an entertaining lecturer to a factual expert (72%). Exam marks were positively correlated with the number of lectures attended ($P < 0.001$) and negatively correlated with the number of recordings viewed ($P < 0.05$), although marks were similar for lecture attenders and nonattenders ($P > 0.05$). Lecture attenders mostly missed lectures to complete assessments during the same week (68%), whereas nonattenders were more likely to miss lectures due to outside commitments or preference for study from books or recorded lectures ($P < 0.001$). Recordings were used to replace missed lectures (64%), rather than for revision, and were viewed mostly alone (96%) in one sitting (65%). Only 22% of respondents agreed that some lectures could be replaced by recordings, but 59% agreed with having some videoconference lectures from experts on another campus. Overall, this cohort showed a clear preference for live lectures over recordings, with limited support for synchronous videoconference lectures.

THE USE OF RECORDED LECTURES as a learning tool is becoming more common in tertiary education institutes, particularly for large classes (15). While some recordings are made available through video-sharing sites such as YouTube, these carry potential issues with copyright. As a consequence, most online lecture material captured from universities is available only through closed-system, university-administered multimedia programs such as Moodle or Blackboard. Although online lecture capture is a means of providing information to students, its utility may be perceived differently by the three interested parties in tertiary education: faculty administration, teaching

staff, and students. While faculty administration and teaching staff negotiate over the availability of lecture capture resources, ultimately its effectiveness is determined by whether the students utilize the medium and how they value it determines its success.

To date, the reported attitudes of students, faculty administration, and faculty staff toward the provision of online lectures to support live lectures differ; the students are in favor of provision, but faculty staff express reservations. The perceived advantages include increased accessibility, increased flexibility in study habits (7), and an enhanced ability to review concepts and make better notes (13). Conversely, reservations expressed by teaching staff are focused mainly on fears of reduced class attendance (19, 25) and copyright concerns (24). The reported effects of lecture recordings on live lecture attendance are variable; some studies have shown reduced attendance (13, 20), whereas others have shown no influence (1, 19). Part of this variation may depend on how lecture attendance is recorded. Marchand et al. (14) noted that staff and students had contrasting views on attendance once lecture recordings were available; students believed access to recordings had little effect on their attendance, but staff reported a >20% reduction in attendance.

University administration, teaching staff, and students share the desire that online lecture capture will improve pass rates and student retention. Whether this is actually achieved in classes that already have access to live lectures is debatable. Although perceived as beneficial to learning by students and sometimes staff (8, 18, 19), results regarding online lecture availability and improved student performances in assessment vary between studies. A few studies report improved grades when lecture recordings are available (2), but many report little or no change in grades (1, 3, 12, 13, 18, 20), and some report reduced grades (11). Overall, these results do not substantiate the reports of students' belief that access to recorded lectures helps them to learn.

The disparity between the perceived benefit and actual effect on grades warrants further investigation of the actual use of online lecture recordings. When usage is tracked, most students watch only a fraction of the recorded material, viewing either a small proportion of recordings (1, 14) or only portions of some or all of each recording (15, 18). We infer from these data that, despite the popularity of lecture recordings, most students with access will not utilize them as a major source of infor-

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mation. Conversely, some students place heavy reliance on recorded lectures, but their reasons for doing so vary. Owston et al. (15) proposed that weaker students tend to watch more of a lecture than high achievers. Leadbeater et al. (13) proposed that many students who utilize recordings heavily may be studying in their second language or dyslexic. If so, recorded lectures may increase accessibility for some student groups in which retention rates are traditionally low. In contrast, Marchand et al. (14) report that usage is greatest when availability is novel rather than due to specific user characteristics.

Previous work prompts several questions concerning the utility of online lecture capture. Do recordings motivate students to miss live lectures, or are other factors more important? How heavily are recordings utilized when available alongside live lectures? What are the main reasons for students missing live lectures and accessing lecture recordings? Is the utilization of lecture recordings associated with enhanced grades, from which it might be inferred that student learning is enhanced? If given the choice of one or the other, would students prefer to have recorded lectures rather than live lectures? We postulate that students' motivations for using recorded lectures and the impact of recording availability on their willingness to attend lectures may also be significant.

To assess students' attitudes toward and usage of recorded lectures, we sought the opinion of a cohort of first-year biology students who were given access to video recordings of live lectures being delivered for their subject and compared these with actual usage of recorded lectures and grades. We asked students what their attitudes toward their live lectures were, their reasons for missing a live lecture, how many recorded lectures they watched and why, and whether they would favor recorded lectures replacing live lectures.

OVERVIEW

The recording system. All lectures were recorded and made available using an automated system driven by Mediasite software on the Massey University online subject website Stream. Lecture recordings were available 1 h after they were delivered and remained available until the end of the course. The recording showed a video image of the lecturer and the PowerPoint presentation synchronized to an audio recording of the lecture. Each lecture was divided into 10-min blocks and could be viewed in installments or as one block.

Subject structure. "Essentials of Mammalian Biology" is a first-year university subject taught at Massey University in semester 2 of the university calendar. The subject consisted of three 50-min lectures per week and one 3-h laboratory class in most weeks of a 12-wk semester, giving a total of 36 lectures and nine laboratories. The lectures followed a traditional didactic style. The PowerPoint slides used in lectures were made available on paper and online, in addition to detailed study guides that covered key concepts taught in lectures and guided students through the prescribed textbook. All content delivered in lectures was assessed in a final exam at the end of the subject. The first 4 wk of lectures were also assessed in a written test during week 6 of the semester.

The subject material included an overview of mammalian cell biology, properties of mammalian tissues and body fluids, the basic structure and function of the organ systems, the concept of homeostasis, and whole body responses to environ-

mental challenges. The subject was a prerequisite for second-year papers in physiology, sport and exercise science, human nutrition, and animal science.

Teaching staff. The subject was taught by five lecturers, each of whom was teaching into and representing one of the majors into which the subject fed: animal science, human nutrition, exercise and sport science, physiology, and zoology/physiology. All lecturers had ≥ 5 yr of experience in teaching at Massey University.

Student profile. Most of the students were between 17 and 20 yr of age and were in their first year at the university. Most had taken introductory courses in cell biology, animal biology, and organic chemistry before this subject, although some came from different backgrounds, as there was no prerequisite. Students were studying toward a Bachelor of Science, majoring in at least one of the following: animal science, exercise and sport science, human nutrition, medical laboratory science, physiology, and zoology. In all of these programs, this was the only subject in which video recordings of all lectures were available. The other subjects in these majors followed a traditional didactic teaching structure similar to that described for this subject, consisting of live lectures and laboratory classes.

METHODS

Survey questions. The aim of the survey was to determine student attendance at lectures, their use of the Mediasite-recorded lectures available on Stream, and their overall impression of the content of the course. Accordingly, the survey questions were divided into four blocks: attendance at live lectures, use of recorded lectures, attitudes toward recorded lectures vs. lectures, and overall view of the course. The survey consisted of 32 closed questions with two to six response options available per question. Using the data obtained, we assessed whether users who missed lectures actually accessed Mediasite and whether the availability of recordings was a motivation to miss live lectures.

Completion of survey. Students were asked to complete the survey at the end of the last laboratory class during the last week of teaching in the semester. They were provided with the survey questions with a cover sheet attached for their student identification (ID) number. It was explained that the purpose of the survey was to determine their attendance at lectures and the use of recordings available on Mediasite and that their survey data would be collated with the Stream access data recorded by the university and also be correlated against their grades. The ID numbers were used to correlate survey data, user ID, and grades, and then ID numbers were replaced with unique identifiers to maintain the anonymity of the students.

Ethics. The survey, the collection of online data, and the protocol were approved by the Massey University Human Ethics Committee and the Head of the College of Science. All participants provided informed consent to the survey. The survey was administered by a staff member who did not teach into the subject, and data were collated by this staff member and a second independent researcher. Mediasite data were collated with student ID numbers, and then the data were anonymized by replacing the ID numbers with unique identifiers.

Mediasite data. Mediasite was available from the end of week 1 of the semester. Each lecture was recorded and made available 1 h after live delivery. Lectures remained available online throughout the semester until completion of the final exam.

Each time a student logged on to view a lecture, their log-on details (student ID, date, and time) were recorded along with information on the lecture they were accessing.

Exam marks. The final exam for this subject assessed all of the lecture material presented. Final exam marks and grades for the

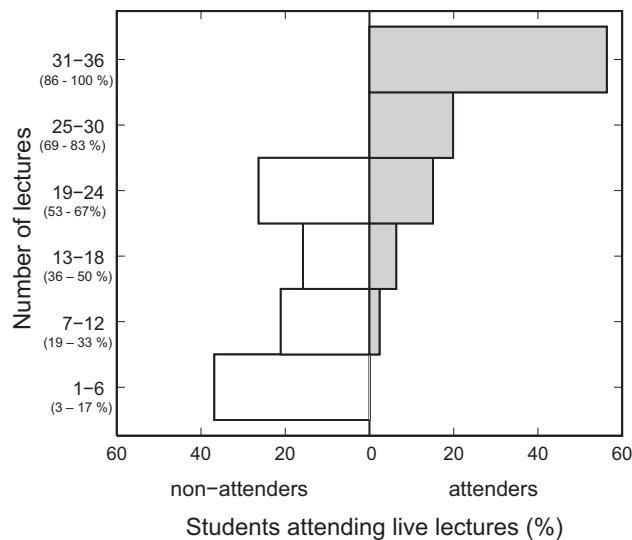


Fig. 1. No. of live lectures attended by students who classify themselves as "lecture attenders" or "nonattenders." Contingency analysis confirms that the distributions are markedly different between the 2 groups ($\chi^2 = 76.0$, $P < 0.001$), with 76% of "attenders" claiming attendance for at least 24 lectures (69%) and 2% attending 12 or fewer lectures (<33%), whereas none of the "nonattenders" went to 24 or more lectures and 58% went to 12 or fewer lectures.

students who undertook the survey were obtained and used for data analysis.

Data analysis. Data were analyzed using R (10, 17) and the exact 2×2 package (6). Contingency tables were analyzed using Pearson's χ^2 test, and where necessitated by empty cells, categories were combined as described. Fisher's exact test was used for 2×2 tables (6). Correlations were analyzed using Kendall's Tau statistical test for correlations.

RESULTS

Out of a total of 267 students, 145 completed the survey, giving a response rate of 54%.

Live lecture attendance. To analyze the motivation of students to attend or miss live lectures, respondents were classified as lecture attenders or nonattenders, depending on their response to the question, "As a rule, do you attend lectures in person?". Most students (87%) were attenders and claimed to have attended most of the lectures in person. Among the attenders, 76% claimed to have attended 69% or more of the lectures (Fig. 1). In contrast, none of the nonattenders went to 69% or more of the lectures, and 58% went to one-third or fewer of the live lectures.

Causes for nonattendance at lectures. Five options were given as possible reasons for missing lectures, with four responses available: "always," "often," "sometimes," and "never." When "always," "often," and "sometimes" were combined, lecture attenders were most likely to miss lectures because of assessments that week (68%) or outside commitments (48%), although some did miss lectures due to a preference to study from recorded lectures (32%) or from a textbook (26%) or due to the style of the lecturer (34%). When "always" and "often" were combined, assessments in the same week were still the most common cause for missing lectures (20%), followed by outside commitments (13%) and preference to study from recording (10%) or a textbook (7%), whereas the lecturer's style was the least common (4%).

Contingency analysis revealed some differences in the motivation for missing lectures between attenders and nonattenders. Compared with lecture attenders, nonattenders were more likely to miss lectures because of outside commitments ($\chi^2 = 16.1$, $P = 0.001$), preference to study from a textbook ($\chi^2 = 29.3$, $P < 0.001$), or preference to study from lecture recordings ($\chi^2 = 36.3$, $P < 0.001$). In contrast, nonattenders were no more or less likely to miss live lectures due to an assessment due in the same week ($\chi^2 = 4.6$, $P = 0.020$) or to miss lectures due to the style of the lecturer ($\chi^2 = 5.2$, $P = 0.154$). Because the number of nonattenders was small (19 out of 145), we combined responses of "always or often" and "sometimes or never" and then conducted Fisher's exact test to compare attenders with nonattenders (Table 1). Results were similar to those stated above.

Use of recorded lectures. Of the students surveyed, 52% claimed they had used the lecture recordings. According to usage logs, many students in the subject who accessed the recordings (55%) responded to this survey. Of those who utilized the recordings, most claimed that they watched relatively few recordings (Fig. 2); 55% claimed they viewed one-third of recordings available or fewer, whereas 24% watched more than two-thirds of the recordings.

The predominant use of recordings was to catch up on a relatively small number of lectures that were missed voluntarily. When asked whether they used recordings mainly to replace a live lecture or for revision, most students (64%) opted for the former. Despite this, nonattenders were no more likely to be using recordings than attenders ($\chi^2 = 3.3$, $P = 0.07$). The majority (71%) of those who used recordings stated that they did "voluntarily miss lectures with the intention of catching them up using recordings," but most did so for a small number of lectures (Fig. 3).

Table 1. Main reasons given by students for missing live lectures

Variable	Reason for Missing Lectures				
	Style of the Lecturer	Assessments that Week	Outside Commitments	Prefer Book for Study	Prefer Lecture Recording
Attenders, %	4.0	20.2	12.7	7.2	10.3
Nonattenders, %	15.7	36.8	50.0	42.1	63.2
Odds ratio	4.7	2.5	6.7	9.1	14.4
95% CI	0.9-21.4	0.8-7.6	2.3-20.2	2.7-32.5	4.6-44.6
P value	0.101	0.140	<0.001	<0.001	<0.001

CI, confidence interval. Responses from students identifying themselves as "lecture attenders" ($n = 126$) and "nonattenders" ($n = 19$) are compared. Responses were analyzed using Fisher's exact test after "always" and "often" responses were combined and compared with combined "sometimes" and "never" responses.

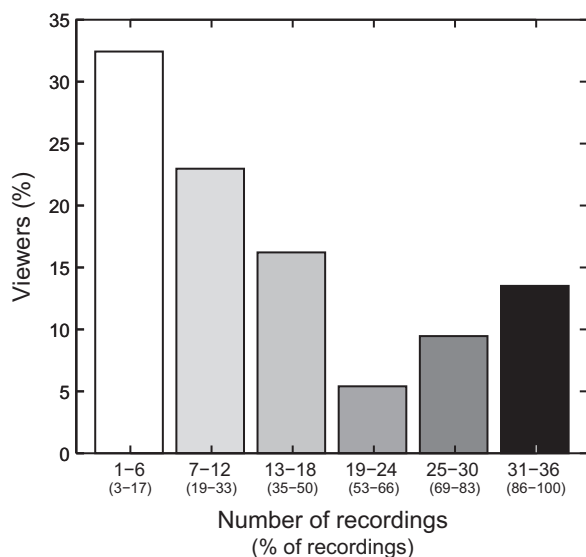


Fig. 2. No. of recorded lectures watched by students who claimed to access recorded lectures. Shown are the proportions for responses to the question, "For how many lectures did you access the lecture recordings?" Optional answers were 1-6, 7-12, 13-18, 19-24, 25-30, or 31-36 recordings.

The availability of recordings was viewed favorably. All of those who watched the recordings found them useful, 97% regarded the recordings as a good quality learning experience, 76% reported that the recordings helped them understand the course material, 74% found the recordings useful at least sometimes, and 64% felt that using the recordings helped them improve their grades. However, none regarded the recordings as their primary source of information. In terms of viewing habits, when using the recordings, most of the students (96%) watched the lecture alone rather than in a group, most of them (73%) viewed the whole lecture, and most of them (65%) watched it all at once rather than in installments.

Logged use of lecture recordings. Mediasite logged which students (IDs) accessed the lectures and the lectures viewed so that we could track general access per lecture and per day. For one of the 36 lectures (lecture 24) the recording failed, but all others recorded accurately. Views per day (as assessed by log-ins) were relatively consistent throughout the teaching period (means \pm SE: 24 ± 1.7), although there was a slight rise just before the semester test and a marked rise in the period after the final lecture and before the exam (Fig. 4). Log-ons during the revision period probably represent a tendency to use recorded lectures for revision rather than to replace lectures. Such usage will not be reflected in the survey responses, as the survey was completed at the end of the semester, before the revision period. Log-ins per lecture data are not presented but were highest for the first lecture (87 views by 56 IDs) and the last lecture (140 views by 96 IDs). We did not count live lecture attendance, but we observed that attendance was highest during the first lecture (estimated at $\sim 90\%$ of the class), and there was a student prank in the last lecture. Therefore, the high access rates for the first and last lecture do not correlate well with survey responses in which students claimed they generally used the recordings to replace the lectures they missed. This apparent discrepancy between reported utilization and actual log-ons may reflect students assessing the quality of recordings in the first lecture. The peak in log-ons for the last

lecture most likely relate to students trying to view a prank performed during the last lecture.

Perceived efficiency of lectures as a learning tool. Most students (75%) considered lectures a very efficient or the most efficient method of learning, but this opinion was more common in those who attended lectures than those who did not ($\chi^2 = 9.01$, $P = 0.03$).

Lecture attendance, use of recordings, and exam marks. On the whole, students claiming to attend lectures as a rule achieved higher exam marks than those who did not ($P = 0.002$; Fig. 5), and there was a positive correlation between the number of live lectures attended and exam marks ($P < 0.001$; Fig. 6). Those that regarded lectures as an efficient means of study also performed better on the final exam ($P = 0.008$). In contrast, students claiming to have accessed recorded lectures had no improvement in marks over those who did not ($P = 0.298$); in fact, there was a negative correlation between the number of recorded lectures viewed and the exam marks ($P = 0.011$; Fig. 7).

Enjoyment of lectures. Overall, 89% of respondents enjoyed attending live lectures. Lecture attenders were no more likely to enjoy lectures than nonattenders ($\chi^2 = 1.79$, $P = 0.18$). Of those who claimed to enjoy lectures, most claimed to do so for academic reasons, such as that the lectures were "often" or "always" useful for learning (89%), were helpful in understanding coursework (94%), or kept the respondents connected with the course (93%). The interactive aspects of live lectures were less common motivators. When "often" and "always" responses were combined, only 34% reported that they regarded the lectures as entertaining, 47% attended lectures because they enjoyed interaction with their lecturers, 51% attended because they enjoyed being on campus, and 58% attended because they enjoyed interaction with their classmates. Despite this, 72% of those who attended lectures preferred a lecturer to be entertaining and competent over being factual and expert.

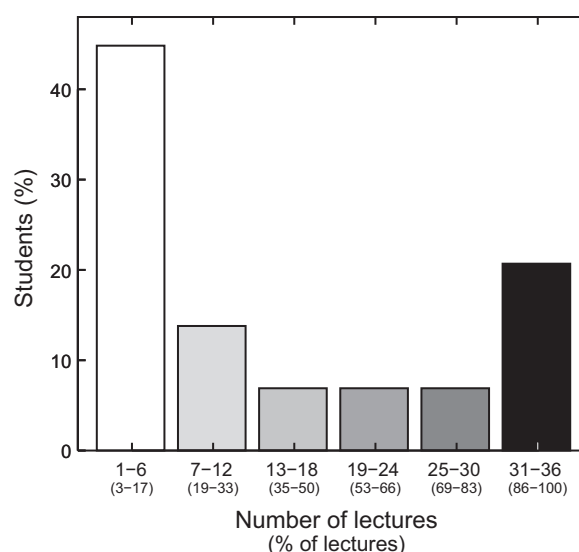


Fig. 3. No. of lectures that students claimed they voluntarily missed with the intention of watching the recording later. Shown are the proportions for responses to the question, "How many lectures did you voluntarily miss with the intention of catching them up using recordings?" Optional answers were 1-6, 7-12, 13-18, 19-24, 25-30, or 31-36 lectures.

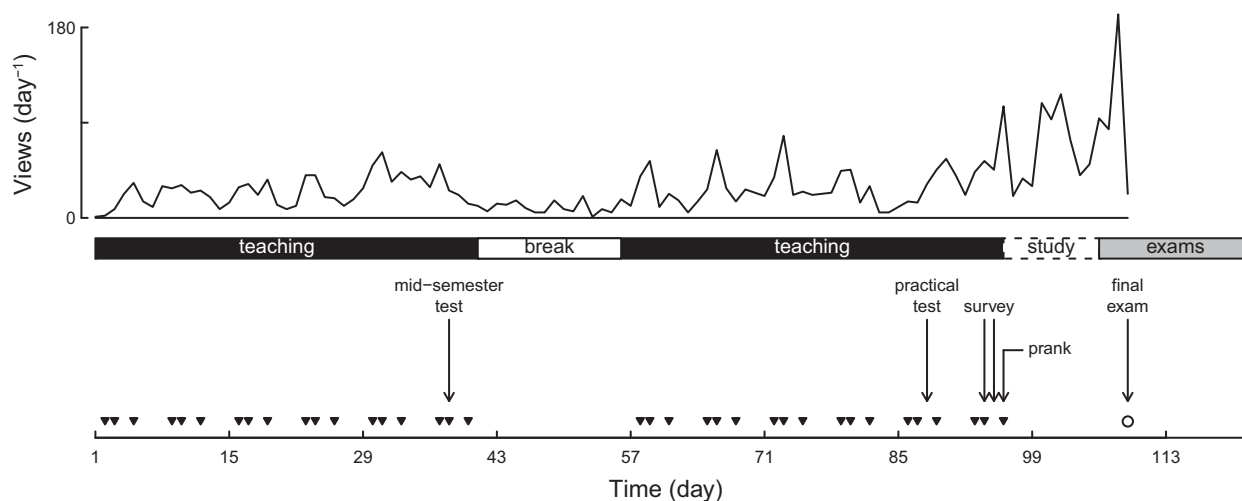


Fig. 4. The use of lecture recordings by students throughout the course as assessed by no. of views per day (assessed by log-ins) during the teaching period. Also shown on the timeline are the structure of the teaching period, delivery days for the live lectures (▼), the day the survey was undertaken, and timing of assessments. "Break" means midsemester break (no face-to-face instruction); "study" means week for revision for exams with (no face-to-face instruction). ○, Final exam.

Preferences for the future: lecture recordings or live lectures. Of the students who viewed the lecture recordings, most (63%) showed no preference for live lectures over recordings, whereas 29% preferred live lectures and 8% preferred the recordings. However, when asked if recorded lectures should replace all live lectures, 70% disagreed or strongly disagreed, although fewer (42%) disagreed (and 22% agreed) with some live lectures being replaced by recordings (Fig. 8). In contrast, a majority (59%) agreed or strongly agreed with having videoconference lectures from expert lecturers who were on another campus instead of a less expert lecturer (Fig. 9A), and 62% agreed that this would still be acceptable if the expert's delivery style was inexperienced. However, the majority (70%) believed that having expert lecturers deliver material via videoconference would be acceptable if it was for only 33% or fewer of the total lectures delivered (Fig. 9B). In the event that lecture theaters became overcrowded due to growth in student enrolments, most students (80%) who used lecture recordings

would still prefer a second lecture time as well as lecture recordings as opposed to one lecture time, which is first come/first served, recordings alone, or two lectures alone.

DISCUSSION

In this study, we examined preferences for and utilization of live and recorded lectures for a subject delivered to an on-campus cohort accustomed to receiving most of their information in didactic lectures. Respondents claimed a much higher attendance at live lectures than use of lecture recordings. Most stated they attended lectures as a rule, and 91% of the respondents attended more than half of the live lectures. In contrast, only 52% reported accessing any of the lecture recordings, and only 8% of respondents watched more than half of the lecture recordings.

The supposed advantages to making recordings of lectures available to students included increased flexibility in study habits (7), catering to a wider range of students (22), and the

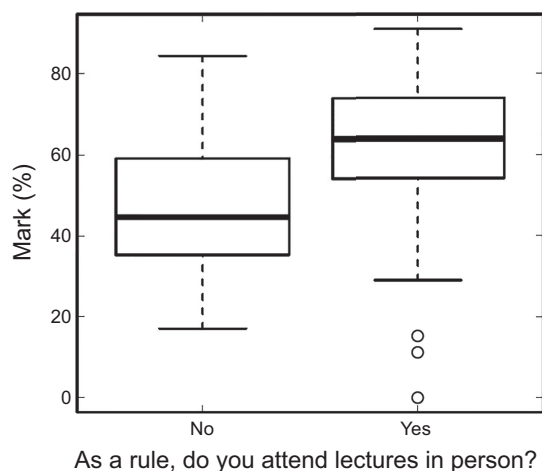


Fig. 5. The range of exam marks for students claiming to be lecture attenders vs. those claiming to be nonattenders. Overall, those attending lectures ($n = 126$) achieve higher grades than nonattenders ($n = 19$, $\tau = 0.21$, $P = 0.002$). ○, Outlier values.

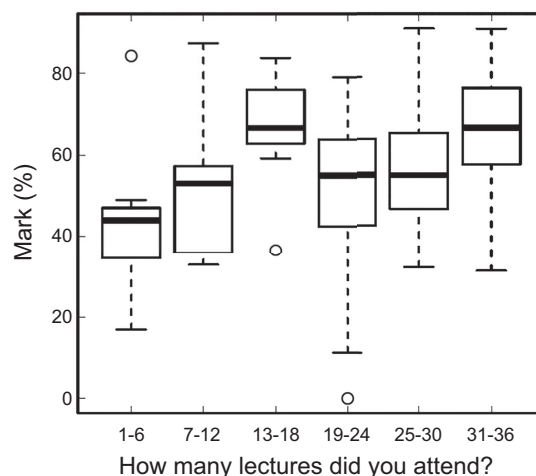


Fig. 6. The range of exam marks achieved by students compared with the no. of live lectures attended. In general, students attending more lectures achieved higher grades ($\tau = 0.24$, $P < 0.001$). ○, Outlier values.

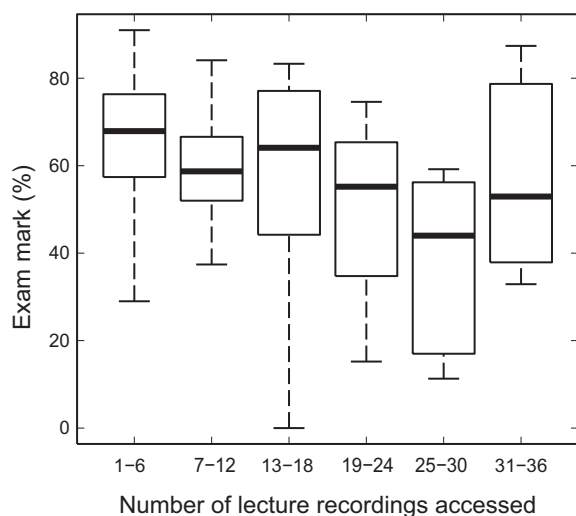


Fig. 7. The range of exam marks achieved by students compared with the no. of lecture recordings viewed. There was a weak negative correlation between the no. of recordings viewed and the exam mark ($\tau = -0.23$, $P = 0.008$).

ability to review concepts (13). A small cohort of the respondents (8% or the total) made extensive use of the lecture recordings and also made up half of the students who declared that they did not attend lectures as a rule. This group may benefit particularly from the availability of recordings, because recordings suit their preferences, learning style, or outside commitments, but even these students did not regard recorded lectures as their primary learning tool.

It has also been reported that use of recorded lectures depends on the structure and information density of the subject and that recordings are utilized more in basic science subjects that tend to be lecture and content intensive (5). However, in this study, although students generally regarded the subject being surveyed as content intensive (data not shown), most (64%) used recordings to replace lectures they had missed rather than for revision, and the majority (55%) claimed to have viewed only a small number of the recorded lectures ($\leq 33\%$). Furthermore, utilization of the recording system was relatively low during the teaching period; despite 267 students being enrolled in the course and 36 lectures recorded, there were on average only 24 views per day of recordings that occurred during the teaching period.

The reported use of lecture recordings to replace live lectures that had been missed rather than for revision does not seem to correlate with logged use of recordings, which peaked just before assessments. There could be several reasons for this. First, it might have been the wording of the question, in that students “mostly,” but not exclusively, used the recordings for catching up on live lectures they missed. Second, they might have watched missed lectures asynchronously while studying for exams rather than in calendar sequence with live lectures. Finally, a large spike in viewing lectures occurred just before the final exam and after the survey was completed, so usage profiles may have changed during study for the final exam.

One concern among lecturing staff is that the availability of lecture recordings will reduce lecture attendance (19, 25). The reported effects are variable; attendance may be negatively impacted (20) or unchanged (3), and some report that students

believe their study habits are unaffected (14). In this study, however, although 71% of students who used the recordings claimed that they intentionally missed lectures with the intention of watching the recordings later, the reasons for missing the lectures were complex. The most significant factor was other commitments, either assessments or other activities outside the university. The prioritization of assessment completion over lecture attendance is a common observation across subjects and universities (23). On the other hand, the impact of outside commitments reported here is not always observed (23). In this study, students sometimes preferred to study from the textbook or from a lecture recording and sometimes because of the style of the lecturer. Furthermore, within this cohort are the small group of lecture nonattenders, but like the lecture attenders they do not use recordings as their primary source, so they probably use other resources provided for the subject instead. Overall, it appears that lecture recordings may motivate students to miss live lectures when they have other commitments, but not as a rule. Even those that routinely miss lectures seem to do so because they prefer to study from another source or have other commitments and not because recordings are available.

In some studies, performance in assessment is improved by making lecture recordings accessible (1, 20). However, as observed here, several other studies have reported that, despite students’ perception of lecture recordings as a useful resource to improve their grades, this is not the case (3, 7, 18). In fact, reduced attendance at live lectures is associated with reduced grades (10), and those who access online resources more often have lower grades (12, 15), as we also report (Figs. 6 and 7). Overall, this prompts the suggestion that the student perception of the availability of recorded lectures should be managed carefully, because they may encourage unproductive study habits or foster a false sense of security, leading to poor time management.

Attendance at live lectures is correlated with higher grades (Fig. 6). This relationship has also been observed previously, notably in a meta-analysis of positive effectors on grades

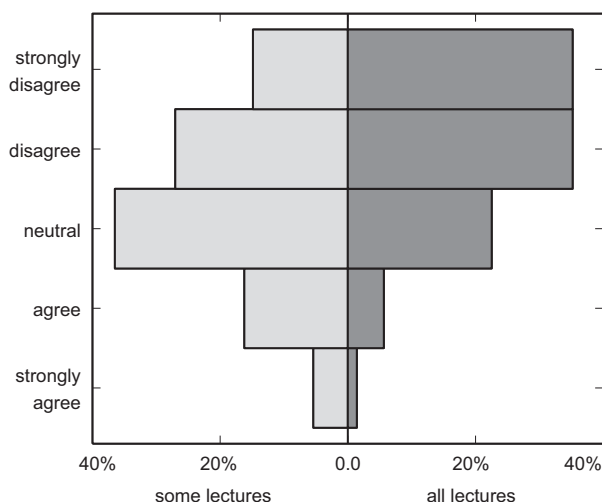


Fig. 8. Opinions of students who used recorded lectures as to whether some (left) or all of the live lectures (right) could be replaced by recorded lectures. For both questions, respondents could answer “strongly agree,” “agree,” “neutral,” “disagree,” or “strongly disagree.” The proportion of responses are shown as percentages.

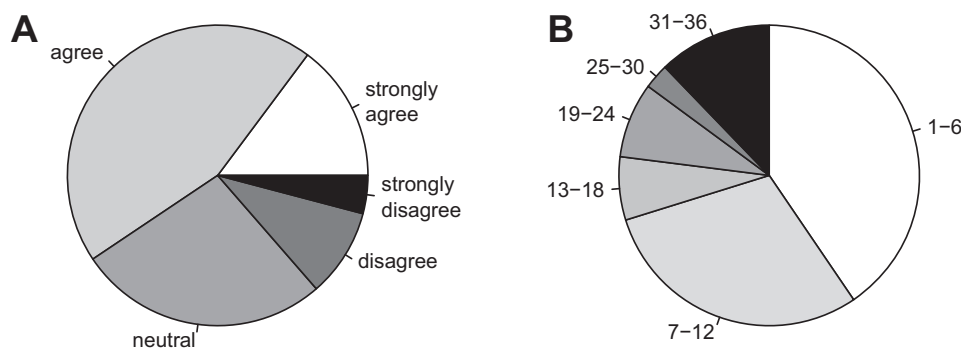


Fig. 9. Student agreement with the concept of replacing live lectures with videoconference lectures from an expert on another campus (A) and for what percentage of live lectures would it be acceptable to have a videoconference from an expert rather than a live lecture (B). Percentages were calculated from a question asking for how many of their lectures would it be acceptable to deliver via videoconference: 1-6 = 0-17%, 7-12 = 19-33%, 13-18 = 35-50%, 19-24 = 53-67%, 25-30 = 69-83%, and 31-36 = 86-100%.

carried out by Credé et al. (4), although some studies report the relationship is weak or nonexistent (9). Among our respondents, attitude toward lectures was also a factor in that those who regarded lectures as an efficient way to learn material tended to score better. Correlations between mark and either attendance at lectures or view of lecture efficiency may relate more to the students' attitudes toward study and the time discipline required to persevere with a live lecture timetable rather than the actual effectiveness of lectures as learning tools.

The value of lectures to students was academic rather than social. Students claimed that they attended live lectures because they were useful for learning, understanding coursework, and staying connected with the subject rather than because lectures were entertaining or because they provided an opportunity for interaction with lecturers or classmates. This is reinforced by the fact that students were relatively amenable to a small number of lectures being delivered by an expert lecturer on another campus and that the lecturer's expertise is valued over their skill as a lecturer. The value placed on lectures by students apparently contradicts constructivist education theory, according to which lectures tend toward one-way transmission of information, promote surface learning, and therefore, are not optimal learning activities (21), leading some to question the place of lectures in universities (16). The reason for this discrepancy is unclear. It could be that the lecturers in the subject surveyed here were effective in promoting active learning in lectures, as all were experienced, but it could also be that students place higher value on lectures and "surface learning" than is appreciated by constructivist learning analysts. Alternatively, it may be that deeper learning, as promoted by other teaching methods, is not being assessed here or is not appreciated as important by students.

In general, students were against lecture recordings replacing all live lectures, and the majority opposed the proposal that they replace even some of the lectures. This seems to contradict the fact that students are motivated mainly to attend lectures for academic reasons, as the recorded lectures had exactly the same factual information. This suggests that other factors, such as interaction with fellow students, do have an impact on lecture attendance, even if this was not acknowledged. This is supported by the fact that students regarded receiving videoconference lectures from an expert on another campus as only acceptable for a minority of scheduled lectures. Taken together, this suggests that there is a desirable effect from having in-room, face-to-face contact, and perhaps naturally, most students would prefer a lecture to be entertaining, suggesting that there is some merit in a personal experience. Therefore, any move away from live lectures to other teaching

methods, such as blended learning approaches (2), needs to be managed with carefully structured learning resources that promote student engagement, along with assessment reforms, or the effects may not be viewed favorably.

Overall, although students did utilize recorded lectures, they did not engage with the recordings extensively and valued live lectures more. Most students claimed to view recordings for only a few lectures, which they had not attended live. Even though a small cohort utilized lecture recordings extensively, none of the students who used recordings regarded them as their primary source. Reinforcing this, students did not favor live lectures being replaced by recordings, although they said they would accept a few lectures being delivered by videoconference from a lecturer on another campus. In terms of performance, live lecture attendance showed a weak correlation with exam performance, and despite student perceptions to the contrary, the use of recorded lectures did not.

Reduced attendance at live lectures is a concern among teaching staff. The main reasons given by this cohort for missing live lectures are prioritizing assessments or outside commitments. Because the timing of both assessments and live lectures (and therefore, lecture accessibility) is scheduled within the university, the most significant factors affecting lecture attendance are factors controlled by the university rather than student attitudes. It follows that faculties that schedule lectures at times suitable to the students and separated from assessments will have more successful students and probably more popular courses. Furthermore, students prefer an on-campus expert lecturer who, ideally, is also entertaining. We infer from this that investment in staff who can engage students in valuable face-to-face experiences is more likely to enhance the student learning experience than investing in expensive multimedia units, which are utilized infrequently by students. Finally, any move away from live lectures should be carefully structured with appropriate support and probably needs to be accompanied by assessment reform.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

D.C.S., W.H.C., and S.B. interpreted results of experiments; D.C.S., W.H.C., M.H., M.T.L., and S.B. drafted manuscript; D.C.S. and S.B. edited and revised manuscript; D.C.S., W.H.C., M.H., M.T.L., and S.B. approved final version of manuscript; W.H.C. and M.H. performed experiments; M.T.L. and S.B. analyzed data; S.B. prepared figures.

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