Lecture capture in higher education: time to learn from the learners

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Abstract

In this review we consider the evidence concerning the impact of student access to lecture recordings. Overwhelmingly, students perceive having access to recordings as enhancing their experience and providing a flexible resource to aid their studies, deal with competing demands, and reduce anxiety. Research to date has largely focused on a binary question concerned with attendance and not the rich pedagogic tapestry revealed by the student data. There is no systematic evidence to suggest that access to recordings alone significantly impacts attendance and the impact of access to recordings on performance is related to a range of individual student characteristics such as level of study, ability, and approaches to learning. We argue that situating research in broader conceptual frameworks of student learning will prove a more fruitful approach to opening potential avenues of future research based, for example, around concepts of deep processing and distributed practice. Finally, we provide an overview of current institutional lecture capture policies and present, as a 'starter for 10', recommendations for guidance to support students, staff, and policy writers.

Introduction

The use of lecture capture as a resource to support learning is becoming widespread in Higher Education Institutions around the globe and there are examples of it being used in a wide range of disciplines. Many institutions either have, or are in the process of developing, a policy governing the use of lecture capture. These policies appear mainly concerned with the conditions under which such recordings are made and with issues of access and ownership. The content of policies appears aimed at addressing concerns raised by academic staff in relation to the use, misuse, and abuse of recorded material. Less explicit attention has been directed to how to maximise the pedagogic value of lecture recordings from both student and staff perspectives.

Research into the role of lecture capture has generated a corpus of studies indicating the potential pedagogic value (both positive and negative) of these materials for student learning (see e.g., Karnad, 2013; Kay, 2012; McGarr, 2009; O'Callaghan, Neumann, Jones, & Creed, 2017; Witthaus & Robinson., 2015). In one of the most recent reviews summarising this literature, O'Callaghan et al., (2017) conclude "*the positives of lecture recordings outweigh the negatives and its continued use in higher education is recommended."* (p.1). In this paper we provide an overview of a large sample of lecture capture policies within the UK highlighting their commonalities and providing specific practical recommendations for policy development. We then review the current literature on lecture capture to identify the pedagogic value of recordings. Based upon this evidence we then propose how we can use our existing knowledge to move forward by proposing avenues of research that may move the field on from the basic binary question of whether or not lecture capture should be used, to how it can be used best to support both students and staff.

Lecture capture policies

There is a slow but steady shift towards formalising the use of lecture capture through institutional policies and it is the creation of such policies that often causes the most controversy with academic staff. At the time of writing, we identified 35 UK higher education

institutions that have lecture capture policies[1]; of these, 11 were opt-in, 19 were opt-out and 4 took a custom approach, e.g., School-based (see https://osf.io/m8aqn/ for a database of policies with links to full documents where possible). Although each policy is tailored to the needs and demands of each institution, amongst those that have opt-out policies there are a number of commonalities.

First, in 16/19 policies there is a statement explicitly addressing the issue that not all teaching activities are suitable for capture. These statements largely focus on the issue of lectures versus small-group interactive teaching, however some go further, for example Kings College, London's (2018) policy states that "*a requirement for staff to change their preferred teaching style for the purpose of recording might be detrimental to the student experience, and is not encouraged*" (p2). In a study on staff attitudes towards lecture capture, Bond and Grussendorf (2013) noted that one of the major concerns surrounding recording lectures was the perception that this would lead to changes in the lecturer's performance. Given these findings and the concerns noted above in Gosper et al. (2008), we would encourage policy writers to be explicit about such matters.

Second, in 15/19 policies, there is a statement referring to the provision of lecture capture as supplementary to the live lecture, for example "*The University confirms that ReCap is provided to supplement the student experience and will not replace student contact hours"* (University of Newcastle, 2018). This is important for three reasons. First, it formalises the use of lecture capture as a supplementary tool, which as seen in the review above, appears to lead to the best educational outcomes. Second, it highlights the continued need for students to attend live lectures and may help reduce the anxieties of academic staff surrounding this issue. Third, there is also some concern that lecture capture may be used, or may be threatened to be used, to replace live lectures against the wishes of academic staff, for example, during industrial action. A statement enshrining lecture capture as supplementary to a live performance may help safeguard against these perceived threats and we would suggest that the short-term

[1] By this we refer to formal policies, usually approved by Senate, that cover the recording of lectures by staff using software and equipment owned/licenced by the institution and whose policies were publicly accessible online. There are many more examples of institutions that have information or guidance regarding lecture capture, or policies that cover recordings made by students or disability provision but whom do not have an institutional level policy regarding whether staff are expected to record their lectures. Additionally, these figures should be assumed correct at the time of writing but will likely become quickly out of date.

benefits of using recordings as a substitute in extreme circumstances is not worth the potential long-term costs of reducing staff engagement with lecture capture.

Related to this, the majority of policies (18/19) confirm ownership of intellectual property. In most cases, intellectual property of the recording is held by the institution, however, there are some variations in the application and interpretation of performer and moral rights. Additionally, these policies also stipulate the length of time recordings will be kept, and some also detail what happens to recordings if the lecturer leaves the institution. A more detailed discussion of intellectual property law is beyond the scope of this work, however, Jisc (2015) provides an excellent overview of the legal considerations of lecture capture. One important point regarding intellectual property that may be worth highlighting concerns the different implications of lecture capture and "unofficial" student recordings of lectures. Outwith institutional lecture capture policies, many, if not all, institutions permit their students to record lectures on their own devices, largely driven by disability and accessibility recommendations. The ability for students to make their own recordings of lectures may be used as a reason for staff not to provide official lecture capture, however, this leaves staff open to greater risk. Lecture capture provided by an institution is the intellectual property of that institution and therefore if it is shared without permission, for example, on YouTube, it is a clear violation of the law and the case for removal is clear. If a student produces and edits a recording on their own device, it may be more difficult to determine ownership and remove the recording from the public domain, particularly if there is no policy guidance (16/18 opt-out policies explicitly prohibit the sharing of lecture capture content). It is also worth considering that by forcing students to produce their own recordings, it is far more likely that they will be shared publicly than if they have access to a streamed high-quality lecture capture through their VLE. Most importantly though, regardless of the exact details of each policy, we would encourage all policy writers to ensure there is full transparency regarding rights and ownership.

Finally, the majority of policies (16/19) clearly state that lecture capture will not be used for the purposes of performance management. Again, there are some variations on the exact wording, some simply state that this will not happen, others (e.g., the University of Kent, p3) includes caveats such as *"Recordings will not be used for staff management purposes, including performance review or investigation of student complaints except with the explicit consent of those delivering the lecture or where this is permitted in accordance with the provisions of the Data Protection Act e.g. for law enforcement purposes".* For similar reasons

as the use of lecture capture during industrial action noted above, we would advise against lecture capture being used for performance review and would encourage all policy writers to include explicit assurances that this will not happen.

This section does not represent a comprehensive review of policy minutiae, however, we believe that the above issues represent the most contentious issues and if they are addressed clearly and transparently, may promote staff engagement with lecture capture technology. We will now move on to reviewing the literature surrounding lecture capture, with a focus on the pedagogic value of lecture recordings, the personalisation of learning, and the impact on student performance.

The pedagogic value of lecture recordings

Of particular and recurring concern to academic staff is the assumption that access to lecture recordings will result in a decrease in attendance at lectures (e.g. Gosper et al., 2010). In most courses, attendance is not in itself a learning outcome (Newton, Tucker, Dawson & Currie, 2014), therefore the concern over attendance must be the manifestation of a deeper concern over the impact on achieving the actual learning outcomes of the course and on other aspects of student engagement. It is also worth noting that falling lecture attendance is not a new phenomenon. As Massingham and Herrington (2006) have highlighted, attendance has been seen as an issue by lecturers for decades. As an example, they cite Beard and Senior (1980) who nearly four decades ago reported lecturers complaining '*students are not motivated... [and] lack an urge to work independently, applying themselves only if external pressures are exerted... students these days are not interested in the courses they have selected but simply want a qualification and a good job'* (p.1). It is unlikely that this sentiment was new even in 1980.

Understanding the reasons why students opt not to attend lectures can lead to useful information that can inform pedagogic practice. The reasons students give often have little to do with the availability of recorded lectures. For example, Billings-Gardiardi and Mazor (2007) surveyed medical students on how they made decisions on whether to attend a particular lecture. Their results revealed that the most important considerations were the predicted outcome of attending the lecture (e.g., Will it facilitate my own subsequent study and learning?), the topic or subject of the lecture (e.g., Will I learn this material better by attending a lecture or by individual study?), whether the lecture will meet the students current learning

needs, and personal considerations (e.g., Do I have competing commitments that I view as having a higher priority?), and whether the student had had a previous positive or negative experiences with a particular teacher. Other studies have also highlighted the central importance of the lecturer in attendance decisions. Gupta and Saks (2013) reported that the dominant reasons medical students reported for choosing to attend or to not attend lectures were all associated with the lecturer. The top four reasons for attending were whether the lectures were well organised (90%) and, as with Billings-Gardiardi and Mazor (2007), whether the student had had a positive prior experience with the lecturer (86%), whether the lecturer's style fitted the student's style of learning (81%) and whether the materials were as easily learned from a handout (76%).

Studies have shown that students value face-to-face lectures. In a study of psychology students, Jensen (2011) reported that the most common reason students reported liking face-to-face lectures was that they provide more interaction, were more engaging, and so helped maintain attention. Similarly, Gospers et al. (2008) and Gysbers, Johnston, Hancock and Denyer et al. (2011) report that students found lectures motivating, valuing the contact with lecturers and with their peers, along with the organisational structure that attending lectures provides. Given this evidence of the value and distinct role of face-to-face lectures, concern over the wide spread replacement of lecturers with recordings would seem misplaced.

In relation to the impact of access to recordings on attendance, White (2009) found no association between attendance as measured using iClickers and download frequency of audio recordings as measured by IP address. Similarly, Aldamen, Al-Esmail, and Hollindale, (2015) found no correlation between student attendance (as measured by attendance lists) and viewing lecture video recordings (as measured by LMS access data), for students on an introductory Accountancy course. Yeung, Raju and Sharma (2016) demonstrated that non-frequent attenders were also far less likely to make use of recordings to catch-up on missed classes. This is in line with the findings reported by von Konsky, Ivins and Gribble. (2009) that students in a software engineering course who failed were less likely to have attended or to have made use of recordings and Luttenberger et al. (2018) who found a distinct class of students that made minimal use of any and all educational resources.

In addition to the correlational evidence, a range of approaches have been used to examine the impact of lecture recordings on attendance. Hove and Corcoran (2008) examined

the effect of access to recordings on attendance in a large introductory Psychology class. One group, had access to lecture recordings while the other did not. There was no statistical difference in attendance between the two groups. Chen and Lin (2012) compared attendance on an intermediate microeconomics course following the introduction of lecture recordings with the same course in the immediately preceding session and found no significant difference in attendance. Further Chen and Lin found no linear relationship between accessing online recordings and lecture attendance. In their study those with moderate levels of viewing (6 – 10 times) showing the highest level of attendance (85.91%), those with the highest levels, the lowest attendance (51.53%) and those not accessing recordings being between these values (77.93%). Williams, Aguilar-Roca, and O'Dowd, (2016) report similar results to Chen and Lin (2012), the introduction of lecture capture to a large introductory biology course did not result in significantly different levels of attendance to that reported in the previous year (see also Nast, Schäfer-Hesterberg, Zielke, Sterry, & Rzany, 2009). Though in the case of Williams et al., the lectures had a high level of student interactivity that would not have been captured by the recordings and so may have mitigated any impact of recordings on attendance. McGowan and Hanna (2015) contrasted attendance by the same computing MSc students in two courses with similar levels of technical content, one on Java programming, and one a database module. For the Java course, students were provided with access to lecture recording but not for the database module. McGowan and Hanna found no difference in attendance patterns between the two courses. Finally, Nordmann, Calder, Bishop, Irwin and Comber (2017) examined a range of factors in relation to the impact of access to recordings across all levels of a psychology degree programme. They collected attendance data in class and access to recordings was measured using log files from the LMS. This allowed viewing behaviour and attendance to be to directly linked to attendance. Contrary to previous studies (e.g. Bos, Groeneveld, van Bruggen, & Brand-Gruwel, 2016: Drouin, 2014,) Nordmann et al. report that there was little evidence to suggest that students were substituting lecture attendance with access to recordings. The balance of research suggests that having access to lecture recordings has either no or only a very small impact on attendance.

Taken together, the findings from research into lecture attendance suggests that rather than ask *will* lecture recordings reduce attendance, if that does occur, and the evidence suggests it is unlikely to be a significant factor, then the questions should rather be *why* and *what* can it tell us about our pedagogy.

Personalising the learner journey

One of the key benefits of technology-enhanced learning is in the potential it offers to personalise and allow self-regulation of the learner journey and so improve the overall student experience (see Davies, Mullan, & Feldman, 2017). As Davies et al. suggest, maximum benefit is gained when technology is designed into the process of learning.

From the perspective of the student experience, studies have shown consistently that students value having access to and make use of recordings of lectures. For example, in a large survey in four Australian Universities, Gosper et al. (2010) found that 76% of students reported a positive experience with recordings, 79.9% felt that it made it easier to learn, and 66.7% felt it had improved their performance (see also McNeil et al., 2007). Similarly, in a survey of US first and second year medical students, Franklin, Gibson, Samuel, Teeter and Clarkson (2011) found that 80.1% of students reported making use of the recordings as a regular learning resource. In addition to these studies based on self-report, research looking at access statistics has shown similarly high levels of usage. For example, a two-year study conducted by Elliot and Neal (2016) following the introduction of lecture recording to a large Economics class at a UK University demonstrated that, in the first year of introduction, 87.8% of students accessed the recordings at least once, with this figure rising to 99.7% in the second year of operation (although see Nordmann et al. (2017) for data showing relatively low usage).

Students use lecture recordings for a range of general purposes, for example to balance family, work, and other study commitments (e.g., Chester, Buntine, Hammond, & Atkinson, 2011; Dona, Gregory, & Pechenkina, 2017: Pons, Walker, Hollis & Thomas, 2011; Taplin, Kerr, & Brown, 2014), and as a backup for lectures that were unintentionally missed, for example, as the result of illness or transportation issues (e.g., Yeung et al., 2016; Gysbers, Johnston, Hancock, & Denyer, 2011).

However, the literature clearly indicates that for the majority of students the greatest value of recordings is as a learning resource. They use recordings to revisit and clarify complex confusing topics (e.g., Elliot & Neal, 2016, Yeung et al., 2016), to prepare for exams (e.g. Chen & Lin, 2012; Copley, 2007; Mallinson & Baumann, 2015; von Konsky et al., 2009), and to learn at their own pace (e.g., Cooke et al., 2011; Euzent, Martin, Moskal, & Moskal, 2011; Tarr et al., 2015). While Scutter, Stupans, Sawyer and King. (2010) do report that some students

cited not having to attend the lecture in person as the most useful aspect of podcast access, this was ranked bottom behind advantages associated with personalising the learner experience including; flexibility, revision, clarification, reduced need to take notes in lectures, and simply being able to hear the lecture in full again.

There is evidence that there are some groups for whom access to recorded lecture material may be a particularly important pedagogic resource. Students learning in a second language and students who require additional learning support appear to make greater use of recordings (e.g. Leadbeater, Shuttleworth, Couperthwaite, 2013; Nordmann et al., 2017; Shaw & Molnar, 2011, Taplin et al., 2014). There is evidence that in addition to making greater use of recorded materials, second language learners show different patterns of usage, for example, being more likely to review materials directly after the lecture than other students (e.g., Mallinson & Baumann, 2015). The value of recordings for second language learners is exemplified in the following quote from Collier-Reed, Case, and Stott (2011,) "*Sometimes the lecturer is talking to 100 students and you feel left out but when you listen to the podcast it is literally like a one to-one situation with the lecturer as well which is better. For some of us the command of English isn't that [good] so the problem of hearing each and every word and understanding each and every word the first time it is actually said in that sentence it is not so easy for us as well. So you can rewind the [podcast] if you didn't understand*" (p.337). Pearce and Scutter (2010) find that one of the reasons non-native speakers may utilise recordings more than native speakers is the ability to pause a recording to look up words for clarification. Nordmann et al. (2017) found that non-native speakers accessed recordings significantly more than native speakers in their first-year sample but not in subsequent years. This suggests that access to recordings is of particular importance for the transition to higher education in a second language but also that recordings are being used for positive reasons. For similar reasons, students with learning disabilities also report benefitting from the provision of lecture recordings (Leadbeater et al., 2013) and indeed recording for this purpose is already included in many institutional policies surrounding inclusive learning as a reasonable adjustment following the Equality Act (2010). Jisc, the UK's non-profit organisation for digital services and solutions recommends implementing institution-led lecture recording (Jisc, 2018) citing the ability to revisit content as required as the main benefit to inclusive learning.

In addition to the findings relating to second language learners and disabilities, access to recordings may also provide more general cohort benefits, with a number of studies showing that first year students seem to particularly benefit from having access to recordings (e.g., Cooke et al., 2011; Nordmann et al., 2017; though see Chester, Buntine, Hammond and Atkinson (2011) for the view that it is more senior students benefit most from recordings). For many first-year students, the university lecture format will be a new learning environment and although guidance is often provided about what they should do during lectures, it is unsurprising that these students value the opportunity to get a second chance at the lecture content when in this transitional stage.

By facilitating more active control and self-regulation over learning, lecture recordings may also play a role in supporting a heterogenous range of learning preferences. For example, Gysbers et al. (2011) have suggested that some students find lectures too fast, too dense, and too difficult to follow and so in a similar way to those with English as a second language, value the flexibility to stop, restart, and review the materials at a time and place of their choosing. Linked to this, McCunn and Newton (2015) have shown how frequency of accessing lecture recordings is related to the perceived difficulty of the material. In addition, in a study of medical students' use of recordings by Topale (2016), students identified one of the major advantages of recordings as facilitating the ability to use multiple modes of learning, allowing them to view lectures, consult texts and other resources at the same time. Multimedia learning is suggested to have several pedagogic advantages linked with reductions in cognitive load (Mayer, 2005). Luttenberger et al. (2018) state that the driving force behind student satisfaction with lecture capture and podcasts are the opportunities for self-regulated learning.

The ability to personalise the learner journey and self-regulate learning may also explain why research has suggested that the availability of lecture recordings can reduce feelings of anxiety. For example, Owston, Lupshenyuk, and Wideman (2011) report reduced anxiety when lecture capture is provided due to the ability to review the material later if any important points are missed. Similarly, in a survey conducted with Geology students, 69% agreed that the availability of lecture recordings reduced levels of student anxiety with the course (Traphagan, Kucsera, & Kishi, 2010).

How and when do recordings impact on student performance

Students frequently report that access to lecture recordings improves their learning and performance (e.g., Gosper et al., 2010) and while Ford, Burns, Mitch and Gomez (2012) found no association between access to recordings and grades, they reported that students with access were significantly more likely to report spending more hours studying, more likely to report that learning outcomes were effectively addressed, and more likely to report that they found that the course challenged them to do their best work. However, the positive view expressed by students on the impact of access to recordings contrasts with the view implicit in the concern over falling attendance frequently expressed by lecturers and linked to the perceived relationship between attendance and the attainment of the course learning outcomes. However, perhaps the more appropriate question here is not, do students as a whole benefit from access to recordings of lectures, but why do some benefit and others not? What does this tell us about pedagogy and how people learn, and what can we tell students about how to maximise the value of this type of resource?

Reinforcing the view that the focus should be on pedagogy rather than on the mode of delivery, Newton et al. (2014) have suggested that many of the studies that have shown that lecture attendance is beneficial have not always provided a viable alternative and there is some evidence to suggest, at least in certain situations, lecture recording can provide just such an alternative. Euzent, Martin, Moskal and Moskal (2011) compared students' performance in two sections of a large economics class, one section one taught face-to-face and the other taught using recordings of the same lectures. Students self-selected which section of the course they took part in with an average of 606 students taking the recording section and 348 the face-to-face section across two sessions. No significant difference in the final course grades of the groups based on the mechanism for delivering teaching was found (see also Bosshardt & Chiang (2016) and Bettinger, Fox, Loeb & Taylor (2017) for a contrary view). Related to the discussion of self-regulated learning above, this may suggest that the benefit of lecture capture will differ depending upon the individual and so the importance of having both live and recorded lectures available for self-selection may be paramount. In a similar study, Figlio, Rush and Yin (2013) compared students' performance in two sections of a large microeconomics class, one section one taught face-to-face and the other taught using recordings of the same lectures. with students randomly allocated to each teaching method. Controlling for various covariates, there was a modest advantage for face-to-face delivery on assessment scores. Brooks, Erikson, Greer and Gutwin (2014) also demonstrated a positive relationship between

access to recordings and attainment but the impact of recordings was most marked for high activity users, students who show frequent access to recordings (rather than total duration of viewing). This finding is potentially linked to the concept of distributed practice, the finding that learning that is spread out leads to increased long-term retention (Cepeda, Vul, Rohrer, Wixted & Pashler, 2008).

Given the diversity in how individuals best learn it is perhaps not surprising to see that the evidence on whether access to recordings improves attainment at a group level remains mixed (Heilesen, 2010). After all it is individual diversity that has created the drive to personalising learning[2] (see for example NTEP16). Although there is much evidence to suggest a positive role for recordings, as might be anticipated, the evidence on whether this is consistent appears dependent on a mix of student characteristics, the nature of the material, and the way the recordings are used. Williams, Birch and Hancock (2012) examined the relationship between attendance (self-reported), accessing lecture recordings and attainment in a large introductory economics class. Their results indicated a positive effect of viewing recordings on overall attainment. However, those who gained maximum benefit from accessing recordings were also the students who attended most face-to-face lectures. Chen and Lin (2012) found a positive relationship between students' use of recordings and their grades but also between attendance and grades. As these results suggest, the impact of access to recordings on student performance is nuanced. Bos et al. (2016) split their sample of psychology students into those who neither attended lectures or watched recordings, those who only attend lectures, those who only viewed lectures, or those that both attended lectures and made use of recordings ('supplementers'). Course grades for those students who only view recordings or attended lectures showed no significant difference, however, supplementers received higher grades than any other group. Taken together with the findings discussed previously of greater recording usage by non-native speakers, there is a pattern suggesting that recordings allow students to take control of their learning.

[2] "*Personalized learning* refers to instruction in which the pace of learning and the instructional approach are optimized for the needs of each learner. Learning objectives, instructional approaches, and instructional content (and its sequencing) may all vary based on learner needs. In addition, learning activities are made available that are meaningful and relevant to learners, driven by their interests and often self-initiated." (NETP16, p.7)

Importantly, what these and other results suggest is that the impact of recording usage appears to interact with student ability and overall effort. Nordmann et al. (2017) demonstrated that both attendance and recording use were positive predictors of performance for first year psychology students, however there was an interaction with GPA. For weaker students, supplementary use of recordings was beneficial but only better students' use of recordings helped overcome the impact of low attendance. The relationship between impact of recording use and ability is also seen in Mark and Vrijmoed (2016) who found mid-range achievers benefitted most from using recordings. Similarly, Luttenberger et al. (2018) found that students who reported that they predominantly learnt from podcasts did better, but they also indicated spending a significantly longer time studying. The difference in the impact of recording use on attainment as a function of academic strength is also reflected in differences in viewing patterns that are seen in high achieving students' relative to those with lower levels of attainment. Owston et al. (2011) reported that high achieving students tended to only view certain sections and to view those sections only once. In contrast students who had lower levels of attainment viewed whole lectures and often multiple times.

The relationship between viewing patterns and level of attainment has been interpreted through learning theory and levels of processing. Vajoczki, Watt, Marquis, Liao and Vine (2011) found that students who have a deep approach to learning (Marton & Säljö, 1976), were characterised by making learning meaningful and internalising content, using lecture recordings as a supplement while students with a surface learning approach, characterised by rote memorization and reproducing facts, had a tendency to use recordings as a substitute. Wiese and Newton (2013) demonstrated that students who had higher deep learning scores on the revised two-factor study process questionnaire (R-SPQ-2F: Biggs, Kember, & Leung, 2001), used recordings more frequently, used them to master and review material, and had higher levels of attainment. Students with higher surface learning scores showed the contrasting pattern. The distinction between deep and surface learning is relevant to findings suggesting that year of study also appears to be a potential moderator of recording impact with Nordmann et al. (2017) finding the relationship between recording use and achievement was weaker for second year students and for third and fourth year students neither attendance or recording use were related to performance. Nordmann et al. suggest that this is potentially related to the content and nature of the course (see also Phillips, Gosper, Mcneill, Woo & Preston, 2007). For sub-honours courses that are focused upon knowledge acquisition and facts (Demetriadis & Pombortsis, 2007) recordings may be particularly useful. In later years that

require deeper critical thinking skills and the application of knowledge, the impact and usage of recordings may depend more upon personal preference and the factors discussed above. It is also possible that the split between introductory and higher-level courses may in fact describe the same split between deep and surface learning and as such it may be possible to design interventions and guidance that allows students to optimise their use of recordings.

Where next for research on lecture recordings?

The majority of research covered in this review focuses on whether or not the net effect of recordings is positive or negative. However, the research reviewed also holds a wealth of information about the diversity of student learning and pedagogy but little of this has been situated within the major theoretical approaches to student learning and pedagogy or been translated into advice for students or for staff. Where advice is provided to students on the appropriate use of lecture recordings this has largely centred on encouragement not to use recordings as a substitute for live lectures (although as an example of more comprehensive support see the material here[3], provided by Kings College, London or this [4]from the University of York). In a similar comment on the focus of research in this area, O'Callaghan et al. have highlighted research from Burnett and Meadmore (2002) and Gosper et al. (2008) that suggests support surrounding lecture capture disproportionately concerns technological rather than pedagogical issues.

Based on this review, we propose to progress the conversation from a binary question of whether or not recordings should be used, to how they can be used most effectively and linking the research into broader theoretical frameworks in order to bring our understanding of lecture capture in line with what we know about other learning behaviours and technologies such as note-taking (e.g., Chang & Ku, 2015; Kiewra, 1989; Kobayashi, 2006), the use of PowerPoints and lecture outlines (e.g., Raver & Maydosz, 2010; Zdaniuk, Gruman, & Cassidy, 2017), summarisation (e.g., Bednall & Kehoe (2011), retrieval practice (e.g., Carpenter & DeLosh, 2006; Pyc & Rawson, 2009) and so on. There will always be different samples and different courses to which the binary question of lecture capture use can be applied but we argue that there is now enough evidence that lecture capture does not have any systemic ill

[3] https://www.kcl.ac.uk/study/learningteaching/Learning-and-Teaching-Support/QuickGuides/kcl-qg/dl/7-ways-lecture-capture-students.pdf

[4] https://www.york.ac.uk/staff/teaching/support/recording-lectures/student-advice/

effects and may be beneficial for learning. Indeed, by continuing to investigate the binary question we risk sustaining the idea that the use of lecture capture is something that lecturers should be cautious and concerned about.

Previous research into lecture capture combined with theories from cognitive psychology provide several avenues that could be pursued to provide greater context and nuance to the use of recordings and to maximise their educational impact. The issue of distributed versus massed practice has received much attention by researchers interested in memory and learning. Cepeda et al. (2008) found that although massed practice produced better scores on immediate testing, distributed practice was more effective for long-term retention. Additionally, Cepeda et al. looked at lag effects (i.e., the time between learning sessions) and found that performance was best when the lag was 10-20% of the desired retention interval, for example, to remember something for one week, they recommended spacing learning episodes 12-24 hours apart whereas to remember something for 4 years, learning episodes should be 4.5-9 months apart (although they also recognise that these intervals do not necessarily align with the semesterisation of higher education and therefore recommend one month spacing for university students).

There has been relatively little research that has investigated the use of lecture capture as it relates to distributed practice. This may be in part due to the information that is available to researchers. Those studies that used self-reports did not report collecting information on the exact timescale of lecture capture usage across the term (and indeed one would question the ability of students to retrospectively recall how much they had used the recordings each week). For those studies that use media server data, there may also have been technological restrictions. For example, Nordmann et al. (2017) noted that the statistics tracking function on the VLE Blackboard only provided access data for folders, with no distinction for the different files in a folder meaning that it was not possible to determine whether it was the recording or e.g., the Powerpoint slides in the same folder that was accessed on a particular date. Additionally, the Kaltura media server used in Nordmann et al. provided the number of times each recording was accessed, the total length of time each recording was accessed, and the average amount of time each recording was accessed but did not provide information about *when* the recordings were accessed. The pace of technological change is rapid and increasingly lecture capture software analytics do provide the type of data required to determine the effects

of spacing. For example, systems such as Panopto currently[5] provides far more granular information including the length of access in minutes and seconds per day for each recording.

Given the robustness of the distributed practice effect (see Dunlosky, Rawson, Marsh, Nathan, and Willingham (2013) for an excellent overview of the literature on learning techniques) we would be surprised if the effect of spacing was anything other than the hypothesised direction (i.e., distributed practice over the course of a semester leads to improved learning than massed practice close to the exam in revision week), however, lecture capture specific research may help inform best practice for the availability of recordings. For example, in Bollmeier, Wenger, and Forinash (2010) no correlation was found between the number of live lectures attended and the number of minutes of recordings viewed or between viewing and course grades, however, access to recordings was restricted to 72 hours after the live lecture. It would be interesting to determine whether such an intervention would promote distributed use of recordings across the semester or whether unlimited access, although potentially requiring more guidance, would have the most beneficial impact upon performance.

We believe that the most useful research may come from situating research on lecture capture within the broader frameworks of student learning. For example, expanding what we know about the link between deep and surface learning and the use of lecture capture. Weise and Newton's (2013) findings that students who scored higher on deep learning approaches were more likely to use recordings to master and review material provides an excellent starting point as they highlight a number of limitations with their work, that, if addressed, would strengthen the conclusion that adopting a deep learning approach for lecture capture is beneficial. For example, Weise and Newton note that they did not have access to comprehensive demographic data that made comparisons between the recording and no recording groups difficult, in addition to using self-report rather than usage data, and so an improved replication of their work would be most welcome.

To extend their findings, there is much potential for intervention studies to inform future practice. For example, previous research has found that interventions that focus on curriculum design can result in students adopting deep learning strategies (English, Luckett & Mladenovic, 2004), that active, deep learning activities during lectures are linked to increased

[5] Correct as of 3rd April 2018

attendance, satisfaction and learning (Revell & Wainwright, 2009), and that instructional interventions encourage and improve deep collaborative learning (Khosa, Volet & Bolton, 2010). Additionally, in a self-report study, Owston et al. (2011) found that higher achieving students reported viewing certain sections of the recordings, whereas lower achieving students watched entire lectures multiple times. Replication of this result using methods other than self-report, as well as the interaction with year of study (see Nordmann et al., 2017) would be extremely useful in helping inform and expand the guidance given to staff and students. It would be interesting to see the results of an intervention that taught students how to use lecture capture to promote deep learning, for example by encouraging selective use of recordings to review particular sections of content rather than viewing the entire lecture again.

Maximising the impact of recordings as an educational resource

McGarr (2009) has argued that students need to possess the study skills to make effective use of recordings. While some students may develop these skills independently, if the pedagogic value of access to recordings is to be realized then lecture recordings need to be integrated in a pedagogically sound way (Yeung et al., 2016). As O'Callaghan et al. (2017) have argued, to be an effective learning resource, both students and staff need to be educated in how to use recordings to enhance their learning and teaching. We suggest that based upon our current knowledge this guidance should be formulated around three key themes. These recommendations are by no means extensive (or particularly novel, they build upon existing guidance, see the Kings College, London example on p11) and, as new research is conducted they are likely to be refined, but we believe that the following is a foundation for guidance good practice.

First, students should be explicitly instructed that supplemental use is likely to produce the best outcomes. Although it is important to inform students that most studies find a positive effect of attendance that is often not overcome by substitutive recording use, the guidance should not simply focus on the issue of attendance but also promote *both* attending the live lecture and using the recording.

Second, the concept of deep processing should be used to explain and promote that not only is supplemental use best, but selective supplemental use of recordings (rather than re-watching an entire lecture) will likely lead to better outcomes. Students should be encouraged to use the recordings to revisit only the material that they struggle to understand as the act of

reviewing the lecture to determine which sections require revision may in itself strengthen learning.

Finally, the concept of distributed practice should be linked to the use of lecture capture. Getting students to study consistently throughout the semester is not a new problem, however, the potential to save up recordings and binge the box-set in revision week may exacerbate this issue for some and therefore it is important to be explicit about the disadvantages associated with such a strategy. In conjunction with supplemental selective use, student guidance should promote lecture capture as an educational resource that should be used on a similar timescale to course reading and reviewing notes, that is, on a weekly, consistent basis.

Even in research focused institutions like Universities, evidence is not a sufficient condition to bring about a change in practice at the level of the individual, however it is a necessary condition. Therefore, for staff, when lecture capture training and guidance is provided, staff should be made aware of the evidence in this field, highlighting the many positive findings as well as the additional benefits for students with learning disabilities and non-native speakers. Additionally, institutions may wish to address common concerns as highlighted in the literature and provide practical solutions if appropriate. For example, if attendance at lectures is the key issue, staff could be encouraged to monitor attendance in their lectures. Indeed, given that the possible pedagogic richness that can come from understanding attendance patterns it may be that recording attendance should be something that is encouraged. If, as reported in Chang (2007), lecturers wish to reward students who also attend the lectures then guidance surrounding activities that involve class discussions and other pedagogical approaches that move away from traditionally recorded content could be provided. Gosper et al. also found that the majority of lecturers in their sample reported having changed their lectures or style due to recordings being made. It may be helpful then for staff to be explicitly instructed as to whether their recordings should be expected to provide the same experience as attending the lecture, or whether the recording is offered as a supplementary extra that is intended to capture the content but not the experience of the lecture (this guidance can be incorporated into official lecture capture policies, as is the case for a number of institutions currently, see previous section on policies). By making expectations clear, staff can then make informed decisions and, perhaps, have reduced anxiety regarding these potential concerns.

Table 1. Recommendations for lecture capture best practice

…for students	…for staff	…for policy
1. Promote supplemental use – students should attend live lectures and use recordings to additionally review the material	1. Provide pedagogical support that focuses on lecture capture as an educational tool, rather than a technology.	1. Present a clear statement that lecture capture is supplementary to contact hours.
2. Promote selective use that encourages deep learning – students should review their understanding of the material and target sections of the recording that need strengthened.	2. Provide an overview of the evidence, highlighting the consensus that there is a null effect on attendance and may be positive effects for learning.	2. Present a clear statement that acknowledges the variability in lecture capture suitability for different teaching activities.
3. Promote distributed practice, do not label lecture capture as a tool for revision week as this may unintentionally encourage binging the boxset, instead highlight lecture capture as a constant study resource.	3. Provide clear institutional expectations, guidance, and policies that explicitly address known areas of concern, in particular the equivalence of the live and captured lecture experience.	3. Present clear statements on potential additional uses of captured content, e.g., performance management, intellectual property

Conclusion

In this review we have considered the evidence concerning the perceptions and the impact of lecture capture and arrive at four broad conclusions. First, students overwhelmingly see having access to recordings of lectures as enhancing their experience and providing a flexible resource to aid their studies, deal with competing demands, and reduce anxiety. Staff are frequently more sceptical. Second, and often as a result of student demand, many institutions either have (or are) developing very similar policies that are focused mainly on the use, misuse and ownership of recordings with limited consideration of how to enhance the pedagogic value of recordings. Third, and to date, the research that has accompanied the spread of lecture recording has concentrated largely on the binary issue of whether it has a negative impact on attendance. Relatively little attention has been paid to situating the research in the broader conceptual frameworks of student learning, the pedagogic value associated with understanding any impact on attendance or linking it with the wider questions associated with the drive towards more personalised learning. The literature shows clearly that the impact of access to recordings is a function of a range of individual characteristics and understanding these should be central to future research. Finally, we cannot and should not expect students

and staff to follow best practice without being told what best practice is, and it is essential to remember that guidelines for educational technology should focus on the education, rather than the technology. To aid this, we have provided recommendations based upon the evidence to support students, staff, and policy (see Table 1 for an overview). In short, lecture capture is a positive addition to the higher education toolset and it is time to move on, both as educators and researchers.

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