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The use of lecture recordings in higher education: A review of institutional, student, and lecturer issues

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Abstract Web-based lecture technologies are being used increasingly in higher education. One widely-used method is the recording of lectures delivered during face-to-face teaching of on-campus courses. The recordings are subsequently made available to students on-line and have been variously referred to as lecture capture, video podcasts, and Lectopia. We examined the literature on lecture recordings for on-campus courses from the perspective of students, lecturers, and the institution. Literature was drawn from major international electronic databases of Elsevier ScienceDirect, PsycInfo, SAGE Journals, SpringerLink, ERIC and Google Scholar. Searches were conducted using key terms of lecture capture, podcasts, vodcasts, video podcasts, video streaming, screencast, webcasts, and online video. The reference sections of each article were also searched and a citation search was conducted. Institutions receive pressure from a range of sources to implement web-based technologies, including from students and financial imperatives, but the selection of appropriate technologies must reflect the vision the institution holds. Students are positive about the availability of lecture recordings. They make significant use of the recordings, and the recordings have some demonstrated benefits to student learning outcomes. Lecturers recognise the benefits of lecture recordings for students and themselves, but also perceive several potential disadvantages, such as its negative effect on attendance and engagement, and restricting the style and structure of lectures. It is concluded that the positives of lecture recordings outweigh the negatives and its continued use in higher education is recommended. However, further research is needed to evaluate lecture recordings in different contexts and to develop approaches that enhance its effectiveness.

Keywords Lecture recordings · Lecture capture · Podcasts · Learning outcomes · Attendance · Engagement

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1 Introduction

Universities are under increased pressure to introduce web-based learning technologies (WBLT). The purpose of this review is to examine the use of a form of WBLT: the recording of lectures that are given during face-to-face teaching of on-campus courses. The recordings, which are subsequently made available to students on-line, have been referred to variously as lecture capture, video podcasts, and Lectopia. The present review examines this technology from the perspectives of the students and lecturers within the broader context of the tertiary institutions. Given that students are the 'clients', lecturers are the service providers, and the context is the tertiary institution itself, these groups/concepts provided a useful framework within which to structure the review. We begin by defining key terms and then address the following questions:

1) What are the factors influencing universities to implement web-based learning technologies?
2) What are the organisational implications of the move towards web-based learning technologies?
3) How do students perceive and use lecture recordings?
4) What are the effects on class attendance and academic performance?
5) How do lecturers perceive and use lecture recordings?
6) What practical and research issues need to be addressed in further research?

To conduct the review, we searched the literature in the following major international electronic databases: Elsevier ScienceDirect, PsycInfo, SAGE Journals, SpringerLink, ERIC, and Google Scholar. Searches were conducted using key terms, including lecture recordings, lecture capture (technology), lectopia, podcasts, vodcasts, video podcasts, video streaming, screencast, webcasts, online video, and their combinations with terms such as higher education, learning, and engagement. We particularly focused on the situation in Australia but also considered the wider literature. The reference list for each identified item was also examined to locate additional sources. This was followed by a citation search of the identified material to find further relevant literature. This review focuses on lecture recordings that are used concurrently with face-to-face teaching. Research using lecture recording technologies in place of face-to-face teaching, as in distance education or on-line learning, was not included in the review (except when contrasted to recordings of lectures for on campus students). Such applications are regarded as qualitatively different to lecture recordings that are used to supplement face-to-face teaching, as they are pre-recorded and are used for different purposes.

1.1 Definitions of web-based lecture technologies

Given the wide range of lecture recordings in use, it is important to define the key characteristics of the technology and differentiate this approach from related WBLT approaches. Broadly, *lecture recordings* are technologies involving audio only, or audio combined with video or other media such as PowerPoint slides and document camera images. A widely used lecture recording system is Echo360 (formerly known as Lectopia or iLecture), which can provide both audio and video presentations, although it is more commonly used without the video component due to the cost involved in equipping

classrooms with both capabilities. *Video podcasts* are files that provide video as well as audio, so that students can both see and hear the lecturer and/or other visual information (e.g., lecture slides; Paulo Kushnir et al. 2011). Both video and audio podcasts can be distributed in a digital format via the internet, and obtained by streaming or by downloading to a computer or mobile device (Heilesen 2010; Kay 2012; McGarr 2009). Lecture recordings are used in a variety of contexts in higher education, where classes range from large and diverse cohorts that include students from non-English speaking backgrounds and differing pre-existing knowledge, to relatively small and homogenous groups (see Gosper et al. 2008). Additionally, they vary in their application depending on subject matter, student characteristics, the goals of the lecturer, and institutional guidelines.

2 Institutional considerations for the use of lecture recordings

In considering lecture recordings within the broader framework of WBLT, it is important to identify institutional considerations for the use of such technology. Universities have been under pressure from stakeholders to introduce lecture-recording technologies (Phillips 2005). Apart from pressure from students and pedagogical reasons, which are mainly the focus of lecturers (both of which will be discussed in detail in subsequent sections), there are also many non-academic drivers influencing this move by universities, and these can be more significant than student desire and educational reasons.In the Australian context, Phillips (2005) suggested that three main factors were associated with a shift by universities to WBLT delivery such as lecture recordings: (a) increases in student numbers (e.g., university student numbers in Australia more than doubled from 1980 to 2000; DEST 2001), (b) inadequate funding (funding to universities has not kept pace with the increase in student numbers; Australian Vice-Chancellors' Committee 2001, and (c) the increased need for students to work while studying (about 85 % of Australian university students also work; James et al. 2006). Universities, thus, have pressure on them to modernise, to become accessible to more students, and to become more efficient. They are also under pressure to compete with other educational institutions, locally and internationally, who are offering courses on-line (Apple 2010). Associated with this is the fear of being left behind by other universities if the new technologies are not embraced (Singh et al. 2005).

Depending on whether universities see themselves as locally or globally focused, they can adopt one of four strategic directions (Collis and Gommer 2001). They can have a *back to basics* strategy (focus on traditional, campus-based teaching, supplemented with technologies such as lecture recordings), *global campus* (with on-line students who never attend campus), *stretching the mould* (students take courses from their own or other institutions to suit their timetable, choice, and speed of progress), or *new economy* focus (on-line, world-wide courses from multiple providers). Back to basics and stretching the mould scenarios are more common than the global campus scenario, and few universities take a new economy approach (Boezerooy 2006). In Australia, the back to basics model is dominant, although stretching the mould is increasingly being taken up. The choice of direction for a university will influence the type of IT learning support selected and implemented (Shelton 2014).

Organisational implications of the introduction of lecture recordings are evident for the individual (e.g., task changes; changes to distribution of work, work climate, work group,

and work appraisal processes; professional development requirements), the faculty/department (e.g., changed funding arrangements; new workload models; changes to staff numbers and profiles; curriculum changes), and the university (e.g., new funding models; changes to infrastructure requirements, including changes to the built environment; revision of policies and practices; and new marketing strategies; Gosper et al. 2008). The extent to which lecture recordings are successfully implemented will depend on the finances allocated to it, the support given by middle- and senior-level leaders, and the university's capacity to change (Couperthwaite et al. 2010). Poor uptake means the investment will be devalued and the institution might fail to meet its strategic goals.

In recent years, the implementation and delivery of WBLT more generally have been facilitated by the rapid increase in high-speed internet access and the increasing availability of free-access support sites such as YouTube. Many educational institutions have moved rapidly to implement and expand this mode of delivery (Kay 2012). However, speedy adoption has also created challenges for university administrators. The challenges include developing ways to manage the implementation of change-processes with staff and students, bedding in and maintaining infrastructure standards, providing adequate professional development for academics, creating a spirit of innovation and risk-taking in translating standard lectures to on-line or on-line support, and maintaining a healthy collegiate university environment (Couperthwaite et al. 2010).

Approaches to implementing technology that facilitates the use of lecture recordings by lecturers and students parallel the introduction of other significant organisational changes, and require good change-management practices (Michela and Burke 2000). Couperthwaite et al. (2010) provided recommendations for universities on the uptake of WBLT based on an analysis of how eight (UK and US) educational institutions undertook this task. Similar recommendations might apply to the specific case of lecture recordings embedded within a broader WBLT strategy. Universities should have a *business case* for adopting WBLT (e.g., target enhanced teaching or distance learning, as benefits, costs, and technologies differ), formalise an *implementation plan* (e.g., relying on bottom-up staff uptake vs. large-scale implementation; time-lines for roll-out), establish a *governance model* (e.g., include representatives from all stakeholder groups; set targets for sustainable growth), identify *strategic targets* (e.g., who should roll it out, and when; set medium- and long-term coverage goals), identify *staff development* needs and implement training (e.g., training to use technology to enhance pedagogical practice and foster staff engagement), and *integrate* WBLT systems into existing procedures and practices (e.g., pedagogical aspects of WBLT included in teaching and learning policies and strategies). As students will require training in how best to benefit from WBLT, student-focused strategies need to be developed in parallel and incorporated into these strategies. Salmon and Angood (2013) also note the importance of a collaborative approach involving university staff from both the academic and information technology fields. Their recommendations include both individual and organizational changes needed for there to be a successful integration of learning technologies into tertiary settings.

2.1 Implementation strategies, steps and technology

If considered along a continuum, implementation strategies can vary from being strategically and centrally driven by the university to being driven by passionate individuals, whose role it is to develop interest and to enthuse staff at the grass roots level. A second

continuum is whether lecture recordings take an evolutionary (i.e., are introduced slowly, with pilot projects, evaluations, and adjustments before wider applications are considered) or revolutionary path (i.e., large scale implementation driven by strategic university-based decisions). Most reported introductions have followed the tentative, bottom-up pathway (Collis and Van der Wende 2002; Gosper et al. 2008), and universities generally do not expect radical introductions (Middlehurst 2003). However, formalised implementation strategies seem especially important for universities, which have been described as rigid institutions with little track record in incorporating technological advances, when what are required are flexible organisations with a culture of risk taking and innovation (O'Hearn 2000). Universities are also "professional bureaucracies", where academic staff often hold stronger allegiances to their discipline than they do to their university, and want to control the content, method, and materials used in their courses. This adds another layer of complexity to the implementation of new technologies (Mintzberg 1983), although this autonomy is increasingly being eroded (Fulton 2003).

Steps for the introduction of new technologies need to include pre-initiation and initiation phases (when early-adopters can explore and experiment with the new technologies), an implementation phase (when the organisation or units within the organisation determine a strategic direction), and an institutionalisation phase (when the change is organisationally driven by incorporating it into core policies and processes; Collis and Moonen 2001). Universities can be identified at all three levels of introduction, although there is a general movement towards institutional-based processes for most universities in Western countries (OECD 2005; Smith 2005). Steps to be taken for the successful implementation of new technologies include articulating a vision for teaching and learning, prioritizing courses/programs that could be enhanced by using lecture recordings, fostering early-users of lecture recordings, and identifying units/areas within the university for strategic investment for uptake (Bates 2000). However, little research has assessed the value of these steps; whereas much more is known about student and staff perceptions of the use of technology in general, and lecture recordings in particular.

Many universities have already invested substantially in information technology (IT) and IT staff to manage the infrastructure that supports the delivery of innovative teaching. At the same time, in many cases, fewer resources have been provided to staff and students to facilitate better teaching and learning, meaning support has disproportionately focused on technology rather than people development (Burnett and Meadmore 2002; Gosper et al. 2008). Many academic staff express negative attitudes towards WBLT such as lecture recordings and do not have the required technical or presentation skills, and many students do not use or do not know how to access WBLT (Kay 2012). Staff and student development activities require adequate time and resources for training. Academic staff also require a safe and supportive environment in order to develop their skills in using new technologies (Joy et al. 2014). Adjustments to teaching workload models and management practices also need to be considered. Heilesen (2010) suggested that WBLT can have a "positive impact on the academic environment", but this will depend on how the technology is introduced and how well it is adopted by staff. Students and lecturers are key stakeholders in whether lecture recordings are implemented and how they are adopted. Thus, it is important to consider their perceptions and how these are influencing their behaviour to engage or not with the technology. It is also important to examine the link between the use of lecture recordings and student learning and achievement.

3 Student perceptions and use of lecture recordings

Research on students has addressed their perceptions of lecture recordings, how they use lecture recordings, and the various outcomes for students, including the effects on class attendance and academic performance. In terms of perceptions, students are generally positive about having lecture recordings available (Gosper et al. 2008; Heilesen 2010; McGarr 2009; Pons et al. 2013; Traphagan et al. 2010). Lecture recordings are viewed more positively by second and third year students than first year students (Chester et al. 2011). Chester et al. (2011) suggested that this difference might be because first year students are dealing with transition issues. Students generally also regard lecture recordings as important to their course satisfaction (Traphagan et al. 2010).

A number of studies have considered how and why students use lecture recordings. Most students ratelecture recordings as useful (Copley 2007; Maynor et al. 2013), and 79 % believe it contributes to their learning (Gosper et al. 2008). There is also potential for students to gain further benefit from lecture recordings. McGrath (2015), for example, recommends that students be supported in their use of lecture capture so that the recordings are used to enhance the effectiveness of their study. This is consistent with findings by Mather et al. (2015) who found that students from some disciplines believed that lack of support in the use of lecture capture technology had a negative impact on their learning.

Students also state that they use lecture recordings "frequently" and find it easy to use (Vajoczki et al. 2010). Indeed, 93 % would like to see more lecture material in podcast form (Copley 2007). Students report that lecture recordings make it easier for them to understand content and to learn (Gosper et al. 2008; Traphagan et al. 2010). Students use the recordings to review concepts and issues (Lonn and Teasley 2009; Pons et al. 2013) and to fill gaps where information was not comprehended fully (Leadbeater et al. 2013; McCredden and Baldock 2009). McCunn and Newton (2015) found some evidence of a relationship between an increased number of times lecture capture material was accessed and greater perceived difficulty of the material, surface learning, and gender although they did not examine the way in which students used the lecture capture material (e.g., to supplement or replace the actual lecture).

Students also value the opportunity lecture recordings provide to learn at their own pace (Chester et al. 2011; Cooke et al. 2012), and they like being able to review repeatedly or skip material depending on their needs (McCombs and Liu 2007; Sadik 2015; Toppin 2011). Lecture recordings are used also to make up for missed classes (Leadbeater et al. 2013; Pons et al. 2013). While students occasionally use lecture recordings following classes, mostly to review specific concepts, lecture recordings are considered particularly useful when revising for exams (Copley 2007). Indeed, Vajoczki et al. (2010) and von Konsky et al. (2009) found the heaviest use of recordings was in the week prior to tests or exams. Students in McCombs and Liu's (2007) study also reported that lecture recordings reduced the time they needed to spend on study (36 % of students) and reading (17 % of students).

Different groups of students, however, do vary in their usage. Leadbeater et al. described the differing ways in which "low users" and "high users" made use of lecture recordings. Low users adopted a highly targeted approach; whereas, high users more often listened to the whole lecture and downloaded more lectures. Chang (2007) found that both students and academics agreed that lecture recordings should be used for equity reasons, such as illness, family needs, disability, and work commitments. High

using special needs students included non-English speaking background (NESB) students and students with a disability, such as learning disability (Leadbeater et al. 2013; Paulo Kushnir et al. 2011; Taplin et al. 2014). Cooke et al. (2012) also identified that 65 % of students considered online lectures helped them to cope with work and life commitments, including distance to travel to university, with many students in Pons et al.'s (2013) study also reporting this.

Students also recognise the limitations of lecture recordings. Gosper et al. (2008) found that while 68 % of students using lecture recordings believed that they could learn as effectively from them as they could from face-to-face contact, 50 % also agreed that lectures were worth attending for the visual aids, the motivation generated, and the value added by lecturers. Other studies have found that students do not regard lecture recordings as a substitute for face-to-face lectures, as face-to-face lectures provide richer interpersonal information (Bassili 2008; Fardon 2003) and allow the opportunity to gain immediate feedback from questions (McKinney and Page 2009); although one study indicated that students preferred pre-recorded lectures to lectures recorded live (Toppin 2011). Additionally, some students report that the difficulty they have in accessing lecture recordings is a disadvantage (McKinney and Page 2009).

3.1 Effects on student attendance

Two outcomes of using lecture recordings that have been well researched are the effects on attendance and performance. Many academics express concern about the effects of lecture recordings on lecture attendance (Chang 2007; Secker and Bond 2010). Students also report that the availability of lecture recordings encourages them to miss classes (Brotherton and Abowd 2004; Maynor et al. 2013). Yet, there have been mixed findings regarding student attendance. Traphagan et al. (2010) found a significant relationship between webcast viewing and absenteeism (although they also found that the availability of other course materials, such as PowerPoint slides or lecture notes, had a greater negative effect than webcasting). Others (Hove and Corcoran 2008; Walls et al. (2010) found no relationship between the use of lecture recordings and student attendance. Reports from students themselves are that attendance for many is the same as for courses with no recordings (43 %), that attendance is reduced (55 %), or terminated entirely (2 %; Owston et al. 2011). When students were asked prospectively, 57 % suggested that WBLT such as lecture recordings would have no effect, 12 % thought it would reduce their attendance, and 31 % said their attendance would reduce depending on the lecture content (Copley 2007). In other studies, reports from students were that lecture recordings had no effect on attendance (DeAngelis 2009, cited in Toppin 2011; McClure 2008). More generally, it has been argued that lecture recordings are used more by students to supplement or enhance lectures attended rather than in lieu of lectures (Copley 2007; Traphagan et al. 2010). It is important to note that most of these studies relied on self-reports by students about attendance rather than measuring attendance, and Chester et al. (2011) found that students overestimate their lecture attendance. Nonetheless, there was no systematic pattern of results for studies using lecturer ratings of attendance or student self-reports, indicating that associations are likely to be influenced by contextual factors.

The effects of lecture recordings on student attendance interact with both the quality of the lectures and the quality of the student. Kolowich (2009) found that poorly

attended lectures had lecture capture recordings that were watched less frequently than well attended lectures. Similarly, Von Konsky et al. (2009) argued that the greater the perceived value of recordings, the more likely students were to use them. It is also the case that higher achieving students attend more lectures (von Konsky et al. 2009) and there is evidence that attendance is positively correlated with course grade (Hove and Corcoran 2008). At the same time, Von Konsky et al. found that passing students were more likely to supplement lectures with recordings; whereas, failing students did not. In contrast, Owston et al. (2011) found that higher achieving students viewed recordings significantly less often than low achievers and also tended to fast forward and view certain sections of recordings only once; whereas, low achievers viewed the entire recording multiple times. A key difference in these studies is that Von Konsky measured attendance using signed slips by students and documented use of recordings; whereas, Owston et al. used self-reports of attendance and use.

3.2 Effects on academic performance

Additionally, there is mixed evidence about the effects of lecture recordings on student grades. In terms of student perceptions, Gosper et al. (2008) found 67 % of students reported that lecture recordings improved their performance, and similarly, Paulo Kushnir et al. (2011) found that students believed that lecture recordings helped them attain higher grades. Hove and Corcoran (2008), in one of the few studies that used a control group, found that students with higher grades attended class more often regardless of the format, and students with unlimited access to lecture recordings had higher grades than those in the traditional mode. This latter effect was moderated by attendance: the unlimited access to lecture format was more beneficial for students with lower attendance. Williams and colleagues (2012) also found that lecture recordings benefited students who used them as a supplement, rather than a substitute for lecture attendance. In contrast, Paulo Kushnir et al. (2011) and Leadbeater et al. (2013) found no effect on grades for students who used podcasts when compared to those who did not, although Leadbeater et al. found evidence that lecture capture might encourage a surface learning attitude. Traphagan et al. (2010) suggested that webcasting appears to nullify the effects on grades caused by not attending lectures. Traphagan et al. also found that having webcasts reduced student anxiety about the course. However, in one of the most sophisticated analyses of the relationship between use of lecture recordings and grades, Williams et al. found that the students who derived the most benefit from watching lecture recordings were the students who also attended the majority of lectures. The lecture recordings had almost no benefit for students who attended few lectures. Overall, there is no consistent finding of benefit of lecture recordings on student grades, although student grades are not the only outcome measure that might interest institutions. Young (2008), for example, argues that courses with technologies such as lecture recordings will have lower drop-out rates, although this is anecdotal as we could find no studies to confirm this suggestion.

Overall, the research suggests a range of benefits of lecture recordings for students, and few negative effects. Students evaluate the availability of lecture recordings positively and perceive they contribute to their learning, particularly for reviewing concepts not fully understood, and when revising for exams. Lecture recordings are also advantageous for a range of equity reasons. At the same time, the evidence is

mixed regarding their effect on both student attendance and academic performance. However, there is no strong evidence of a negative effect on either attendance or outcome. Indeed, there is more evidence of a positive effect on student outcomes.

4 Lecturer perceptions and use of lecture recordings

The effective application of lecture recordings in higher education requires the support of lecturers who are willing to adopt the technology and integrate it in their curriculum. However, perceptions about WBLT, and lecture recordings in particular, can vary considerably across lecturers. For example, a study conducted across four Australian universities showed that 55 % of lecturers reported the use of such technology to be a positive experience, whereas there was still a significant proportion of 27 % who reported its use to be negative (Gosper et al. 2008). Some lecturers can be reluctant to adopt lecture recordings because of the perception that the benefits to them and their students are minimal or unknown (Chang 2007; Secker et al. 2010) or that the use of such technology will negatively affect lecture attendance (Chang 2007; Secker et al. 2010; Vajoczki et al. 2010). For reasons such as these, it is important to better understand lecturers' perceptions of lecture recordings and how these might influence the presentation of their lectures and design of the curricula for their courses.

A range of reasons for using lecture recordings has been noted by lecturers. Some lecturers believe that students expect them to use lecture recording technology when it is available (Chang 2007; Gosper et al. 2008). Lecturers might fear that a failure to use lecture recording when students want it will negatively affect student evaluations of their teaching, even though universities also encourage or even mandate the recording of lectures whenever classes are taught in a suitably enabled lecture theatre. Aside from the perceived pressure, lecturers cite using lecture recordings to accommodate students who cannot attend lectures in person due to factors such as family or work commitments and illness (Chang 2007; Gosper et al. 2008). Equity for students with special needs or those who are NESB is also regarded as a valid reason (Chang 2007; Gosper et al. 2008). Lecturers might also use lecture recordings to improve their own lecture performance, to avoid having to repeat lectures, and to help students cope with lecturers' accent (Gosper et al. 2008).

While the advantages of using lecture recordings have been noted by lecturers, reasons for not adopting the technology have also been recognised. The most common concern is the belief that lecture recordings will reduce attendance at class (Chang 2007; Maynor et al. 2013; Secker et al. 2010; Vajoczki et al. 2010). Gosper et al. (2008) found that 55 % of lecturers reported that attendance at their lectures had decreased due to the use of lecture recordings, although 21 % disagreed with this claim and the remaining 24 % were neutral. There is a significant, negative correlation between lecture capture usage and attendance, although students appear not to be merely substituting lecture capture for attendance (Taplin et al. 2014). Related to the issue of lecture attendance is the more general issue of student engagement. Some lecturers have expressed concern that students might use lecture recordings as a substitute for interaction (Chang 2007). By not attending the lectures, students will have less opportunity to interact with teaching staff and with fellow students, at least in the traditional face-to-face manner. Students might also engage less with the subject they are studying, which could result in a more surface approach to learning.

Lecturer perceptions of the effect of lecture recordings on student learning outcomes are mixed. Gosper et al. (2008) found that 53 % of lecturers reported that lecture recordings made it easier for students to learn and achieve results. Toppin (2010) found that 67 % of faculty staff reported learning performance differences between students who viewed certain topics versus those who did not. However, lecturers have been unwilling to claim changes in student performance as directly due to lecture recordings (Chang 2007). This might reflect that lecture recordings are seen as one part of a large suite of additional resources that students have available to them (Neumann et al. 2011) and that lecture recordings might have positive and negative effects simultaneously.

Another concern raised by lecturers is the belief that the restrictions imposed by lecture recording technology do not suit their "style" of lecturing, that it constrains their teaching approach, or that it does not suit the types of activities they use during class (Fardon 2003; Secker et al. 2010; Taplin et al. 2014). Lecturers who present lectures in a traditional manner (e.g., standing behind a podium delivering information) are viewed to be highly suited for lecture recordings (Chang 2007). However, given that lecturers differ in their lecturing style and that there is no necessarily "right" way of lecturing (Fardon 2003), any potential impact of making recordings of lectures will vary from lecturer to lecturer. For example, based on the classification scheme of lecturing styles developed by Behr (1988), lecture recording would have a greater effect for the "dramatic presenter" than the "information provider". Also, there would be minimal impact for Behr's classification styles of "visual presenter" and "structured presenter", unless the lecture recording was audio only. It is possible that lecture recordings will actually be beneficial for students when their lecturer naturally adopts certain lecturing styles. The "information provider" (Behr 1988) tends to present dense, content rich lectures and might read from prepared notes. The increased chance of missing information with this style of lecturing can be negated by the student being able to repeat relevant sections of the lecture recording (Fardon 2003). On the other hand, lecture recordings that show only information presented via the computer or document camera do not pick up the body language and facial expressions of the lecturer, although this could be compensated for somewhat by lecturers exaggerating their vocal expression or including a video component of themselves in the recording. Interactivity between the lecturer and the students is a potentially difficult component to adequately address through the use of technology when lecture recordings are delivered in an asynchronous manner (Chu 1999).

The addition of lecture recordings has the potential to significantly influence the behaviour of the lecturer, and potentially, their effectiveness in engaging students in learning. This issue is particularly salient when lecturers attempt to use novel approaches to engage students (e.g., Neumann et al. 2009, 2010, 2013). Lecturers might need to adapt their behaviour to suit the technology, such as using the microphone, repeating questions made by students, or using visual aids associated with the presentation software (e.g., mouse pointer). In one study, the majority of lecturers (75 %) reported that they have not changed the structure of their classes and assessment due to the introduction of lecture recordings (Gosper et al. 2008). However, in the same sample, more than half reported that the use of lecture recordings had changed their lecturing style or what was done in the lecture. The same survey found that a third of lecturers adjusted their behaviours during the lecture, such as restricting their movements around the lecture theatre. A similar number of lecturers reported changing the activities done during lectures and using less multimedia content due to copyright

restrictions. Chang (2007) reported that approximately half of the lecturers became more conscious of their presentation in class. This included not presenting inappropriate material or saying things that could be viewed negatively.

Chang (2007) noted that given the possibility that lecture recordings will affect student engagement and attendance at lectures, it might be necessary for lecturers to rethink the role that they play within a course. Moreover, it might be necessary to consider using additional contact time during other classes (e.g., tutorials, laboratory classes) or outside of class (e.g., student consultations) to make up for any loss due to the use of lecture recordings. However, given the current limitations in lecture recording technology, this might have the drawback of steering lectures increasingly towards an information supply format and less towards personal interaction and engaging activities. This is consistent with the notion that the lecture format is an effective method for transmitting information and that there is little evidence that it is effective for provoking thought and changing attitudes (Bligh 2000). Indeed, lecture recordings have been criticised for tending to reinforce the model of lectures as the mere transmission of information (Donnan et al. 2004).

Chang (2007) also noted that many lecturers believed it was important for them to add value for students who attended the lectures. There can be a blurring of the lines in whether this "value adding" is aimed at rewarding attendance. To give students who attend lectures something extra, lecturers have taken advantage of the limitations of lecture recordings. Such strategies can include handing out resources to students in class, using extensive discussions with students, stopping the recordings for interaction with students or the showing of copyrighted material, and using demonstrations. Some lecturers have adopted strategies of recording student attendance at lectures and awarding marks for attendance (Gosper et al. 2008). However, such strategies do not address the issue that students should be able to access recorded lectures if they learn just as well from them as they do in face-to-face lectures.

From research to date, it is clear that a major issue that needs addressing in the implementation of lecture recordings is lecturer perceptions of the technology. The perceptions that lecture recordings have few or uncertain benefits for lecturers are an impediment to their adoption. While universities might mandate the compulsory use of lecture recordings, this is not necessarily the best strategy for expanding its use. The adoption of new technology requires the user to perceive benefits in its use (Sugar et al. 2004). Lecturers should be informed of the advantages of lecture recordings both for themselves and their students. The advantages can include the ability to archive lectures, to improve upon lecturing style, using prior lectures when it has not been possible to give a face-to-face lecture (e.g., due to illness, technology problems), and using recorded material in assessment or in other classes of the subject (Chang 2007). Lecturers should also be informed of the potential drawbacks of the approach and how any limitations can be minimised or avoided. However, it should also be emphasised that lecture recordings need not limit the use of engaging and well-designed face-to-face lectures (Horvath et al. 2013).

5 Future research directions

The research suggests a range of benefits of lecture recordings for students, and few negative effects. However, although research to date has used large samples of students

from a wide variety of disciplines and institutions and across different year levels, many studies are descriptive, based on self-reports, and have few links to learning theories to explain findings. By applying principles from learning theories into the design and presentation of the curriculum and the presentation of lectures, future research into lecture recording technologies might lead to better learning outcomes for students. Research using theories such as Mayer's (1997) *cognitive theory of multimedia learning* has led to various evidence-based principles and recommendations that can be used to improve the design of multimedia instruction, including lecture recordings (e.g., Mayer 1997; Mayer and Alexander 2011; Mayer and Johnson 2008; Moreno 2006). A complementary theory relevant to the practice of lecture recordings is *media richness theory* which emphasises that when individuals are presented with ambiguous tasks, where information can be interpreted in multiple and possibly conflicting ways, the richer the media, the better the learner's performance (Daft and Lengel 1984, 1986; Daft et al. 1987; Webster and Trevino 1995).

Another important area to be addressed in future research is the need for studies using large, demographically representative samples of lecturers. Research focusing on lecturers (but not students) has generally used qualitative methodology and small samples (e.g., 11 academics in Chang 2007). While these initial studies have been useful to gain rich information about lecturer perceptions and practices, more extensive research is required to generate conclusions that can be applied to the wider population of lecturers. Moreover, this would permit comparisons across different subgroups. For example, this might answer questions regarding whether perceptions of use of lecture recordings differ among lecturers of different academic rank, experience, age, or subject discipline.

It is also important for future research to collect parallel data from lecturers and students. In some cases, this collection of data from students allowed for the confirmation of findings obtained from the lecturers (e.g., Chang 2007). However, in other cases, it is apparent that lecturers hold different perceptions about lecture recordings to that of students. For example, 80 % of students reported that lecture recordings made it easier for them to learn, and 67 % reported that it helped them achieve better results (Gosper et al. 2008). In contrast, the same study found that only 53 % of lecturers agreed that lecture recordings benefited student learning and performance. Toppin (2011) compared responses from 7 lecturers and 319 students on similar items of a survey and concluded that the two groups differed in perceptions about student performance as a result of using lecture recordings. For reasons such as these, the use of lecture recordings will be influenced by differences in the way it is perceived by both lecturers and students (McGarr 2009). In addition, lecturer perceptions might be influenced by the lack of information about the effects of lecture recordings on their students, citing that they have no real evidence of its benefits or drawbacks for student learning (Gosper et al. 2008).

While lecturer perceptions are important, they can be discordant with the actual behaviours of students and the needs and desires of universities. For this reason, it is important that lecture attendance is objectively quantified and related to the use of lecture recordings for a course. It is also important to understand what other variables affect lecture attendance independent of lecture recordings (e.g., time of day of lecture, ease of access to university campus, demographics of students) as these are potential confounding variables. The lecturers themselves are also an important variable.

Kolowich (2009), for example, noted that lecturers who had well-attended lectures also had frequently watched lecture recordings, whereas other lecturers who had poorly-attended lectures had their lecture recordings watched less frequently. In other words, good lecturers will attract students to their lectures regardless of whether the lectures are delivered only face-to-face, only on-line, or through both modes.

Concerns over the reliability of the technology also inhibit lecturers' adoption of lecture recordings (Secker et al. 2010). Related to this is a need for guidelines on *how* to use the relevant technology. This should be done in a way that does not detract from the face-to-face lecture (e.g., minimizing movement might aid with the recording of lectures but negatively affects the face-to-face lecture). There is also limited research on what qualities of technologies, such as lecture recordings, make them more or less effective for students. There is also a need to increase the use of psychometrically sound measures that would allow comparisons among studies and reduce reliance on dichotomous (yes/no) items.

6 Concluding comments

There are a range of factors that have been driving the adoption of lecture recordings in universities. These include pedagogic reasons, as well as students both desiring and increasingly expecting lecture recordings to be available, in part driven by the increasing hours that students are engaged in external work. Moreover, universities are also aware of the need to be seen to make use of new technologies. However, successful implementation of lecture recordings requires an implementation strategy that takes account of the changes needed at individual, faculty and the university levels. We proposed that Couperthwaite et al.'s (2010) model provides a useful implementation framework for universities to use. While many universities change using a bottom up approach, we recommend an institutional based approach, especially for universities with little experience implementing technological advances. Such an approach needs to include a focus on both the people and technology aspects of introducing lecture capture.

Specifically, we recommend that:

1) Students are educated in how to use the technology to enhance their learning. This includes students gaining a better understanding of how it can be best used as a supplement to face-to-face attendance at lectures and recognising the drawbacks if used as a replacement for lecture attendance;
2) Lecturers are educated about the benefits of lecture capture for student learning. This includes correcting misunderstandings, such as that lecture capture will inevitably cause a decline in student attendance;
3) Lecturers are provided with training in the effective use of lecture capture. This includes an understanding of what teaching styles and approaches are best suited to lecture capture. Such training should also focus on how lecturers can enhance interaction and engagement, and foster deep learning; and
4) Institutions provide the necessary technological support so that lecture capture technology is reliable and easy to use by students and lecturers. Moreover, the technology should also ensure that the recordings are high quality with clear audio.

In conclusion, we have reviewed the relevant literature on lecture recordings from the student, lecturer, and institutional perspectives, and made recommendations for its effective use across the three domains. While much insight can be gained from the studies to date, we have been critical of the breadth, depth, and quality of this research. Advancing our understanding of this form of delivery will require sizeable additional research. The research in the WBLT area has not kept pace with that of the roll-out of the technologies, which is now inexorable. The question for academics and universities is not whether to use the technologies; the question for both is how the technologies can be best applied to benefit all parties involved, particularly the students. This needs to be the focus for future research.

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