

Lecture Capture Literature Review

A review of the literature from 2012 to 2015

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Executive Summary

This report was written for the Centre for Academic Practice at Loughborough University in order to provide a snapshot of how lecture capture (LC) is currently being used in higher education. It draws from literature published internationally between 2012 and mid-2015. The aim was not to provide an exhaustive review of the relevant literature, but rather to provide indicative findings that could inform day-to-day practice in a higher education institution.

It should be noted that, in many of the studies reviewed, data was gathered by self-reporting of students, and not all students responded to surveys, therefore providing only a partial picture. Also, most of the studies were conducted within specific programmes, mostly within the STEM subjects, and so we should be cautious about making generalisations from the findings.

The first finding was that there appeared to be a wide range in the percentage of students who used LC, from as low as 21% to as high as 100% of cohort members. A few studies found that usage increased when the LC recordings were “enriched” with additional online materials, and some found increased usage when LC was made available in formats that lent themselves to mobile access. There were some examples of different usage patterns across different years of study, with first-year students either watching more LCs than students in later years (possibly due to the novelty effect of the technology) or watching less (possibly because they had not yet settled into a “serious” study routine). Very little information was found in the literature regarding advice given to students about the use of LC by lecturers.

There appears to be a great deal of variety in the manner in which students use LC. LC is most often used for revision and note taking. Almost all respondents claimed to use LC as a supplement to, rather than a replacement for, lectures. Most students use LC selectively, choosing specific sections of videos to watch. A small number of students watch entire LC recordings – these are often (but not always) speakers of English as a second or foreign language or students with learning difficulties such as dyslexia. There is tentative evidence from one study to show that LC is most efficient for learners when the recording contains only the slides and the lecturer’s voiceover (without the video of the lecturer) – this is because the video of the presenter reduces the amount of space available for the slides.

With regard to whether LC has any impact on student learning, the findings here are varied. Some studies found little or no evidence of any impact. Two examples were found of the provision of LC apparently having a negative impact on a minority of students: in these cases, students who used LC as a substitute for attendance at lectures were found to be at a severe disadvantage in terms of their final marks; moreover, those students who attended very few live lectures did not close the gap by watching more LC online. In one study it was found that the quality of student interaction in class dropped when LC was introduced, as students were reluctant to speak up when being recorded. By contrast, in another case it was reported that students’ contributions in class were of a better quality when the class was being recorded.

There were several situations in which a positive relationship was found between the use of LC and student learning outcomes. Students perceive the greatest value for LC in courses that move quickly, rely heavily on lectures, and for which the information provided via lectures is not readily available from any other sources, as well as courses which emphasise the assimilation of information rather than the development of applied skills (an important distinction in medicine and related subjects, where many of these studies took place). LC was also found to have a positive effect when the teacher used it as a tool to “flip” the classroom and asked students to view the LC before coming to class. In several of the studies, students who were non-native speakers of English emphasised the value of LC to them, and this sentiment was echoed by learners with dyslexia or other learning disabilities.

A positive relationship was also identified between learners who used LC and certain approaches to learning. In one paper (Brooks et al, 2014), learners were categorised according to their usage patterns (i.e. how often they viewed the LCs, and at which points in the semester), and it was found that students categorised as “High Activity” outperformed their peers by up to 16.45%, while students in other clusters obtained more or less the same grades as each other. Other studies concluded that there was a positive effect only for those students who use LC as a supplement to regular lecture attendance, and that LC appeared to be correlated with “deep” learning as opposed to “surface” learning.

The overwhelming majority students, when asked, say they do not view recorded lectures as a replacement for attending live lectures. This finding was borne out by several studies which included evidence from analytics on lecture attendance and LC views. In one case, increased attendance at live lectures was reported, on the basis that learners felt more confident about their grasp of the subject matter from having viewed the LCs. However, in several studies, lower attendance at live lectures was found to be a direct result of implementing LC. There is some discussion in the literature about contributing factors here, especially around the notion that learners who skip lectures tend to be “surface learners” (as opposed to “deep learners”, and that these learners do not generally compensate for missing lectures by watching the LC.

A few examples were found of lecturers changing their teaching style as a result of the introduction of LC. These generally revolved around the concept of the so-called flipped classroom (teachers providing lecture content for students to read or view before coming to class, and changing their teaching style towards more active, learner-centred learning in the classroom). Other opportunities for innovating in teaching related to the use of LC by lecturers for reflection on their teaching style, and the creation of additional materials to support learners’ independent learning from LC.

A few further points arose out of the literature that are worth highlighting. It is clear from the comments made by students throughout the literature that the provision of LC is perceived as strongly enhancing their learning experience. There is evidence from one study that if LC is mentioned as being an integral part of the learning and teaching approach in marketing brochures or on programme websites, it may influence students’ choice of programme - or even institution to study at. One study also found that LC was particularly useful for students on work placements.

Certain recommendations arose out of the literature – sometimes implicitly. For example, there is a gap in the literature regarding the nature of the advice given by lecturers to students. This might be especially important in the case of first year students who seem to be less consistent in their viewing patterns. Guidance given by lecturers to learners as to how to make effective use of LC may help here. In addition, at-risk students can be identified through a combination of tracking views on the LC system and tracking attendance in class, and automated alerts could be sent to them with advice on recommended behavioural changes, or information about support mechanisms available.

Another important consideration for institutions is the growth in mobile access to LC by students, which suggests that institutional platforms and tools used to deliver LC to learners need to be mobile-friendly.

The paper concludes with responses from the literature to a number of statements from academics in an earlier survey at Loughborough University, where concerns were expressed about the use of LC. It is clear that lecturers need to be supported in the adoption and implementation of LC – not just from a technological point of view but also in terms of their questions about potential copyright infringement, their worries about the potential drop in attendance if LC is introduced, and any other concerns they have about the possible impact of LC on the learning and teaching experience. For LC to have the greatest possible positive impact on learning for students, lecturers, managers and support staff need to jointly create a learning environment that is conducive to effective use of LC and that limits the risks.

Introduction

This report was written for the Centre for Academic Practice at Loughborough University in order to provide a snapshot of how lecture capture (LC) is currently being used in higher education internationally. It follows on from earlier, internal research carried out at Loughborough University in 2012 and 2014, and draws from literature published internationally between 2012 and mid-2015. This was not an exhaustive study of every recent publication on the use of LC, but was rather conducted with a view to providing practical guidelines on the contexts or circumstances in which LC has been found to be useful, and ways in which LC can be effectively implemented, both from an institutional and an individual academic's point of view.

Usage of LC is known to be increasing in UK universities, with 63% of institutions reported to have been supporting a central lecture recording solution in 2014 - an increase of 12% since 2012 (Walker et al, 2014). In a 2014 survey of LC use in the Russell Group universities by Henderson (2014), all of these institutions apart from Cambridge and Liverpool were listed as implementing at least a pilot of lecture capture, with Cambridge using a podcasting system for LC purposes. Since then, Liverpool has also announced the introduction of LC¹. Students are generally in favour of the provision of LC, while lecturers and department heads still have many unanswered questions about its implementation.

The research questions for this paper were as follows:

1. What percentage of HE students use LC when it is available?
2. How are students using LC? Which types of LC recordings are viewed, to what extent, and what experiences are reported by students?
3. What advice is given to students about the use of LC by lecturers, and what is the students' experience of following this advice?
4. Has LC been shown to have any impact on student learning? If so, what impact has been described, and how is this impact related to context? For example, disciplines, stages in HE, students who speak English as a second or foreign language, disabilities, others?
5. What impact, if any, does LC have on attendance at lectures?
6. Are there examples of lecturers changing the way they teach as a result of LC? If so, have these changes been found to have any influence on student learning?
7. What opportunities are there for innovating in teaching by using LC?
8. Anything else?

The paper is structured according to these questions. In order to link the findings from the literature back to the previous research done at Loughborough, the Conclusion includes a section with the key reasons given by academics in a survey conducted in 2012 for choosing not to use LC, and responses from the literature to those statements. The paper concludes by reiterating some of the other key findings from the literature that may be helpful in supporting academics and heads of discipline in making decisions about how best to use LC in their context.

¹ <https://news.liv.ac.uk/2015/07/06/launch-of-new-lecture-capture-tool/>

Methodology

The literature review aimed to identify relevant literature on the use of LC in higher education institutions around the world, between 2012 and the time of writing (mid-2015).

The search terms “lecture capture” and “lecture recording” were used, and were inputted into the following search portals and websites: ResearchGate, Academia.Edu, Google Scholar, and the Jisc and Higher Education Academy websites. The date range for the search was restricted to 2012-2015. Journal articles and conference proceedings were prioritised, and blogs and unpublished reports were included where they had something relevant to add to a particular research question. Backward snowballing was used to identify further relevant items (by reviewing the reference lists of the items that came up in the first round of the search). Reports that appeared to have a high degree of reliability (e.g. where the research methodology involved large samples, control groups, etc.) were prioritised. Smaller, less rigorous studies, were included where they contained relevant, indicative findings. The use of the social sharing sites ResearchGate, Academia.Edu led to the discovery of some recent and as yet unpublished work, which was included where relevant. Information about research methodology used in the studies referred to was included in the write-up where applicable. The Mendeley reference management system was used to store and share files and create annotations².

Findings

1. What percentage of HE students use LC when it is available?

This question proved rather tricky to answer. Firstly, the findings from different sources were not easily comparable because of the different ways in which studies had been set up. For example, in some cases, analytics were used to ascertain student use of LC, and in other cases, surveys and focus groups were used to elicit self-reported use. Where analytics were used, all we can deduce is that a certain number of students clicked on, streamed, or downloaded a certain number of LCs - and clicking/ streaming/ downloading does not necessarily equate to actually viewing the LC. On the other hand, where surveys were used, we can expect a bias in the response rate towards more frequent users of LC (this bias was identified by Wiese & Newton, 2013), with survey results therefore possibly indicating higher usage of LC than is likely to be representative of the whole cohort. Secondly, in cases where the institution streams the videos from a central server, duration of views could be ascertained, but this information was not available in most cases. Thirdly, all of the studies focused on a particular discipline or programme, predominantly in the STEM subjects, and so we must be cautious about generalising the findings to all disciplines.

Bearing these limitations in mind, the findings that emerge from the literature reviewed here show a very diverse picture, which is neatly represented by a single study – that by Turró et

² A public Mendeley ‘library’ containing all the items referred to for this study was created at <https://www.mendeley.com/groups/7503301/lecture-capture-2/papers/>.

al (2014) - involving more than 2,000 students in different disciplines at a university in Spain. In this study, of the 10 courses investigated, the percentage of students who had viewed at least one LC video ranged from 21% to 99%. Some examples of this range reflected in the literature are given below.

Fewer than half the students

In the study by Dickson et al (2012) at an American university, 35% of students in four computer science courses who responded to a survey reported having used LC more than once or twice. Brooks et al (2014) were able to ascertain, based on data from analytics, that just over one-third of the total number (232 out of 636) of Chemistry students at a Canadian university watched at least five minutes of video in at least one week, out of 13 weeks.

Around half the students

Leadbeater et al (2013), in their study into LC use amongst undergraduate Medical Science students at the University of Birmingham, UK, found that around half of the 140 students who responded to the survey had accessed the LC material. This number rose to 75% for specific lectures. In Revell's (2014) study amongst introductory chemistry students at a university in the USA, LC was used by around 40% of the 125 students who volunteered to participate in the study.

More than half the students

In the study by Drouin in an American university involving 55 psychology students who returned surveys, a total of 67% said they had viewed the lecture recordings. Of those, 29% said they had viewed one LC; 22% had viewed two or three, and 16% four or more.

100% or close to 100% of the students

According to Johnston et al (2013), 96% of the 211 nursing students enrolled on an Australian university course accessed the LCs, with an average of 52 hits per student, or two hits per LC file. In Elliott & Neal's (2015) study, 84% of the 728 students in a first-year undergraduate Economics programme at Lancaster University in the UK accessed the LC in first year of investigation, and in the second year of their investigation (with a new cohort of 711), the number rose to 95%.

Increased usage when LC "enriched" with additional materials

A few studies found that student views of LC increased when additional materials were provided online to accompany the LC. Moes & Young (2013), reporting on a pilot study in Belgium and the Netherlands (OASE³) found that there was 20% more use of LC if the LC content was provided with additional "enriched content" on the VLE, such as quizzes or discussion forum activities. Ferriday (2015), reporting on a LC initiative at Cardiff University's School of Healthcare Sciences (HCARE), notes that 27 out of 45 students accessed LC

³ <http://www.weblectures.nl/>

when it was broken into chunks interspersed with interactive content - as opposed to just two out of 45 students when the LC was simply uploaded as an MP4 (video) file.

Increased usage when LC made available for mobile access

Other studies found that the technical format in which LC files were made available could affect the number of uploads. In a longitudinal study at a German HEI by Stickel et al (2013), they noted a marked increase in LC access across the university over five years, particularly in the LC files delivered in MP4 format as opposed to those provided in flv format.⁴

Usage of LC changing according to year of study

Finally, there was some evidence that use of LC recordings differs according to the stage students are at in their degree journey. Drouin (2013) noted that introductory (first year) students were less likely to access online lecture recordings - or even attend face-to-face lectures. She speculates that "introductory students have not yet realized the benefit of viewing lectures, or it could be that they let other social or academic obligations take precedence" (Drouin, 2013, p.17). By contrast, the study by Williams, Pfeifer & Waller (2013) reports very similar access patterns for students of all years in the psychology programme at an Australian university; however first-years showed more initial enthusiasm for LC - but with their use of it waning more quickly.

In Marchand et al's (2014) investigation into use of LC amongst Pharmaceutical students at a Canadian university, analytics from the LC platform showed that the number of individual LC accesses was 42% lower in the second year than the first year; however, the total viewing time for the recordings was 13% longer. They suggest that second-year students were accessing the recordings more selectively, and for longer periods of time. Marchand et al conclude that in the first year, the students were partially motivated by the novelty effect of LC, and it was only in the second year that they began to experience the true benefits of the tool.

⁴ MP4 video is a highly compressed high quality video format, similar to MP3s which are high quality audio files (dependent upon the bitrate used for recording), which deliver some of the best file size to video/ audio quality ratios. FLV is Adobe Flash's video format that is now actually quite an old legacy format, that produces high quality video but at the expense of file size. FLV is not supported by Apple devices, whereas MP4 is, being a more universal file format and playable on pretty much all platforms. FLV would not therefore be viable for those students who have Apple devices.

It is also worth noting here that this institution was using high definition, high quality video which was made possible through the use of heavy, bulky equipment (placed on a wagon for portability). The size of the LC materials on disk was causing problems for the institution, and at the time of writing they were planning to move to a streaming model rather than progressive download on their server, to solve the space problem. (Streaming would involve students watching the videos on the LC server, while downloading would require a lot of space on the university server. In order for streaming to be done smoothly, the institution would need to be able to ensure that all students could access a high speed internet connection.)

2. How are students using LC? Which types of LC recordings are viewed, to what extent, and what experiences are reported by students?

It is clear from the literature that learners are not accessing LC in a uniform way or using it for identical purposes. This variety is encapsulated in the study by Brooks et al (2014), who created a model to quantify the behaviours of learners in an LC environment in a Chemistry programme in Canada. They included only the students who had used LC for at least five minutes per week (N=232), and clustered them according to five types of behaviour: High Activity - those learners who watched LC regularly throughout the term (4.3%), Just-in-Time - those learners who accessed the LC just before the exam (42.2%), Early - those learners who were mostly active in the first half of the course (3.5%), Deferred - those learners who were mostly active in the second half of the course (5.6%) and Minimal Activity - learners who used LC sparingly throughout the course (44.4%). In a nutshell, only the High Activity learners appeared to be benefitting from their use of LC. (See Section 4 for a more detailed description of how these categories were correlated with performance.)

LC used as a supplement to (not replacement for) live lectures for most students

The message that comes through most frequently from the literature reviewed is that, whenever students were asked how they used the LC, the vast majority stressed that they used LC as a supplement to, not a replacement for, live lectures (e.g., Karnad, 2013; Marchand et al, 2014; Dickson et al, 2012; Saunders & Hutt, 2014; Wiese & Newton, 2013).

LC used selectively by most students

A general finding from the literature reviewed is that most students do not watch entire LC films, but view specific sections of recordings to reinforce their understanding of concepts, confirming what Karnad (2013) found in his review of the earlier literature. For example, around 75% of the 140 students in the Leadbeater et al (2013) study watched specific lectures, with most students reporting that they were using the LC to focus on difficult areas, take notes, or for revision. Bird (2014) notes that students at the University of Leicester reported viewing the LC on the same day when their memory of lecture was still fresh, and then viewing again, often specific segments only, when preparing for an exam. In the study by Danielson et al (2014) amongst veterinary science students at an HEI in the USA, students reported viewing specifically flagged sections of lectures to keep up with fast-moving lectures or to study for exams. Moes & Young (2013) point out that the implication of this selectivity is that students are making very active use of LC, as opposed to passively revisiting entire lectures.

Entire LC recordings viewed by some students

Karnad (2013), in his literature review, found that students with lower academic achievement tend to access recorded lectures more frequently and are more likely to view the lecture in its entirety. This finding was echoed in Turro et al, who noted that 5% of the students at a Spanish university were downloading every lecture and viewing the material for long periods. This group was found to "get less benefit in their marks" (Turro, 2013, p.1) from this approach. Similarly, Leadbeater et al (2013) report that 5% of students viewed whole

recordings, and that these learners appeared to be motivated by surface learning, as they said that they thought the lecture content was sufficient to enable them to perform well in assessment, and that following the lecture recordings was an efficient way for them to learn this.

By contrast, Gorissen et al (2012) found that the majority of students in their study involving over 500 students in two universities in the Netherlands who used LC said they liked to watch entire, or almost entire LC recordings. No data is given in this paper on any correlation between LC viewings and learner performance, but it seems unlikely that such a large proportion of the classes surveyed would have failed their assessments, and therefore this finding seems to stand in contradiction to Leadbeater's hypothesis. It should also be emphasised that, even in cases where a correlation has been found between learners who use LC and lower marks in assessment relative to their peers, this does not imply causation, and we did not come across any evidence to say that these learners were disadvantaged by their extensive use of LC. To the contrary, they may have been helped by it. (For a more detailed discussion of LC and performance, see Section 4.)

LC used for revision purposes

Karnad (2013), in his literature review for the London School of Economics, found that students largely use recorded lectures to catch up on missed lectures and as a revision tool for exams and assessments, and often find recorded lectures to be a useful learning tool. This finding is borne out by other investigations. Johnston et al (2013) found peaks in views around the weeks of summative assessment. In the research carried out by Dickson et al (2012), exam preparation was the highest reported use of LC. The majority of students in this study also asked for improved search features - both within and between lectures - to enable them to navigate efficiently to the desired sections for revision. Elliott & Neal (2015) found that students at Lancaster University made greater use of LC in the days preceding exams, and noted that they were using LC to help them take better lecture notes and understand the more difficult sections of lectures. In Scott & Summerside's (2013) study of LC viewing statistics at Newcastle University, they observed definite peaks in viewing during revision/ exam periods, and 81% of the 707 students who responded said they used LC for revision. Similarly, Wiese & Newton (2013) found that over 80% of their 308 respondents used LC to help with difficult material and to study for exams.

LC used to support note-taking

In the student focus groups that were held at Aberystwyth in the study by Hall (2015), students reported having conflicted feelings about the lecture environment itself. They said it was difficult to concentrate for the full duration of a lecture, and they reported experiencing great anxiety when they were not able to "keep up" with note-taking, for example, when a lecturer delivered the content too fast. Hall concludes that one of the main benefits of LC, therefore, is to offset many of the perceived disadvantages of lectures, by enabling post-lecture review, where students could fill in missing information to their notes, and make sense of unclear notes.

Several of the other studies mention that students reported using LC to help them with note-taking – for example, Karnad (2013), Marchand et al (2014), Hall (2015), Price et al (2015),

Elliott & Neal (2015), Bird (2014) and Scott & Summerside (2013). Wiese & Newton (2013) identify a gender disparity here, with female students being more likely than males to use LC to generate notes with LC. (However, no significant differences were found between females and males in their exam results in this study, implying that additional note-taking is not necessarily correlated with better performance.)

The types of LC recordings that are viewed and not viewed by students

Danielson et al (2014) report that students are more likely to watch LC recordings when the session is a "straight lecture" as opposed to an interactive session, or if the LC was perceived to include information that could not be obtained from anywhere else. Examples given included lecturers moving quickly through the materials in class, making it impossible to take adequate notes in class, and the exclusion of important details from any handouts given out. Finally, LC was more likely to be watched if any annotations made by lecturers on the slides during class were captured on the LC using what the authors refer to as "digital ink" - as opposed to the laser pointer, which was not picked up in the LC captured by the system they were using (Echo360).⁵

Danielson et al (2014) also found that students were *not* likely to watch the LC if it was perceived to be superfluous – for example if lecturer was simply reading from the slides (in which case students prefer to just access the slides), or if the session is not perceived as relevant to the assessment.

LC used for homework

In one case (Prodanov, 2012), the highest reported use of LC was to support homework in an Engineering course. He notes that this was perhaps because homework tasks were given which were closely tied to the lecture.

LC used in preparation for lectures

Several examples appear in the literature of lecturers asking students to access multimedia content before attending class, in an approach to teaching generally referred to as the flipped classroom. For example, Saunders & Hutt (2014) describe how short clips of audio-narrated slides were created for students to view as preparation for lectures, and were made available to students a few days before lectures. They note that viewing numbers were higher for these clips than for the standard LC files, which were made available to students a week after the lecture. The role of LC and related multimedia content in the flipped classroom is further discussed in Sections 4 and 6.

While the flipped classroom examples found in this selection of literature all involved the lecturer producing additional materials for their classes, one case was found, at the University of Oxford in the UK, where the standard, unaltered LC files from the previous year's teaching were being accessed before students attended the corresponding lecture

⁵ It is not clear exactly what is meant by 'digital ink', but it is possible that the authors are referring to the lecturers simply editing the slide during the presentation (which would involve temporarily exiting 'slideshow' mode and going into 'edit' mode).

(Gracey-McMinn, 2015). This was a surprising finding for the research team, who upon further investigation found that the students were watching the LC in preparation for attending the lecture. This spike in LC viewing was not accompanied by any noticeable drop in attendance rates at the live lectures.

Students' response to the videoed image of the lecturer in LC

Two of the reviewed papers reported on how students had responded to the presence (or absence) of the lecturer's image in the LC videos. Moes & Young refer to recent research using eye-tracking analysis of lecture capture environments by Kukkonen (2012), where it is noted that, despite the content being provided primarily through the slides and the lecturer's voice, students still glanced consistently at the video window showing the lecturer. No explanation was offered for this. In the study by Saunders & Hutt (2014), in which students at Manchester University were given different versions of the LC in a range of formats, students said they felt the most efficient way of learning was by watching the narrated slides, without the image of the lecturer. This was because the slides had to be reduced in size in the standard lecture capture, in order to make space for the video of the lecturer. Despite this finding, the majority of students in this study said they would prefer to be given the full lecture capture, including the video of the lecturer, rather than these short, narrated slide clips.

3. What advice is given to students about the use of LC by lecturers, and what is the students' experience of following this advice?

Very limited information was found in the literature to answer this question. Drouin (2013, p.14), notes: "To encourage class attendance, the instructor told both classes that attendance would be taken in class each day, that their participation in groupwork in class would constitute their "class participation" grade (they had to be present on 5 of the 8 random class participation days to receive full credit), and that because of the nature of lectures and exams (i.e. they covered much information that was not in the book), the class would be difficult for students who did not attend regularly".

Along similar lines, Williams et al (2013, p.921-922) discuss the kind of advice they plan to give students as a result of their study: "We... wonder whether the small number of students who may be deliberately using LC as an attendance substitute might not be better advised to enrol in online versions of units... specifically designed to support learning in the absence of lectures. In the short term we intend to report the results of this investigation to our students as strong advice on effective study habits and allow them to make an informed choice about their LC use."

In both these cases, the advice to students focused on the importance of attending live lectures rather than on how to get the best use out of LC. The implication of this gap in the literature is that either lecturers are not providing any advice to students on how best to use LC, or this aspect of the LC experience has not been reported.

4. Has LC been shown to have any impact on student learning? If so, what impact has been described, and how is this impact related to context? For example, disciplines, stages in HE, students who speak English as a second or foreign language, disabilities, others?

Many of the studies reviewed attempted to answer this question and, as in the previous questions, a wide range of answers was provided. As before, we also need to be cautious about making generalisations from these findings, as the research methodology differed from study to study, and all studies were discipline-specific. Bearing this in mind, examples of the findings representing the range of answers to this question are presented below.

Little or no relationship between LC and learning outcomes

There were many examples in the literature of LC use having little or no effect on student performance - measured either in terms of assessment results or self-reported impact on performance. This bears out the findings reported by Karnad (2013) from his earlier literature review.

Brooks et al (2014) in their study in Canada, found that the "Just-in-Time" approach taken by a large proportion of students did not provide a statistically significant benefit to midterm or final exams, or overall assessment. Leadbeater et al (2013), Marchand et al (2014) Prodanov (2012) found no significant difference in performance between users and non-users of LC. Saunders & Hutt (2014) found no discernible improvement in the grades of students who used LC.

Negative relationship between LC and learning outcomes

Three examples were found in the literature of the provision of LC apparently having a negative impact on a minority of students. The main finding from Williams, Birch & Hancock is that the students who use LC as a substitute for attendance at lectures are at a severe disadvantage in terms of their final marks; moreover, those students who attend very few live lectures do not close the gap by watching more LC online. These findings were echoed by Johnston et al (2013), who found that the nursing students who had access to the recorded lectures demonstrated significantly poorer overall academic performance (with overall fail rates being 28%, compared to 9% the previous year). The combination of drops in live lecture attendance and the fact that there were high peaks in LC viewing just before summative assessment events led the authors to conclude that many of these failing students were using LC as a replacement for lecture attendance, and were trying to consolidate a large amount of knowledge in a very short time frame by "cramming" from the LC recordings. They conclude that, while LC could support effective revision by students who are already engaged, it can actually disadvantage students who use it as a replacement for ongoing engagement with course content through attending lectures. Similarly, Drouin (2013, p.11) says: "The class with lecture recordings available had significantly lower attendance rates and course achievement (final grades), and attendance mediated the relationship between class section and achievement. Further analyses showed that the negative effects of offering lecture recordings were not global; instead, lecture recording availability appeared to increase nonparticipation (in exams, class activities, and

assignments) in a select group of students. When these non-participants were excluded from analyses, significant differences between class sections disappeared.”

On a separate but related note, Fei et al (2014) give evidence from one lecturer who said that using LC had had a negative impact on participation in class discussion, in that students became more reticent about speaking up in discussions when the class was being recorded.

LC linked to a general improvement in performance

In a small number of cases, an improvement in student performance was reported that appeared to be linked to LC, without any associated conditions. Wiese & Newton (2013), in their Canadian study, found that students who were given access to LC videos increased their final exam grade by approximately 5%. Price et al, in their report from the University of Southampton, found that, according to some lecturers, students asked “better questions” in class (Price et al, 2015, p.224) after watching lecture capture.

Positive relationship between LC and learning outcomes in certain kinds of courses/lectures

Several examples were given of the positive relationship between LC and learning outcomes in certain kinds of courses. Danielson et al (2014), in their USA-based study, find that students see greatest value for LC in courses that move quickly, rely heavily on lectures, and for which the information provided via lectures is not available from any other sources, as well as courses which are perceived to be vital for their future success. Danielson (2014) also found that lecture capture benefits students' learning in courses in a “basic science” teaching context with a focus on research, but LC views did not significantly alter students' test scores in parts of the course that focused on “applied teaching”. (As the context of this paper was veterinary medicine, “applied teaching” is interpreted as referring to hands-on practical sessions.) According to Fei et al (2014) the use of LC in an Australian university was seen by staff and students to be appropriate for traditional lectures, but not to seminars and open discussions which involved more interaction and participation by students. Similarly, Horvath et al's (2013) study into the use of LC in several dental schools in North America reports that just under half of the responding dental schools had recordings for all or most of their “didactic” courses only.

Positive effect when LC is designed for interactivity

A small number of studies commented on the gains that could be made by creating additional, interactive material on the VLE to accompany the LC materials. Ferriday's (2015) study at Cardiff University's School of Healthcare Sciences found that more students used the LC and commented positively on it when it was broken into chunks of less than 20 minutes, interspersed with interactive content (MCQs, drag-and-drop exercises, and a discussion forum or Padlet notice board where students could post questions and comments, and answer peers' questions). Moes & Young (2013) discuss two case studies from the OASE project at universities in the Netherlands, which showed that “Knowledge and instruction clips” (short videos made by the lecturer), which were “enriched with quizzes, web tasks, etc.” (Moes & Young, 2013, p.4) were linked to an improvement in first year exam pass rates – in one case by as much as 15%. Pale et al (2014), in a small study at the

University of Zagreb in Croatia in which 23 students were given two contrasting LCs, found a small but statistically insignificant increase in test scores when students used "rich" LC content for one lecture, in comparison with "traditional" LC for another lecture.

Germany (2014) suggests, based on data from a survey with academics at an Australian university, that providing interactive content for students can help staff to be more reflective about their teaching, by noting the detailed usage patterns and responding to student comments and discussions.

LC perceived as helpful for non-native English speakers and students with learning difficulties

In several of the studies in this review, students who were non-native speakers of English emphasised the value of LC to them (e.g. Saunders & Hutt, 2014), and this sentiment was echoed by learners with dyslexia or other learning disabilities (e.g. Bird, 2014; Leadbeater, 2012; Scott & Summerside, 2013; Elliott & Neal, 2015; Revell, 2014).

Positive effect for students in courses taught by lecturers who speak English as a second or foreign language

The corollary to the above point is that LC was reported to be helpful to students in cases where teaching staff who spoke English as a second or foreign language had accents that the students struggled to understand (Scott & Summerside, 2013).

Positive effect for students with certain kinds of learning approaches

Brooks et al (2014) found that students categorised as "High Activity" in their model (described in Section 1) outperformed their peers by up to 16.45%, while students in other clusters obtained more or less the same grades as each other. Williams, Birch & Hancock (2012) gathered data from 371 students in a first-year Microeconomics course at an Australian university via analytics and a survey, and concluded that there was a positive effect only for those students who use LC as a supplement to regular lecture attendance. They developed an algorithm from their data that showed that, although students who attended fewer lectures tended to watch more LC than students who had attended all or most of the lectures, a greater increase in final exam marks could be predicted per LC recording viewed by a student with high attendance records, than per LC recording viewed by a student with minimal attendance.

In contrast, the study at a Spanish university by Turró et al (2014) showed that the students who benefited most from LC were those with marks in the mid-range. They identified an increment up to a 9% in students' marks related to watching LCs; however, their analysis showed that mark increases were greater amongst students in the mid-range rather than amongst the highest- or lowest-performing students. The authors hypothesise that this is "probably because high level students already know the topic enough and low level students are too far [behind] on their knowledge to be helped by only having the recordings available" (Turró et al, 2014, p.4). Revell (2014) also reports that extensive use of lecture replay did not correlate with high grades, since most heavy users of LC were in the B-C bands. However,

he points out that many of these were students who speak English as a second or foreign language, who might otherwise have obtained lower grades or not completed the course.

It should be emphasised that, while the relationship between LC and performance appeared to be correlated in several of the above-mentioned studies, it was not demonstrated to be causal. In keeping with this observation, Wiese & Newton (2013) discuss the differences in behaviour between the learners in their investigation who had a "deep learning" approach, and those with a "surface learning" approach. They found that a deep learning approach was "associated with more video views, better performance, and a greater tendency to watch videos to master and review material... Moreover, a higher deep approach score was related to fewer absences [from the live lectures], while a higher surface approach score was related to more absences and increased the likelihood of a student missing a class" (Wiese & Newton, 2013, p.1). (For more discussion on LC and attendance, see Section 5.)

Positive effect for students on placements

In one study in the USA, it was found that "Students participating in a lecture-capture-style online section of an outpatient clerkship demonstrated equal learning to students in a live lecture group, and did so in significantly less time" (Danielson et al, 2014, p.130).

LC perceived as enhancing the student experience

Scott & Summerside (2013, p.12) quote from a student who says, "Without a doubt [LC was] the best resource made available to me in my time at university, I was lucky in my exam timetable that I could dedicate the May bank holiday to stats weekend, over which I worked through my lecture notes by reattending all of my lectures on ReCap, this provided an excellent structure to my revision and the ability to watch consecutive lectures was fantastic, a lot of people moan about top up fees but if they are going to [provide] facilities like this then I say they are worth every penny. I only hope that many more of my modules next year take on the scheme as I can definitely say that this has aided my exam results no end".

Hall (2015) notes that students at Aberystwyth said they did extra reading as a consequence of watching LC, and they felt they had a greater sense of control over their learning; LC also enabled these students to study independently in a comfortable and mobile environment, and they felt it enabled them to catch up effectively after illness or unforeseen family problems. He suggests that it is therefore possible that LC facilitates retention and could play a role in widening participation.

5. What impact, if any, does LC have on attendance at lectures?

This question is often asked by academics, and was also asked by most of the researchers in the literature reviewed. The possibility that the provision of LC will reduce attendance at lectures is of great concern to many lecturers. As with the previous questions, the answers cover a wide spectrum. There were inherent methodological difficulties for researchers in attempting to answer this question, in that the researchers had to rely on self-reported data from students because of the difficulty of tracking physical attendance at lectures, especially in very large classes - and so the resulting data does not necessarily provide an accurate

picture of actual patterns of presence/ absence. Furthermore, as noted previously, the students who responded to surveys may have been those who were more enthusiastic about LC than their peers. For both of these reasons, it is therefore possible that these statements provide a falsely positive picture. Bearing this in mind, examples from the literature are given below.

Little or no impact

In their literature reviews, both Karnad (2013) and Mahal (2012) found that students generally prefer blended teaching methods which incorporate both lecture recordings and live lectures, and that the majority of students do not view recorded lectures as a replacement for attending live lectures. This finding was borne out by several studies in the current review. Examples falling into this category are: Moes & Young (2013), with reference to a study conducted at University College London; Saunders & Hutt (2014), reporting from the University of Manchester; Hall (2015), discussing findings from Aberystwyth University; and Stickel et al (2013) who looked at the use of LC in a higher education institution in Germany.

Some authors gave quantitative data to back up their claim of LC having little or no impact on attendance. Price et al (2015) noted that 79% of student respondents at Southampton Solent University said the provision of LC would not encourage them to skip class. Similarly, Williams, Pfeifer & Waller found that about four-fifths of their respondents indicated that they tried to attend all lectures and used LC only to make up for missed lectures or for revision, while the remaining one-fifth noted that they used LC in place of lectures. Wiese & Newton found that 84% of students in their study in a Canadian university reported no reduction in attendance, with only 5% of students indicating that they had reduced their attendance by 25% or more. Scott & Summerside (2013) report that, at the University of Newcastle, 90% of students said that LC did not affect their attendance at lectures.

According to Marchand et al (2014), in their Canadian study, most of the 239 students who responded to the survey stressed that they were using LC as a supplement to live lecture attendance, not a replacement for it. 10% of the pharmacy education students who filled in the survey said they sometimes used LC as a substitute for attending classes, but even these students said they only skipped one class per week.

In the study by Saunders & Hutt (2014), 10% of the 84 students who responded to the survey of Manchester University's MSc in the Management of Projects said they used LC as a replacement for attending classes.

Prodanov (2012) found that very few of the responding students in his USA-based study had missed more than three lectures; he speculates that this might be explained by the fact that class sizes were relatively small, and refers to earlier literature (not related to LC) by Friedman et al (2001), in which student absences were found to occur more often in large classes, where there was a perception that their absence would go unnoticed.

Lower attendance

In several studies, lower attendance at live lectures was found to be a direct result of implementing LC. For example Leadbeater et al (2013) note that in the second year of their study, there was a marked decline in attendance at lectures (from 84% to 71%), and more students said they used LC to help them catch up on missed lectures. Drouin's (2013) analysis of the attendance record found that it was lower for the LC group than for the control group - at its lowest point dipping to 58%, while the lowest attendance recorded in the control group (and in the previous cohort) was 73%. Johnston et al (2013) report the most dramatic drop in attendance (53% of total enrolment, as opposed to the usual 80-85%) as some students used LC in place of attending lectures.

Wiese & Newton (2013) draw the conclusion from their data that identifying the students' approach to learning (whether deep or surface) can help to predict attendance. Learners in this Canadian study who were identified as "surface learners" tended to report missing more lectures and using LC as a replacement for lectures, while learners identified as "deep learners" tended to use LC as supplementary resources for mastery and revision.

There is also some discussion in the lecture about the nature of lectures (as opposed to the nature of LC) and the extent to which students might be motivated, or not, to watch or rewatch a film of what is already perceived by many to be a passive event for learners (e.g. Pale et al, 2014; Saunders & Hutt, 2014; Karnad, 2012; Moes & Young, 2013). Representing one extreme on the continuum, the following advice given by UCL, in the EU's REC:all project, is: "If for example a lecture is little more than the repeating of notes from a PowerPoint presentation it is probable that some students will choose to spend their time more efficiently" (Moes & Young, 2013, p.2). In contrast, Gorissen et al (2012) note that respondents in their study involving over 500 students in the Netherlands did not mention the quality of the actual lectures, even prompted to do so, and therefore this factor did not seem to have any bearing on whether they chose to watch LC or not. It appeared that practical considerations, such as whether they had already attended the live lecture or not, and lack of time, were far more important to students in this study.

Increased attendance

This surprise finding comes from the study conducted at Southampton Solent University: in a focus group with lecturers, it was suggested that LC had increased attendance at lectures "because you get students more confident to come back here if they miss a session" (Price et al, 2015, p.223).

6. Are there examples of lecturers changing the way they teach as a result of LC? If so, have these changes been found to have any influence on student learning?

More interactive, student-centred teaching

A small number of examples were found in the literature reviewed of lecturers changing their teaching style as a result of the introduction of LC. These generally revolved around the concept of the so-called flipped classroom (teachers providing lecture content for students to

read or view before coming to class, and changing their teaching style towards more active, learner-centred learning in the classroom).⁶ Examples from the literature in this review are given below.

Horvath et al (2013), in their study of LC usage in 25 dental schools in North America, note that respondents from 36 percent of the 25 institutions surveyed stated that it was good practice to use lecture recordings outside the classroom and to use class time for student-centered learning and activities that developed higher order thinking skills. To achieve this, some lecturers assigned students to view LC prior to class. Other changes made by lecturers included: providing supplementary materials, better integration of cases and problem-based learning into their teaching, incorporating more video, avoiding statements in lectures that could not be supported, keeping their materials up-to-date.

In the study by Marchand et al (2014) on LC in a pharmaceutical science programme in Canada, just over a third of the faculty members said they had started to use the LC technology to pre-record content which they incorporated into their teaching. Similarly, some staff in the Newcastle study were exploring the possibility of creating recordings on their desktop computers using the institutional LC software, to be used as a reflective tool to facilitate group work in class (Scott & Summerside, 2013).

In the report by Moes & Young (2013) on findings from the EU project, REC:all, a lecturer at UCL invited students to add questions based on "knowledge clips" (short information films made by the lecturer) into a list system in the VLE. Other students could vote on these questions and add more. Questions with the highest number of votes were designated "hot questions", and were answered first by the teacher. Reportedly, this encouraged a high level of group interaction.

Giannakos and Chrisochoides (2014), in their small experiment with 11 students in Norway, report that students were given video lectures on YouTube to watch outside of class, along with some online questions to assess their understanding of the material in the video. Then in class, they were given another online quiz to test their recollection of that material (to motivate students to watch the video before class), and finally students had to create a presentation based on this material. The students' scores in the first week were the lowest, but they improved over time. Overall it was felt that the active learning enabled by LC led students to better learning,

Giannakos and Chrisochoides (2014, p.2) sum up their flipped classroom approach with this diagram:

⁶ There is a wealth of literature available on this topic which was not picked up by the search terms for this report and would make a good topic for a follow-up study.

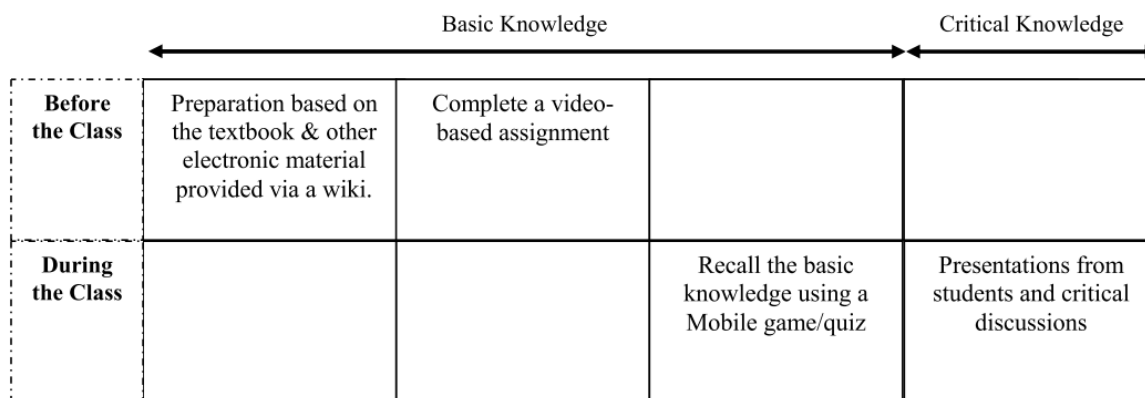


Figure 1. The proposed flipped classroom framework

Technical challenges for staff who want to innovate

In some cases, it was reported that staff want to innovate but are frustrated by the limitations of the LC system they are using. For example, Germany (2014) notes that many staff in her investigation in an Australian university were looking to move beyond simple lecture capture and innovate in their use of technologies for learning and teaching. In particular, lecturers were looking for a system that was flexible in terms of place and time, one which would allow them to control the recording as it takes place (e.g. muting the recording for parts of a lecture), and one which would enable them to make sections of LCs available as supplementary materials or to create short lecture summaries. It also emerged from this study that some staff had paid for software out of their own pockets to enable them to do some of the things that the institutional LC software could not do.

7. What opportunities are there for innovating in teaching by using LC?

The greatest opportunity for innovating in teaching through effective use of LC is probably that of flipping the classroom, as described in Section 6. A few other opportunities were noted in the literature, and these are outlined below.

LC can help lecturers reflect on their teaching, identify potential problems and intervene

Some authors gave examples of how LC can be used to make lecturers more reflective and proactive in their teaching. Prodanov (2012), for example, suggests that students' usage statistics of LC can indicate to lecturers where students are struggling with the content, thereby providing useful data to enable lecturers to improve their teaching materials and delivery. Scott & Summerside (2013) note that, in many cases, staff at the University of Newcastle are reviewing their teaching, "looking at what and how they deliver in lectures in order to make use of the opportunities afforded by the [LC] system" (Scott & Summerside, 2013). Brooks et al (2014), with reference to data from second-year Chemistry and Biomolecular Sciences courses in a Canadian university, suggest that, by observing patterns of LC-watching activity amongst students throughout the term, it may be possible to predict which students are at risk of failing mid-term exams. A detailed example is given in their

paper (Brooks et al, 2014, Table 12, p.289-290) to show how a cohort can be analysed into the clusters "High Activity", "Deferred", "Minimal Activity", "Early" or "Just in Time". According to this model, all learners who do not fall into the "High Activity" cluster are at some risk and could benefit from being prompted to use LC. They postulate that it would be reasonable to set up alerts on the VLE from Week 8 onwards, whereby students would receive advice about "recommended behavioural changes" (Brooks et al, 2014, p.289).

Student-generated learning content

The concept of student-generated learning content was mentioned by Moes & Young (2013), who found in their study that students themselves began using institutional systems in the creation of video clips, both as learning resources and as assessment materials. They conclude that LC is "emerging as a core technology for generating media-rich educational resources for blended and virtual campuses" (Moes & Young, 2013, p.2).

Lecturers creating supplementary material to support the LC

A few of the authors in the selected literature proposed that LC would be enhanced by the provision of additional, "rich" or "enriched" materials to support the LC. Moes & Young (2013) discuss the experience in the European REC:all project of lecturers producing "enriched knowledge clips" - i.e. short films in which knowledge is given, usually in video format, with additional information such as graphics, text and images; these clips are "enriched" with interactive content such as quizzes, polls or discussions. (As mentioned in Section 4, the provision of these "enriched knowledge clips" was found to have a significantly positive impact on student attainment in this study.)

In the pilot study at the University of Zagreb reported by Pale et al (2014), a lecturer created "rich" content for one LC, which involved a set of links to additional readings, some supplementary teaching notes for the lesson, and a MCQ self-assessment quiz for each slide of the presentation. (As noted in Section 4, their results were inconclusive in terms of impact on learning outcomes.)

In the LC investigation carried out at the University of Manchester, for the purposes of the pilot, "each core concept was made available in four different formats; an audio-only podcast, as audio-narrated PowerPoint slides, as a short video segment and as a video recording of the full lectures in which these core concepts were taught" (Saunders & Hutt, 2014, p.6). The first three of these formats were created in advance of the lecture, and uploaded for students to view a few days before the lecture. (As noted in Section 2, the format that proved most "efficient" for student learning was the short, audio-narrated PowerPoint file, whereas the format most desired by students was the complete LC file, including the videoed image of the lecturer.)

Use of webinars

Moes & Young (2013) mention that Webinars were used for further exploration of issues discussed in lectures and captured with LC in their study. The context was a teacher training programme, and the purpose of the Webinars was to give feedback to students on their lesson plans.

8. Anything else?

A number of other issues were discussed in the articles reviewed that went beyond the scope of the questions being focused on in this study. A few of these issues have been selected for brief discussion below, with the intention of offering further fuel for thought by anyone who is making decisions about LC adoption and implementation in a higher education context.

Potential role of LC in institutional marketing and student enrolment decisions

Moes & Young (2013), in their EU project involving 15 pilot studies in the UK and the Netherlands, concluded that institutions are beginning to build extensive libraries of recorded material. They note that these recordings are being reused for marketing purposes, that they are raising institutional profiles, and that they are providing a route to more flexible provision of higher education, including distance and blended modes of learning. Thus LC can potentially be seen as playing a central role in the university's reputation-building strategy, in its recruitment of students, and also, as suggested by Hall (2015), in widening participation.

Providing anecdotal evidence of how LC can affect student enrolment, the study by Prodanov (2012) amongst junior level engineering students in an American university found that, when students had a choice of classes to attend on exactly the same topic, they chose to enrol in the class with LC option over others because of the provision of LC. This implies that if LC is mentioned as being an integral part of the learning and teaching approach in marketing brochures or on programme websites, it may influence students' choice of programme - or even institution to study at. The evidence from Scott & Summerside (2013) and Hall (2015) about LC enhancing the student experience (see Section 4) seems to strengthen this view.

Growth in mobile access to LC

Questions of technology and format have not been a major focus of this paper; however the finding from Stickel et al (2013) from their study in Germany bears reiterating here: students' use of LC increased significantly when LC files were made available in a format that could easily be downloaded onto small mobile devices (MP4); therefore mobile devices may be seen as a driver for growth in this area. Ferriday's (2014) study is also relevant here - she found a significant increase in viewing statistics when MP4 files were broken into shorter chunks and interspersed with interactive content.

Potential role of LC in work placements

Another finding that might be relevant to many departments in higher education institutions is related to the potential role of LC for students in work placements. Danielson et al (2014) reported that students on a clerkship work placement in the USA demonstrated equal learning to students in a live lecture group, and in significantly less time. (see Section 4.)

Importance of staff support

Many of the papers in this review included mention of obstacles that were preventing staff from implementing LC - these primarily revolved around the lack of clarity for academics regarding the copyright status of third-party materials shown in lectures when LC is used (for example, Fei et al, 2014; Scott & Summerside, 2013). Williams, Pfeifer & Waller (2013) noted that some lecturers are deliberately downgrading their teaching materials (for example by removing images from their slides), in order to avoid inadvertent copyright breaches.

There was also some mention of technology frustrations experienced by some lecturers who wanted to innovate in their use of LC. In the Australian study by Germany (2014), three key requirements for a university-wide "web-based lecture technologies" system were identified: flexibility in where and when recordings can be made, flexibility in control over those recordings, and the ability for lecturers to interact with the recordings and incorporate them as an integral part of their courses. These findings indicate that teaching staff may need to be given technical support in their attempts to innovate in their use of LC.

Moes & Young (2013) note that, as academics in the 15 case studies on LC gained confidence in using the technology, they rapidly began to ask, "What can I do next?" The authors conclude that "this academic engagement is an important step in innovation in learning design and with so many of our participants taking this step quite naturally, we believe lecture capture has a genuine capacity for transformation at the individual and institutional level" (Moes & Young, 2013, p.8).

Conclusions

It is important to reiterate that this was not an exhaustive study of every recent publication on the use of LC. Furthermore, as noted in the previous sections, many of the findings are difficult to compare across the different studies because of the particularities of the research questions asked and methods used. Percentages of students who used LC, benefitted from it in some way, or who attended/ did not attend live lectures need to be read with caution, bearing mind that the data was often either self-reported or based on a relatively small sample of a cohort. The majority of the studies in the papers reviewed were conducted within computer science, engineering, medical sciences and related subjects, and findings may not transfer to other subjects. In several cases, correlations were found between assessment results and LC viewing patterns of students, but correlation should not be confused with causation, and it is likely that there were many other factors at play in determining learners' results.

Despite all these limitations, we can still draw some conclusions from the reviewed literature to help in making decisions about how to proceed with LC in the context of a higher education institution. In this section I start by offering some responses from the literature to the reasons that have been given by some academics as to why they choose not to use LC⁷, and then recap on some additional key points from the reviewed literature to be borne in

⁷ These reasons are quoted directly from a LC Research Study carried out by Janette Matthews at Loughborough University in 2012.

mind by anyone making decisions about whether or how to implement LC in a higher education setting.

Responses from the literature to some commonly stated reasons why academics may not wish to use LC

a. I am reticent about appearing on camera

Although students like seeing the lecturer in the video frame, there is evidence to show that this is not necessary for effective use of LC by students. In fact, one study (Saunders & Hutt, 2014) found that the learning was more "efficient" when LC was formatted to include slides and audio only.

b. Lecture capture may lead to lower attendance

There is evidence from multiple sources that attendance may drop when LC is made available. However, in most cases this drop is minimal, and the vast majority of students, when interviewed, say that they see LC as a supplement to, not a replacement for attendance at class. There is plenty of statistical data from the papers reviewed to confirm that this is, indeed, how the majority of learners use LC.

There is also evidence from the literature to show that a small minority of students is likely to reduce their attendance significantly and rely on LC to help them pass assessments. We can also predict that many of these students will be "surface learners" - as opposed to "deep learners" (Wiese & Newton, 2013) - and that they will not watch LCs regularly throughout the term but will attempt to "cram" from the LCs in a "just-in-time" fashion, before an assessment event. This small percentage of learners represents the ones who are most at risk of being negatively affected by the mere provision of LC. Steps can be taken to militate against this risk, such as for example giving students a small number of assessment tasks for marks, to be carried out individually or in groups during lectures on certain, randomly selected days, as described in the paper by Drouin (2013). Additionally, these at-risk students can be identified through a combination of tracking views on the LC system and tracking attendance in class, and automated alerts could be sent to them with advice on recommended behavioural changes (see for example Drouin et al, 2013 and Williams et al, 2013), or information about support mechanisms available.

c. Students may be inhibited in their questioning and interaction

There is evidence from the literature to show that, in some cases, student participation in class discussions was inhibited by the introduction of LC. One solution would be to have a system whereby the lecturer can control when the LC recording starts and stops, and make it clear to the class when the recording is on or off. Lecturers should also be trained in how to edit their LC files, in case something is said in class that needs to be edited out after the session.

d. Students may publish my lectures elsewhere

Neither the possibility of this, nor examples of it actually occurring were mentioned anywhere in the reviewed literature.

e. Recording lectures is "spoonfeeding" students who should be taking notes independently

There is some debate in the literature about the role that LC plays in helping or hindering students in their note-taking. For the vast majority of students who responded to survey or interview questions, the perception is that LC helps them enormously in note-taking, and allows them to focus more effectively on what the lecturer is saying during live lectures. There appears to be a gender disparity between students who use LC to help them enhance their notes (predominantly females) and those who don't (mainly males) - and yet no identified difference in assessment results between males and females, implying that giving students the opportunity to take notes from LC does not have any bearing on learning outcomes (Wiese & Newton, 2013). The more important question, perhaps, is whether students who take notes effectively in class perform better in assessment than those who rely on LC to help them take notes; this question did not arise in the reviewed literature, and is an area where further research may be needed.

Where the ability to take notes based on LC seemed to be particularly relevant in many of the studies referred to here was in the case of students who speak English as a second or foreign language who were getting to grips with the language, and also students with learning disabilities such as dyslexia (Saunders & Hutt, 2014; Bird, 2014; Leadbeater, 2012; Scott & Summerside, 2013; Elliott & Neal, 2015; Revell, 2014). While this data is mainly self-reported, it does seem that students who fall into these two categories are reassured by the provision of LC and use it extensively to review lectures and extend their notes. It is possible that some of these students would either fail or drop out without the support provided by LC.

f. There is sensitive content in my lectures

See c) above.

g. There is confidential content in my lectures

See c) above.

h. I express opinions in my lectures which should not be recorded

See c) above.

i. I make use of copyright content in my lectures

Clearly this is a concern shared by many lecturers in different institutions around the world. The lack of clarity about what may or may not be shown in lectures when LC is being used is a common reason given by lecturers for choosing not to use LC - and some lecturers have deliberately "downgraded" their lecture content (e.g. by removing images from slides) to avoid any potential problems (Williams, Pfeifer & Waller, 2013). Staff need to be given clear guidelines and support in this regard.

- j. *Recordings of my lectures should look professional and I do not have time to edit them*

This issue came up in only one article in the current review - and the finding was that students did not comment on the quality of LC recordings, even when prompted to do so (Gorissen et al, 2012). The authors concluded that quality of recordings was not a factor in determining whether students viewed the LC or not - other factors, such as whether students had attended the lecture or not, and time constraints, had a greater bearing.

- k. *I am concerned that confidential conversations with students may be recorded without me realising*

This issue was not discussed in the literature, but presumably if the lecturer had access to editing facilities and knew how to use them, the potential impact could be minimised if this problem occurred.

Additional points arising from the literature pertaining to the management of LC implementation

The above points all relate to lecturers' concerns about the use of LC. In addition, several points arose in the literature that might be useful for people managing the introduction and implementation of LC initiatives in different Schools to bear in mind. The key points here are:

- There are many opportunities for lecturers to innovate in their teaching through thoughtful use of LC, especially in relation to "flipping" the classroom. This may require additional work on the part of the lecturer, and line managers need to consider the implications for workload. In cases where it is possible for lecturers to make old LCs from the previous year available to students, the classroom can be flipped with minimal additional work on the lecturer's part.
- Where lecturers have concerns about the use of LC, for example regarding copyright regulations or technological issues, prompt and clear guidance should be made available.
- There is also evidence from the literature that, in Schools or Departments where one person has tried LC, other colleagues have become willing to try it. Early adopters could be encouraged to be "LC champions", and offered support to ensure that they continue to use LC effectively and provide a good model for colleagues.
- Maintaining an opt-in policy for LC is one way of ensuring that only those lecturers who feel comfortable to try LC do so. It is likely that LC is not appropriate for all subjects (the range of disciplines covered by this literature review is rather limited), and also, that LC is not suitable for certain lecture types, for example those which are based on learner participation.

In conclusion, there is overwhelming evidence from the recent literature, that LC is not only desired by great numbers of learners in higher education, but that it has enhanced the learning experience for many learners, in some cases leading to significant improvements in learning outcomes. LC may *not* be appropriate in certain cases, for example in courses which rely on participation by students in lectures, or in cases where confidential or sensitive

information is discussed. We can also predict from the literature that a relatively small minority of learners are likely to be disadvantaged by making the choice to use LC as a replacement for attendance at live lectures, and then waiting until the last minute to view the LCs, or neglecting to view them at all. Mechanisms will need to be found to identify and support these learners. It is unclear from the range of literature reviewed whether the findings apply across all disciplines, or the extent to which the learner's stage in the degree journey affects the impact of LC.

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