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Nordmann, E., K uepper-Tetzl, C.E., Robson, L. orcid.org/0000-0003-2984-6520 et al. (3 more authors) (2020) *Lecture capture: Practical recommendations for students and instructors*. *Scholarship of Teaching and Learning in Psychology*. ISSN 2332-2101

<https://doi.org/10.1037/stl0000190>

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Lecture capture: Practical recommendations for students and instructors

Emily Nordmann¹, Carolina E. Kuepper-Tetzel¹, Louise Robson², Stuart Phillipson³, Gabi I.
Lipan⁴ and Peter McGeorge⁵

¹School of Psychology, University of Glasgow, 62 Hillhead Street, Glasgow, G12 8QB

²Department of Biomedical Science, University of Sheffield, Western Bank, Sheffield S10
2TN

³IT Services, University of Manchester, Oxford Road, Manchester, M13 9PL

⁴School of Psychology, University of Aberdeen, Aberdeen, AB24 3FX

⁵School of Education, University of Aberdeen, Aberdeen, AB24 3FX

Corresponding author:

Emily Nordmann

emily.nordmann@glasgow.ac.uk

Carolina.Kuepper-Tetzel@glasgow.ac.uk

l.robson@sheffield.ac.uk

Stuart.Phillipson@manchester.ac.uk

g.lipan@abdn.ac.uk

mcgeorge@abdn.ac.uk

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Abstract

In this paper, we provide practical recommendations to help promote self-regulated strategies for the use of lecture capture for both students and instructors. For students, we suggest that the importance of attendance and effective note-taking should be reinforced, as well as specifying how lecture capture can best be used as a catch-up or revision aid. For instructors, we highlight the need to provide guidance for students on how to learn and to adopt a context-dependent approach to lecture capture based on pedagogical considerations, rather than all-or-nothing. Regarding the issue of the relationship between lecture capture and attendance, we suggest the focus should move to a more nuanced discussion of why students fail to attend lectures and how they are using lecture capture. Finally, we discuss other concerns commonly raised by instructors related to lecture capture. Our student guidance is available for dissemination in infographic form at <https://osf.io/esd2q/files/>.

1. Introduction

Lecture capture typically refers to the recording of live lectures. The information captured can vary from an audio recording of the instructor speaking, to audio plus presentation slides, to a full video of the instructor plus slides, projectors, and/or the use of chalkboards. Lecture capture technology can be used for pedagogically progressive purposes such as flipped classrooms and additional learning and support resources, however, its primary application is the recording of traditional, live didactic lectures and it is this usage that is the focus of this paper. This is not to endorse didactic lectures as an effective teaching method, indeed, there is much research and discussion that suggests straight lecturing is less effective than active modes of teaching (see e.g., Cerbin, 2018; Freeman et al., 2014). However, traditional lectures are ubiquitous in higher education and the introduction of lecture capture technology may indeed be solidifying their position. The 2018 Survey of Technology Enhanced Learning for higher education in the UK (Walker et al., 2018) cites lecture capture as a core service that higher education institutions (HEIs) should be expected to provide and 75% of responding HEIs indicated that lecture capture was a centrally-supported software tool used by their students, yet guidance on how to maximise its pedagogical effectiveness does not seem to have caught up with demand. There is of course substantial variance in what constitutes lecture capture provision both between and within-institutions, however, lecture capture policies are now commonplace, with only 22% of HEIs reporting that they did not have a policy (Newland, 2017). Whilst the majority (54%) of HEIs currently have an opt-in policy, there is a slow but steady move towards implementing policies that require the recording of all standard lectures as default (the “opt-out” approach, see Nordmann & McGeorge, 2018, for an overview of lecture capture policy in the UK).

Yet, lecture capture remains a controversial issue with faculty frequently expressing both pedagogic and ethical concerns (Morris et al., 2019; Newland, 2017). We believe that a large part of the driving force behind the controversy may stem from a lack of concrete

1 guidance for how to maximise the pedagogic value of recordings. For example, in an early
2 review of the literature, Witthaus and Robinson (2015) state that empirical studies rarely
3 indicated that much advice was given to students on how to use lecture capture. There are
4 excellent examples of guidance available at the local level (see e.g., “7 ways to get the most
5 out of lecture capture: A guide for students”), but it is notable that the existence or use of
6 such guidance does not always permeate to the instructor level, perhaps because the format
7 of the guidance generally targets students, or perhaps because it has not been accompanied
8 by a robust evidence base. We are not alone in thinking that there is a need for more
9 guidance, but rather join recent calls for support for both students and instructors (French &
10 Kennedy, 2017; MacKay, 2019) in recognition that neither should be expected to instinctively
11 understand how best to use lecture capture without explicit guidance.

12 Research on the impact of lecture capture has lagged behind the adoption of lecture
13 capture and there is more work to be done. However, this should not preclude us from
14 applying the wealth of cognitive and educational research on learning and teaching more
15 generally to help support the use of lecture capture whilst this work evolves. Thus, the aim of
16 the current paper is to provide guidance to students and instructors on how effective
17 learning and teaching strategies can support the use of lecture recordings in higher
18 education. Our paper is predominantly aimed at higher education practitioners, namely
19 those involved in the provision of lecture recordings - instructors, learning technologists, and
20 policy makers. However, to aid dissemination of our guidelines to students, we also provide
21 infographic institution-agnostic guides in English, German, Welsh, and Dutch, that can be
22 shared with students where lecture capture is used (see <https://osf.io/esd2q/files/>). Whilst
23 we will discuss relevant research, for a comprehensive overview of the lecture capture
24 literature or policies we direct the interested reader to existing reviews (e.g., O’Callaghan et
25 al., 2017, Nordmann & McGeorge, 2018). Additionally, the focus of the advice provided in
26 this paper will be limited to the recording of traditional, didactic lectures where attendance
27 at the live lecture is expected and lecture capture is provided as a supplement. Finally,
28 lecture capture is often touted as the solution to cuts in disability provisions and there is a

1 need for a critical discussion on this topic. For example, without captions, recordings do little
2 to help the needs of deaf or hard-of-hearing students (see Kent et al.(2018) for a convincing
3 argument that all recorded lectures should be captioned), however, for the purposes of this
4 paper, we will focus on lecture capture as a general educational provision for all students.

5 **2. Lecture capture and self-regulation**

6
7 Effective self-regulation, in which an individual sets their own learning goals and
8 then attempts to actively monitor, control, and regulate their cognition, motivation and
9 behaviours in order to achieve those goals (Pintrich & Zusho, 2007), has been shown to be a
10 reliable predictor of better academic achievement both in traditional (Dent & Koenka, 2016;
11 Richardson et al., 2012) and online educational settings (Broadbent & Poon, 2015) . In a
12 systematic review and meta-analysis, Richardson et al. (2012) reported that goal setting,
13 effort regulation, and academic self-efficacy were the strongest correlates of GPA and they
14 suggest the introduction of interventions that target these three key areas. Additionally, Chen
15 et al. (2000) and Lent and Brown (2006) suggest that these three areas are more malleable
16 during early skill development to argue that such interventions should occur early in the
17 university process. Hockings et al. (2018) conducted a large qualitative study of students'
18 understandings, approaches and experiences of independent learning. They found that first
19 year students in particular used their experience of homework in high school to frame their
20 conception of independent learning and this led to many feeling overwhelmed, uncertain as
21 how to best spend their time, and lacking the self-motivation to study independently when
22 they would not "get in trouble" for failing to do so. Given that lecture capture is likely to be a
23 new technology, first-year university students do not even have the luxury of relying upon a
24 poor model of how they should use lecture recordings to help inform them of how best to
25 study and this is highlighted by Nightingale et al. (2019) who find that despite the increasing
26 adoption of the technology, surface approaches to lecture recordings are still common, thus
27 the need for additional guidance.

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Self-regulation is also seen as critical for success in environments in which the learner may have lower levels of support and guidance (Kizilcec et al., 2017). These are characteristics that are often true of the higher education environment with its increased emphasis on autonomous study, compared to the more structured educational environments students will typically have experienced before coming to university. The use of lecture recordings, as conceptualised in this paper as a supplementary material, can be viewed in this light. In most cases, students will use recordings as part of their independent studying (see e.g., Leadbeater et al., 2013) rather than it being integrated into the curriculum or structured classroom activities by instructors and they may have had little experience studying from this type of material before attending university.

This is increasingly important for students enrolled in traditional, on-campus courses due to demands on time, caused by for example, the need to work and/or caring responsibilities. A 2015 survey by Endsleigh Insurance in collaboration with the National Union of Students Insight Team found that 77% of students reported working to help fund their studies, increasing from 59% in 2014 and 57% in 2013. This is not the place for a discussion of the impact of employment on student achievement (see e.g., Callender, 2008, or Dennis et al., 2018), rather, we raise the issue because as French and Kennedy (2017) have noted, the proliferation of competing demands is a key cause of poor attendance. If used appropriately, lecture capture has the potential to support not only traditional learners as they transition to an independent mode of learning but a more diverse and flexible higher education landscape.

Lecture capture often leads to fears by instructors that it will be used in a sub-optimal way and will negatively impact students' educational attainment and experience (e.g., Bond & Grussendorff, 2013). In contrast, there is a preference by students for having lecture recordings available as a supplement to live lectures (Soong et al., 2006). At the same time, students may not be using provided lecture recordings to their best benefit, for example, by

1 not engaging with the recording at all or engaging with it in an ineffective way, i.e., crammed
2 viewing of recordings before exams (Liles et al., 2018; von Kinsky et al., 2009).

3 Research on the relationship between recording usage and exam performance
4 strongly suggests that the impact of using lecture recordings is not one-size-fits-all.
5 Nordmann et al. (2019) investigated the relationship between attendance, recording use, and
6 exam performance across four levels of an undergraduate psychology programme in a cross-
7 sectional design and found that the relationships differed depending on the level of study.
8 For third and fourth year students, there was no relationship between attendance and
9 recording use and exam performance and the authors suggested that this may be due to
10 higher level exams requiring students to go beyond the lecture content. For second year
11 students, attendance and recording use were both positively correlated with exam
12 performance although regression analyses found that these variables were not predictive of
13 final grade. However, for first year students, both attendance and recording use were
14 predictive of higher exam grades, but there was also an interaction with GPA. Whilst
15 stronger students increased use of recordings helped them overcome low attendance, this
16 was not the case for those with the lowest GPAs for whom attendance at live lectures was still
17 crucial. Additionally, in some of the earliest work to consider the relationship between
18 lecture recording usage and wider approaches to learning, Wiese and Newton (2013) found
19 that a deep approach to learning (Marton & Säljö, 1976) was associated with using recordings
20 to review and master material whilst a surface approach was associated with more absences
21 and being less likely to use the recordings to augment their notes. Meanwhile, Ebbert et al.
22 (2019) identifies five clusters of engagement that differ on whether recordings are used as a
23 substitute, as a supplement to enrich and deepen understanding, or as a shallow rehearsal
24 tool. What we conclude from these inconsistencies is that lecture recordings are a tool that
25 can be used in different ways by different students. That is, we believe ,that many of the
26 concerns regarding lecture capture are, at their core, concerns about study strategies and
27 self-regulation. The current paper is written with this view in mind.

1 Dörrenbächer and Perels (2016) report that content-independent self-regulation
2 training is effective and this is of importance to the current paper for two reasons. First, by
3 targeting the general use of lecture recordings we can aim to improve foundational study
4 skills. Lecture capture is hugely popular amongst students (Leadbeater et al., 2013; Morris et
5 al., 2019; O’Callaghan et al., 2017) and this popularity presents an opportunity to promote
6 effective study strategies. Indeed, in a recent paper, Morris et al. (2019) argue that lecture
7 capture has made it even more crucial for instructors to highlight the importance of note-
8 taking, understanding, and extra reading as part of the learning experience. Second, the
9 literature has largely focused on descriptive accounts of the relationship with attendance and
10 attainment (Nordmann et al., 2019) rather than higher-level concerns and this is especially
11 apparent when compared to the vast and nuanced literature on self-regulation. By focusing
12 on the underlying study strategies that relate to lecture capture we aim to bridge the gap
13 between these two fields and therefore it is by design that the majority of our
14 recommendations refer to research on learning and teaching more generally.

15 **3. Recommendations for students**

16 **3.1 Attend live lectures and use lecture capture as a planned supplement.**

17

18 In a meta-analytic review, Credé et al. (2010) found that attendance had a strong
19 relationship with final course grade and was a better predictor of academic performance than
20 standardised test scores. Additionally, an emerging picture from the lecture capture
21 literature is that there is no systematic relationship between lecture capture usage and
22 attendance (see Nordmann & McGeorge, 2018, O’Callaghan et al., 2017, Witthaus &
23 Robinson, 2015, for reviews). Rather, there is increasing evidence that supplemental use of
24 lecture capture is best. Bos et al. (2016) found that students who both attended the live
25 lecture and used the recording received higher grades, followed by those who only attended
26 the lecture, those who only watched the recording, and non-users, respectively. As noted

1 above, Nordmann et al. (2019) found that *both* recording usage and attendance (i.e.,
2 supplemental use) were significant predictors of achievement, although attendance was the
3 stronger predictor. In an earlier study of psychology students using a quasi-experimental
4 design, Drouin (2014) reported that course grades were lower in the section of the course
5 that had lecture capture available, however, that this effect was mediated by attendance.
6 Interestingly, Drouin identified a group of “non-participants” - students who neither
7 attended the lecture nor watched the recordings and once these students were excluded from
8 the analyses the group differences disappeared, suggesting again that the interaction
9 between attendance and recording use is nuanced and related to more general approaches to
10 studying. In a similar vein, von Kinsky et al. (2009) found that higher achieving students
11 were more likely to supplement non-attendance with lecture recordings than low-achieving
12 students. However, in general, that study, too, supported the lack of a clear missing link
13 between lecture recording availability and attendance.

14 There are many potential explanations for the above pattern of findings; it may be
15 that we find the live lecture more engaging than a recorded version (Schreiber et al., 2010),
16 that there are socio-motivational benefits of attending (French & Kennedy, 2017), or simply
17 that supplemental use means greater total time-on-task (Carroll, 1989). Attendance at
18 lectures is linked to a number of self-regulatory components such as organisation,
19 motivation, help-seeking, planning and effort regulation, and therefore it is not surprising
20 that the relationship between attendance and achievement is strongly positive. Effort
21 regulation, the management and control of one’s effort expenditure (Halisch & Heckhausen,
22 1977), normally refers to the persistence of effort in the face of difficulty, e.g., “I work hard to
23 do well in this class even if I don't like what we are doing” and there is a clear parallel with
24 the concerns surrounding lecture capture, e.g., “I continue to attend class even when there is
25 a recording”. In two separate meta-analyses of the literature (Richardson et al., 2012;
26 Robbins et al., 2004), effort regulation was amongst the strongest predictors of GPA and so
27 combined with strong evidence for the links between attendance and achievement, the
28 recommendation is clear - students should continue to attend live lectures and use the

1 recording as a supplementary resource. In fact, Soong et al. (2006) reveal that students
2 (67%) indeed preferred a “whole package” approach consisting of live lecture, uploaded
3 recording, and presentation slides. Interestingly, scenarios that did not include any live
4 lectures were the least preferred modes of delivery.

5 It should be remembered that failure to attend live lectures may not represent poor
6 effort regulation (see Kelly, 2012 for a discussion of additional factors that impact
7 attendance). In the case of students who are having financial difficulties, physical or mental
8 health problems, or who have caring responsibilities, the choice not to attend may be driven
9 by a thorough consideration of competing demands and where their effort is best spent. It is
10 a position rarely considered that students who plan ahead to watch a recording instead of
11 attending so that they can meet their learning goals in spite of external demands are actually
12 engaging in the type of self-regulation we seek to encourage and that this technology may
13 help support e.g., students who attend university through widening participation
14 programmes. Even for those without these pressures, the choice to use the recording may
15 reflect what they believe is best for their learning and with the proliferation of Massive Open
16 Online Courses (MOOCs) (Shah, 2018) the idea that a recording may provide a viable
17 alternative to attendance is not illogical or lazy and so providing evidence-based guidance is
18 crucial.

19 **3.2 Take effective notes during lectures for later use with lecture recordings**

20 Most students will take notes when they are attending a lecture (Morehead et al.,
21 2019). Taking notes has two main functions when it comes to learning: First, it can support
22 taking information in and encoding new information in memory and, second, it has an
23 external storage function in that notes can be reviewed at a later point in time - supporting
24 self-regulated studying of previously-taught material as a goal setting behaviour (Di Vesta &
25 Gray, 1972; Kiewra et al., Meyerhoffer, & Roskelley, 1991; Morehead et al., 2019). Thus,
26 taking notes should be encouraged as a valuable activity to engage in during lectures and this
27 is true for lectures that are captured or not, however, the availability of lecture capture can

1 undermine note-taking. In a recent survey (Morehead et al., 2019), students in online classes
2 that were based on recordings only reported to be less likely to take notes during lectures
3 (49%) compared to students in live lectures (96%). Further investigation of this pattern
4 revealed that 67% students in online classes thought that note-taking was “unnecessary”
5 because the lecture was available to them online. This together with the finding that the top
6 reason for students to use lecture recordings is to make up for missed lectures (Gorissen et
7 al., 2012), highlights the importance of guidelines and hands-on recommendations for
8 student note-taking when using lecture recordings. Not only that, lecture recordings can be
9 seized as an opportunity to promote effective note-taking and it is important to integrate
10 recording usage with other, more traditional study behaviours. Producing notes whilst
11 listening to a lecture is a dual task, in which cognitive resources need to be allocated to either
12 listening to the instructor or to writing down notes (Jansen et al., 2017). Thus, considerable
13 cognitive resources need to be expended to create useful notes and lecture recordings can
14 support better note-taking.

15

16

17 Lecture capture can be used to support generative note-taking in multiple ways.
18 Students can use recordings to reduce the cognitive load associated with note-taking by
19 using them to revisit the material and improve the quality of their notes (Wood et al., 2018),
20 which may be particularly helpful for those students who struggle to produce generative
21 notes in a live lecture. Indeed, there are four studies that are consistent with this claim: First,
22 McKinney et al. (2009) showed that providing students with an audio recording of a lecture
23 only (i.e., without the option of a live lecture) were more likely to produce extensive notes
24 which was attributed to the possibility of stopping and rewinding the recording while note-
25 taking. Although, it should be noted that approximately one-third of the students in the
26 audio lecture condition decided not to take notes at all, which is in line with results reported
27 by Morehead et al., (2019) for students in online classes. This again highlights the
28 importance of clear guidelines for students. Second, Gosper et al. (2007) surveyed 815

1 students and found that 63% agreed with the statement that lecture recordings helped them
2 “to take comprehensive notes”. Third, Chinnery et al. (2018) found that students report that
3 the provision of lecture capture can be helpful in reducing anxiety surrounding note-taking,
4 that is, there is less pressure to ensure every word is captured. Because of this, the safety net
5 that the recordings offer can be used to encourage students to make generative notes and by
6 planning to use recordings to supplement notes, students also engage in effective processing
7 of identifying which sections of their notes need augmenting. Finally, a recent study by
8 Nightingale et al. (2019) revealed that students with dyslexia report that they struggle with
9 note-taking during live lectures and that lecture recordings can help these students to
10 overcome this.

11 Similarly to other study habits that students adopt over the course of their education,
12 note-taking is one that they usually are not explicitly taught. Morehead et al. (2019) reveal
13 two crucial points: First, students would like to have more instruction on how to take notes
14 and second, only about one-third of the surveyed students has ever come across note-taking
15 systems such as Cornell notes. In fact, the authors state that “one straightforward
16 implication is that many students will need to be instructed to take notes while watching to-
17 be-tested content from online courses” (p. 816). To fill this gap, our recommendations for
18 students include how lecture capture can be used to improve general study skills by linking
19 the use of the recordings with note-taking systems that encourage self-regulatory strategies
20 such as the Cornell note-taking system (see Appendix A).

21

22 **3.3 Identify problem areas and watch specific sections of a recording, rather** 23 **than the full lecture**

24 Owston et al. (2011) found that students who reported watching specific sections of a
25 recording received higher course grades than those who watched the entire recording, with
26 the lowest achievers being those who watched whole lectures multiple times. When students
27 are asked how they study, they often report using strategies that may work in the short-term

1 such as repeatedly reading over notes or lecture slides or copying notes from one format into
2 another but that are ineffective for long-term retention of knowledge (Kornell & Bjork,
3 2007). Not only will students need to spend time studying previously learned material from
4 scratch in the future, repeated and massed rereading has been found to increase the
5 likelihood that students will experience mind wandering; the intrusion of unrelated thoughts
6 (Phillips et al., 2016). The same has been shown to happen when students rewatch lecture
7 recordings: Martin et al. (2018) found that massed rewatching of a lecture recording had no
8 positive effect on performance and led to more mind wandering. Mind wandering is
9 negatively correlated with learning outcomes (D’Mello, in press) and attentional shifts lead
10 to poorer memory performance for encountered material (Risko et al., 2013). Lecture
11 capture allows for task-switching in the form of students pausing the lecture to consult other
12 material, indeed, this feature is reported as a benefit of the technology by students (Luke,
13 2017).

14

15 Before watching a lecture recording, students should consult their notes and
16 try to retrieve as much information from memory as possible . This can be done by free
17 recalling everything the student can remember (“brain dumping”) or by answering questions
18 on the topic. Retrieval practice has been shown to be an effective learning strategy for long-
19 term retention of knowledge (Roediger & Karpicke, 2006). Following this, students may
20 check their notes for feedback and identify parts they were not able to recall or understand
21 and then use the lecture recordings to watch specific sections related to these problem areas.

22 In addition to the question of how students should revisit a lecture, there is also the
23 question of *when* they should use the recording. Research suggests that students should
24 retrieve lecture content from memory often in order to strengthen the memory (Halamish &
25 Bjork, 2011). Spaced practice is the idea that adding breaks between revising the same
26 material and engaging in several shorter revision sessions is better for long-term retention
27 than cramming all studying into one big session before the exam (Carpenter et al., 2012;
28 Kuepper-Tetzel, 2014). The question about how to best schedule revision session after the

1 live lecture is a tricky one: Although we know that distributing practice of material over time
2 is a good thing to do, the exact intervals between study sessions is not set in stone. Theories
3 suggest that learning of previously-taught material may particularly benefit from a revision
4 session when re-studying requires some effort to bring information to mind and remember
5 the material (Thios & D'Agostino, 1976). Thus, the idea is to avoid too long intervals that lead
6 to too much forgetting, so that it feels like one is learning from scratch.

7 With this in mind, one way to schedule revision sessions that has been shown to be
8 beneficial for long-term retention of information is to increase the breaks between revising
9 the same content resulting in an expanding learning schedule (Kuepper-Tetzel et al., 2014;
10 Toppino et al., 2018). Thus, shorter breaks in the beginning when the material is taught for
11 the first time and increasing the breaks to weeks and months as the semester progresses
12 seems to be a good way to schedule revision sessions as it results in an expanding retrieval
13 schedule (Storm et al., 2010). Liles et al.(2018) investigated the relationship between
14 different study habit characteristics and academic success. They found that the most
15 successful students did the first revision of lecture material on the same day of the lecture.
16 Although we cannot make any causal inferences from this, it is in line with the theoretical
17 approach explained below: usually, new material is taught in lectures and an immediate
18 refresher of the material a few hours after the lecture can be beneficial to avoid too much
19 forgetting. Engaging with the lecture recording as described above is one way to support
20 these revision session. If the live lecture was attended it seems to be an ineffective strategy to
21 simply re-watch the recording (Liles et al., 2018).

22 **3.4 If it is not possible to attend the live lecture, watch the full recording**
23 **within one week at normal speed, and then follow the above guidelines**
24 **for clarification and supplement.**

25 A spaced approach to learning, i.e. having formal teaching as well as self-directed
26 learning activities over an extended period before the assessment, generates opportunities
27 for reflection and review and leads to long term learning by students. In contrast, massed

1 learning, where students cram just before the assessment leads to short-term recall (Cepeda
2 et al., 2008). Sarsfield (2018) found that students who access lecture recordings for the first
3 time outside of the teaching period (i.e. in the examination period) do less well in
4 assessments. While this research does not differentiate between students who attended the
5 live lecture and those who did not, it clearly highlights that early access of recordings is
6 beneficial. Another reason for students to catch up close to the live lecture relates to the
7 links across different sessions, thoughts and ideas covered in one session being built on and
8 expanded in a later session (the spiral curriculum, see Bruner, 1960). Students who review
9 sessions out of sequence may therefore also put themselves at a disadvantage in their
10 learning in additional sessions to the one they missed.

11 In section 3.3 we recommended that students should not watch the whole recording if
12 they have already attended the live lecture. However, for a student who has missed the live
13 session, there is a need to review the full lecture. Song et al. (2018) provide evidence that if a
14 video is watched at 1.5x normal speed then test performance is negatively impacted, and so
15 there is a strong recommendation that students watch the recording at normal speed the first
16 time it is viewed. This also ensures that time-on-task (Carroll, 1989) is comparable between
17 those who attended and those who watched the recording. Although there is convincing
18 evidence that attending live lectures leads to better outcomes than only watching a recording
19 (e.g., Bos et al., 2016) there is still no definitive answer as to why this may be the case. Until
20 there is more data that addresses these questions, we recommend that if a lecture is missed,
21 the recordings be used in a manner that is similar to the live experience, that is watching the
22 recording from start to finish in one go, taking generative notes and using additional
23 viewings to supplement notes and consolidate understanding.

24 **3.5 Use lecture recordings to help ask for help**

25 There is a substantial literature on help-seeking as a facet of self-regulation (see e.g.,
26 Karabenick & Berger, 2013; Karabenick & Dembo, 2011). Previous research has found that
27 students who report greater willingness to seek help when needed are more likely to self-

1 regulate in other ways (Karabenick & Knapp 1991). Whether a student engages in help-
2 seeking or whether help-seeking is viewed as a threat to their self-worth is related to self-
3 efficacy (Karabenick & Dembo, 2011).

4 Help-seeking relates to lecture capture in four ways. First, lecture capture technology
5 can be used to encourage participation when teaching large classes. Some lecture capture
6 technologies integrate anonymous polling and questions (see e.g., Couperthwaite, 2018) and
7 these can be used to promote help-seeking during the lecture, as well as active learning.
8 Second, Tobias (2006) suggests that if students are able to accurately self-monitor their own
9 understanding then they are more likely to seek specific help and lecture recordings may
10 help support this. Karabenick and Dembo (2011) propose that students are more likely to ask
11 for help if they have a better understanding of what it is they do not know, a process which
12 involves engaging in metacognitive reflection. Drawing on work by Goldstein and McGinnis
13 (1997) they also highlight that some students do not know how to ask for help. As noted in
14 section 3.3, lecture recordings may be most effective when their use is targeted to particular
15 sections a student is struggling with, identified through reflecting upon their understanding
16 of the lecture. Karpicke et al. (2009) have argued that repeated self-testing of reviewed
17 material conveys significantly more learning gains than repeated reading of the material,
18 which tends to provide limited gains. Self-testing is a key element in identifying the areas in
19 which additional help is needed and embedding understanding of areas that have been
20 mastered. In a similar vein, recordings can be used to help formulate questions by allowing
21 them to review the sections they had difficulty with, and to use the phrasing and terminology
22 from the lecture to help structure their questions.

23 Third, students can use lecture recordings as a form of help in conjunction with the
24 note-taking systems described in section 3.3. Recordings can help answer questions as
25 students can get feedback after trying to recall information themselves from memory.
26 Finally, there is some preliminary evidence that some students are using lecture capture
27 collaboratively, that is, they are watching the recordings in pairs or groups (Luke, 2018). Chi
28 et al. (2008) have previously found that students who watched a video of a tutorial in pairs

1 did as well students who were tutored individually and this raises some important questions
2 relating to lecture capture. As discussed in section 3.1, lecture attendance is predictive of
3 attainment and supplemental use is generally conceptualised as being individual use. Again,
4 more research is needed to answer the question of whether watching lecture capture as part
5 of a peer-group would negate the negative effects of not attending live lectures.

6 **4. Recommendations for instructors**

7 There has been less research conducted on the attitudes of instructors towards
8 lecture capture, however, the themes discussed appear remarkably similar across institutions
9 and disciplines. Bond and Grussendorf (2013), Gosper et al. (2010), and Morris et al. (2019)
10 all report on instructor attitudes and find broadly the same pattern of concerns; reduced
11 lecture attendance, changing an instructor's performance and interaction with students, a
12 lack of equivalence between the live and captured experience, the permanence of a recording,
13 and the belief that lecture capture may result in a loss of skills such as note-taking or
14 prolonged attention . Bond and Grussendorf found that the prevalent barrier to adopting
15 lecture capture was the fear of reduced attendance although they also note that their
16 participants were unable to support their fears with anything other than anecdotal evidence.
17 Similarly in Morris et al., 53.6% of instructors felt that lecture recordings had impacted
18 attendance and 24.3% that recordings encouraged superficial learning. More positively,
19 Morris et al. also reported a number of positive comments from instructors regarding how
20 lecture capture can help support students with disabilities or for those who are learning in
21 their second language and Bond and Grussendorf found that most instructors were
22 supportive of lecture capture for reasons of disability and for allowing students with good
23 cause to miss lectures to catch-up.

24 Draper et al. (2018) highlight that the inclusion of lecture capture and how best to
25 integrate it does not seem to be included in teacher development programmes and
26 integrating lecture capture in a pedagogically sound and progressive way (particularly
27 without guidance) is challenging. Although many of the themes do not appear to have

1 changed since early studies on lecture capture, there are a few newer concerns that are
2 becoming increasingly prevalent, particularly in online discussions. Dommett et al. (2019)
3 recently investigated instructor and student views towards opt-out policies and found that
4 the key concern amongst instructors was consent, that is, whether lecture capture would be
5 used for purposes to which they had not consented. These concerns have been reflected in
6 other recent work, for example, that recordings will be shared on sites such as YouTube
7 (MacKay, 2019) and that lecture capture will be used to break strikes and for the purposes of
8 performance management (Edwards et al., 2018), and need to be addressed.

9 **4.1 Provide students with guidance on how to use lecture capture effectively.**

10 Improving self-regulation improves learning outcomes (Richardson et al., 2012). If
11 we want students to use lecture capture in a way that best supports their learning, we should
12 inform them how to do so and not hope that they will discover this by chance. We also
13 recognise that many academics have limited experience integrating lecture capture into their
14 teaching and providing study. We hope that this paper and the guides we have provided
15 reduce the challenge associated with providing appropriate teaching and learning support.

16 **4.2 Adopt a context-dependent approach to lecture capture rather than all-or** 17 **nothing and explain the reasons to students.**

18 Didactic lectures cover a vast range of different subject matters and approaches to the
19 material. In a survey of heads of eLearning departments, Newland (2017) reported that the
20 most significant barrier to the adoption of lecture capture was the concerns of instructors.
21 The context in which lecture capture is acceptable to instructors can often be seen in lecture
22 capture policy documents (see Nordmann & McGeorge, 2018 for details of specific policies).
23 For example, many policies acknowledge that not all teaching contexts are suitable for
24 recording, for example, when material is sensitive or when recording may stifle discussion
25 and most discourage instructors from altering their teaching style or content to fit the
26 recording process. A number of policies also highlight that lecture capture is not simply a

1 binary choice of recording or not, with most technologies permitting pausing or editing to
2 allow instructors to retain control over the suitability of material within a given lecture.
3 Throughout these policy documents recurring themes include lecture capture as an
4 appropriate tool for didactic teaching and a less appropriate tool for Socratic teaching,
5 sensitive information or materials making an event unsuitable for lecture capture, and
6 permitting control over the recording process (such as pausing).

7 When a specific choice to not record an event is made, clear communication of the
8 rationale is key. Often students will be unaware of the justifications and recommendations
9 held within University policy documents, placing a responsibility on instructors to
10 communicate why this decision has been reached and the justification for it. On a more
11 positive note, this can have educational benefits, sparking discussions about ethics, political
12 sensitivity, and academic freedom. The key takeaway from this section is that the decision to
13 record does not have to be all-or-nothing. If a ten-lecture course contains three lectures that
14 cover sensitive topics or have a high degree of interactivity, it is entirely reasonable to opt-
15 out of capturing those lectures, whilst recording the others.

16 **4.3 Investigate the reasons for why students fail to attend lectures.**

17 Whilst some studies (e.g., Edwards & Clinton, 2019) have found a negative
18 relationship between lecture capture usage and attendance, reviews of the literature
19 conclude that there is little evidence that the provision of lecture capture systematically
20 affects attendance (see Nordmann & McGeorge, 2018; O'Callaghan et al., 2017).
21 This does not negate the fact that attendance at lectures is still crucial and is highly
22 predictive of success (see section 3.1) but we suggest that the focus should be on
23 understanding the reasons *why* students fail to attend lectures and what they are doing
24 instead, rather than being preoccupied about lecture capture. Indeed, Clair (1999) argues
25 against compulsory attendance policies in higher education on the grounds that it is the
26 underlying motivation and effort regulation that is important rather than mere attendance
27 and Marburger (2006) found that mandatory attendance policies increased attendance but

1 did not result in greater achievement. In a recent study investigating individual differences
2 and course attendance, Fryer et al. (2018) found that students' perceived competence, rather
3 than their actual competence, predicted attendance and they cite work by Sherer et al. (1982)
4 suggesting that giving students the opportunity to experience success is crucial in improving
5 self-efficacy for learning. In the current context, active learning activities noted in section 4.4
6 could be used in lectures to promote perceived competence, for example, giving students
7 multiple-choice questions at the end of each lecture using personal-response systems may
8 allow them to recognise the learning that has taken place during the lecture.

9 As considered in Nordmann and McGeorge (2018), the reasons students give for non-
10 attendance when lecture capture is available tend to focus on what they perceive the benefit
11 of the lecture to be, whether they believe it will meet their current learning needs, their
12 previous experience with the instructor, and whether the materials were as easily learned
13 from a handout (Billings-Gagliardi & Mazor, 2007; Gupta & Saks, 2013). In Bos et al. (2016)
14 and O'Brien and Verma (2018), students were categorised into different clusters depending
15 upon their behaviour (e.g., those who only attend the live lecture vs. those who only use the
16 recording vs. those who do both vs. those who do neither). What predicts which category a
17 student will fall into is still in need of investigation although O'Brien and Verma (2018)
18 provide preliminary evidence that students' commuting distance to campus is predictive of
19 reduced attendance at live lectures (a lack of detailed statistical information makes it difficult
20 to assess the strength of this finding and replication is needed).

21 If lecture attendance falls after the introduction of lecture capture, it is also worth
22 evaluating the teaching that is being delivered given recent findings by Wood et al. (2018)
23 that students report that as long as they perceive the live lecture to have any additional
24 benefit beyond the recording, they will still attend. Anecdotally, there is the tendency for
25 institutions to commit to monitor attendance after the introduction of lecture capture to help
26 allay the concerns. Whilst this may be necessary for political reasons, we would strongly
27 recommend that this is accompanied by more qualitative insights into the reasons why
28 students choose not to attend class, and this would be possible at a local level using existing

1 evaluation systems. For example, the Student Course Evaluation Forms at the University of
2 Aberdeen, UK, include the question “*What, if anything, limited your attendance and do you*
3 *feel there is anything that could have been done for you to improve your attendance?*” that
4 allows insight into this matter. In terms of lecture capture research, we would welcome
5 additional studies that investigate what students do if they fail to attend class and how
6 differences in these behaviours influence achievement. It is likely that a student who does
7 not attend the lecture but watches the recording with a study group every week and then
8 discusses the associated reading will have a different outcome to a student who watches all
9 the recordings on their own at the end of term. What distinguishes these two examples is not
10 the use of lecture capture or attendance, but rather effective self-regulation, and it is
11 important that both researchers and instructors begin to focus on this rather than
12 decontextualized viewing or attendance figures.

13 **4.4 Increase the effectiveness of lecture with active learning activities**

14 Mazur (2009) highlights that “the majority of uses of technology in education consist
15 of nothing more than a new implementation of old approaches” (p51) and as noted at the
16 beginning of this paper, not only are traditional lectures prone to being less effective than
17 more active forms of delivery, but lecture capture has now joined the lecture in its ubiquity.
18 Given the concerns about attendance and student reports that they prefer live lectures and
19 will continue to attend if they perceive the live event to be of additional benefit to the
20 recording (Wood et al., 2018), it is worth briefly discussing how to improve the effectiveness
21 of lectures as we cannot discuss the impact of lecture capture without considering what
22 is happening in the live lecture (see Cerbin, 2018, for a more comprehensive discussion of
23 how to improve lectures).

24 Active learning activities in large lectures usually refer to two prominent activities:
25 having students answer questions during the lecture and allowing students to engage in peer
26 discussions (see Mazur, 2009, for a personal account on implementing both activities in
27 large lectures). In this section, we provide a brief overview of these activities and highlight

1 how they can support students' self-regulated learning and in turn provide a benefit to the
2 live lecture that may promote attendance.

3

4 *Questions during lecture*

5 Retrieval practice works better for maintaining knowledge than simply rereading the
6 same content (Roediger & Karpicke, 2006). Consequently, asking questions in lectures and
7 encouraging students to answer them before proceeding is a way to introduce retrieval
8 practice in lectures. In addition to boosting their memory for the tested material, it
9 cognitively engages students during the lecture by allowing them to interact by responding to
10 questions. Mayer et al. (2009) showed that using so-called "clicker" devices - an electronic
11 response system - and having students actively answer questions during the lecture
12 increased their performance on the final assessment more, compared to a class where
13 questions were asked, but students were not required to answer using clickers, or a class
14 where no questions were asked. It is important to note that the key is not the electronic
15 response systems *per se*, but rather providing students with the opportunity to answer
16 questions. Simply showing them questions in class, but not requiring an answer will not lead
17 to beneficial retrieval from memory. Electronic response systems can facilitate this process,
18 but it is not the only way to promote retrieval. For example, asking students to write down
19 their answer to a question in their notes can trigger the same beneficial processes. However,
20 using an electronic response system has further advantages in that students can get an idea
21 of their understanding compared to the class, and it provides instructors with immediate
22 feedback on students' comprehension of the topic (Gauci et al., 2009). Moreover, it has been
23 shown that requiring students to answer questions is not only beneficial for performance,
24 but it also helps students to keep focused during online lectures (Szpunar et al., 2013). Thus,
25 if students decide to watch lecture recordings in full, having quiz questions interspersed
26 across the lecture reduces the likelihood of mind-wandering and enhances their learning.

27

28 *Peer discussions*

1 Another way to increase student participation in live lectures is to have them engage
2 in brief peer discussions during the lecture. Cavanagh (2011) reports that students perceive
3 cooperative activities during lectures as helpful to understand the material, but also that it
4 helps them to keep focused and pay attention. The question is if such peer discussions
5 translate into better academic performance. This, indeed, seems to be the case. Rao and
6 DiCarlo (2000) compared students' answers to in-class quiz questions before and after peer
7 discussion and found that the proportion of correct answers increased after engaging in
8 discussions with a peer. Additionally, Smith et al. (2009) found that peer discussion followed
9 by additional instructor explanations was most effective, a technique that could be facilitated
10 through the use of clicker questions to obtain feedback on the peer discussion to guide
11 additional instructor explanation. Importantly, this results pattern was found for students of
12 all abilities, i.e., low-, medium-, and high-performing students. Interestingly, the reason for
13 peer discussion benefits seems to stem from students obtaining a better understanding of the
14 material during the discussion and is not simply due to stronger students giving out the
15 correct answers to their peers (Smith et al., 2009).

16 **4.5 Seek clarification from relevant teaching and learning leads on the**
17 **expectation for equivalence and inform students as to whether they should**
18 **expect an equivalent experience from lecture capture.**

19 The following three recommendations are closely related to issues surrounding
20 lecture capture policies and instructors. Lecture capture policies (and guidance provided to
21 students) tend to state that recordings will be used to supplement the live sessions
22 (Nordmann & McGeorge, 2018), i.e. they are not a replacement and they should not be
23 expected to provide an equivalent experience to the live lecture. There are a number of
24 reasons for this lack of equivalence; first, in the live lecture, the academic will provide
25 additional insight through students reading body language cues (York, 2015) that will not be

1 present in an audio plus slides recording¹. Additionally, without a high-quality video feed
2 there are many cases where lecture content cannot be equivalent. For example, in the case of
3 active learning activities where the activity is either not captured or the usefulness is lost
4 without e.g., the ability to engage in peer discussion, but it could also be the use of a signed
5 language or the use of a chalkboard (see Murray, nd, for an account of a technological
6 solution to chalkboard recording).

7 There are some cases where the format of the class makes it unsuitable for recording
8 (see section 4.2), but it is important to remember that for supplemental lecture capture, total
9 equivalence is not the aim. Due to the small number of publications that have looked at
10 instructor perceptions, there is not much formal evidence on the matter (Bond &
11 Grussendorf, 2013), although anecdotal evidence would suggest that it is a widespread
12 perception that the live and the recorded lecture should be the same. While the literature
13 does not explicitly ask students about equivalence to the live session, research has shown
14 that they prefer live lectures (Jensen, 2011) suggesting that they recognise recordings are not
15 equivalent (although reinforcing the importance of attendance as in section 3.1 is still
16 crucial). As in section 4.3, we would strongly advise against basing pedagogical decisions on
17 whether the lecture will be recorded, and it is worth reiterating that this is a viewpoint
18 encapsulated in many existing lecture capture policies. If parts of the lecture will not
19 translate well to a recording, highlight this to students before the lecture, and provide the
20 recording even if that means parts of it will not be useful. Again, there is little concrete
21 evidence on this topic, but it is the experience of all authors that students have few
22 complaints about a recording that does not provide a 1:1 experience.

23 An additional aspect that some instructors have anecdotally expressed concerns
24 about is the quality of the recording², e.g., that it should be a perfectly polished version of the

¹ We have no data on whether audio or video lecture capture is more common, however, from the experience of the five institutions of the authors, audio plus slides appears to be in the majority at the time of writing.

² For clarification, we intend this guidance strictly for supplemental recordings, not in cases where the recording is the only method of delivery like for fully online courses where the quality of the recording is more important.

1 lecture, an anxiety that is perhaps connected to concerns about performance management
2 that will be discussed in section 4.6. From our experiences, we have observed junior
3 instructors or those inexperienced with lecture capture feel the need to spend time editing
4 out sections just before and just after their lectures, while more experienced instructors will
5 leave these in. We again argue that recordings are defined as supplements and should be
6 treated as such: they are not expected to be perfect and from experience students will simply
7 fast forward to the start of the lecture and ignore anything after the end. We would therefore
8 recommend that there should be no requirement for the routine editing of captures and that
9 instructors should not feel pressured to produce a perfect product. Where instructors feel
10 concerned about this they should first seek clarification from relevant teaching and learning
11 leads in their institution, rather than taking on additional work that is likely unnecessary.
12 Finally, we believe that more research on the attitudes of both instructors and students on
13 the issue of equivalence is needed as it may help alleviate such anxieties and provide an
14 evidence-base to the above suggestions.

15 **4.6 Consult lecture capture policy for a statement about performance** 16 **management.**

17 Intertwined with the concerns noted by Bond and Grussendorf (2013) and Gosper al.
18 (2010) about the permanence of lecture capture, there is a recurring anxiety that recordings
19 will be used for the purposes of performance management, that is, that recordings will be
20 used to judge the quality of teaching delivered and be used against instructors in appraisals
21 or promotion applications (Edwards et al., 2018). Whilst the fear that lecture capture may be
22 used in this way is entirely rational, the reality is that the majority of institutions that have a
23 clause in their lecture capture policy that explicitly safeguards against this, e.g., *recordings*
24 *will not be used for purposes of monitoring staff or students; management processes such*
25 *as appraisal or performance management; nor for purposes of quality assurance and*
26 *management* (Nordmann & McGeorge, 2018). We would therefore encourage all instructors
27 to consult their lecture capture policy for a clause that relates to performance management

1 and if it is lacking, or indeed if no institutional policy exists, to make the argument for its
2 adoption so that these concerns may be mitigated.

3

4 **4.7 Consult lecture capture policy for statement on performance rights or the** 5 **control of the release of recordings.**

6 A final issue surrounds ownership of lecture recordings. Another recurring concern is
7 that once a lecture is recorded, it may be used without the consent of the instructor, for
8 example, in the case of industrial action or that it will be used as material for new online
9 courses. Again, the best protection against these concerns is to have a comprehensive
10 institutional policy. Almost all lecture capture policies state that, as with any other teaching
11 material, the institution holds intellectual property rights, however, some go further and
12 specify that instructors have performer's rights (see Nordmann & McGeorge, 2018).
13 Performer's rights prevent the use of a recording without the consent of the performer, in
14 this case, the academic. In response to such concerns Jisc (2018) have recently updated their
15 guidance on the legal considerations for lecture capture that we would encourage all
16 instructors to review. The updated guidance states that "*Colleges and universities need*
17 *consent of performers (including employees and visiting speakers) in order to record, copy,*
18 *or make available a performance*" (p1). Policies that follow this guidance ensure that
19 recordings cannot be repurposed against the wishes of the academic for any reason. As in
20 section 4.6, we encourage instructors to consult their institutional lecture capture policy and
21 to call for changes if necessary.

22 **Conclusion**

23 In this paper, we have drawn on a diverse literature to provide evidence-based
24 practical recommendations for both students and instructors that integrates lecture capture
25 with existing knowledge on learning strategies and self-regulation. We hope that by doing so
26 we can help shift the conversation surrounding lecture capture away from a dichotomous

1 argument about whether it is good or bad, to a more nuanced discussion about how best to
2 use the technology in a way that is pedagogically effective for students, and fair for
3 instructors, and that recognises the limitations of the lecture format more generally. In turn,
4 we hope to reduce some of the anxiety that has built up around lecture capture.

5 In writing this paper we have identified a number of gaps in the literature or new
6 avenues for research. Whilst the recent work of Morris et al. (2019) has helped reduce the
7 imbalance, there is still a real need for more research on *how* instructors use lecture capture,
8 how they believe it impacts their teaching and their interactions with students, and how
9 these beliefs are related to their other beliefs about teaching, in line with the suggestions of
10 MacKay (2019). This is particularly important given the growth in the use of lecture capture
11 in the last decade and such research would help inform and refine our recommendations.
12 Similarly, there is a lack of concrete evidence as to *how* students are using lecture capture
13 with most of the research to date focused on *if* they use it with fairly blunt measures like the
14 number of minutes viewed used in empirical studies. Finally, we hope that our work may
15 promote the integration of lecture capture data with a stronger theoretical framework and
16 that the use of lecture capture as a tool to promote and support effective self-regulation can
17 be empirically tested, supported, and refined as an educational intervention.

18

19

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11

12

1 Appendix A

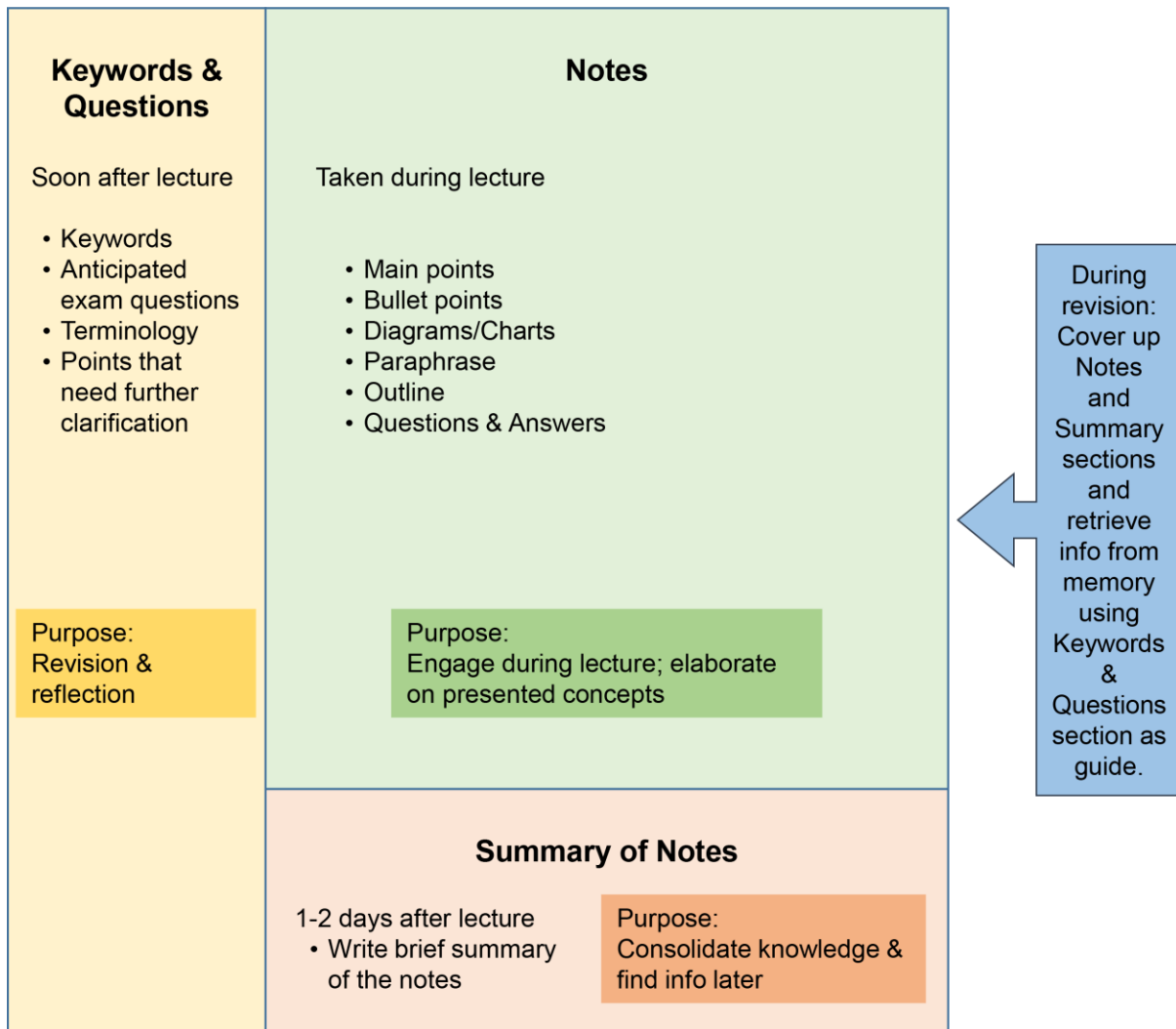
2 Cornell Note-Taking System and Lecture Capture

3 For Cornell notes, the notepad is divided into three separate sections (see Figure 1): a
4 main note-taking section, a keyword/questions section, and a summary section. During the
5 lecture, students make their notes as they usually would in the designated note-taking
6 section. After the lecture, students generate keywords and questions that capture the essence
7 of their lecture notes and write these in the keyword/questions section. Finally, one day later,
8 students write a brief summary of their notes. When students revise the material, they first
9 cover up the main note-taking and summary sections and try to retrieve their notes from
10 memory using the keyword/questions section only. This incorporates retrieval practice – an
11 effective learning strategy – which is the memory advantage of testing one’s memory and
12 bringing information to mind (Roediger & Karpicke, 2006). It is a powerful learning strategy
13 and can be easily combined with the Cornell note-taking technique. Akintunde (2013)
14 compared different note-taking strategies and found that participants who used the Cornell
15 note-taking strategy outperformed participants who paraphrased, took verbatim notes, or
16 took no notes. Cornell notes can nicely complement lecture recording use by supporting
17 targeted completion of notes, generation of keywords and summaries. The Cornell note-
18 taking system can help support the use of lecture recordings: Before watching a lecture
19 recording, students should consult their Cornell notes by covering up the notes section, and
20 try to retrieve information from memory using the keyword and question sections as cues to
21 guide recall. Following this, students may check their notes for feedback and identify parts
22 they were not able to recall or understand and then use the lecture recordings to watch
23 specific sections related to these problem areas.

24 Thus, students should be encouraged to target their use of lecture recordings to
25 rewatching specific sections and the use of a note-taking system can help guide this in
26 addition to allowing them to reflect on the accuracy of their notes.

27

28



1

2 Figure 1. The Cornell note-taking system.

3