British Journal of Educational Technology *Vol 47 No 5 2016* 906–917
doi:10.1111/bjet.12300

The use of recorded lectures in education and the impact on lecture attendance and exam performance

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Abstract

Universities increasingly record lectures and make them available online for students. Though the technology to record these lectures is now solidly implemented and embedded in many institutions, the impact of the usage of recorded lectures on exam performance is not clear. The purpose of the current study is to address the use of recorded lectures in an authentic setting by focusing on the actual time spent on the usage of recorded lectures and the impact on lecture attendance and exam performance. The participants were 396 first-year university psychology students attending a mandatory course on biological psychology. During the course, student attendance to face-to-face lectures was registered and the viewing of the recordings monitored. Results revealed that a large amount of students used the recorded lectures as a substitute for lecture attendance. The group who uses recorded lectures as a supplement when developing a knowledge base score significantly higher on the assessment. When assessing higher order thinking skills, no significant differences were found between using recording lectures and attending lectures. This can be partly explained by relatively low predictive value either form of lectures have on exam performance.

Introduction

Universities increasingly record lectures and make them available online for students. These recorded lectures mostly comprise integral recordings of face-to-face lectures that are made available as a supplement to students directly after the lecture. In these cases, face-to-face lectures are often not mandatory. State-of-the-art technology makes recording lectures an ongoing business and the recordings are subsequently embedded in many institutions. However, the impact of the usage of recorded lectures on exam performance is not clear. Proponents of recorded lectures argue that recording lectures offers students flexibility (Evans, 2008), facilitates students' variety in learning styles (Bassili, 2008) and offers the possibility of revision or repetition in preparing for the exam (Cramer, Collins, Snider & Fawcett, 2007; Van den Bossche & Verliefde, 2012). Opponents claim that offering recorded lectures leads to procrastination (Griffin, Mitchell & Thompson, 2009; Gysbers, Johnston, Hancock & Denyer, 2011) and lower attendance at lectures (Gupta & Saks, 2013; Traphagan, Kucsera & Kishi, 2010). Availability of recorded lectures is associated

Practitioner Notes

What is already known about this topic

- Adoption of the use of recorded lectures is mainly based on teacher beliefs.
- Students appreciate the availability of recorded lectures, which leads to higher course satisfaction.
- Exact implications on lecture attendance and course performance are not clear.

What this paper adds

- Our research analyses the use of recorded lectures in an authentic setting by focusing on the actual time spent on the usage of recorded lectures.
- This paper provides insight in the effects of integrally recording lectures on lecture attendance, students' usage of recorded lectures and their effects on exam performance.
- This paper shows how much both types of lectures (online and face to face) contribute to the final course performance.

Implications for practice and/or policy

- This paper shows that students use recorded lectures as a substitute for lecture attendance and not complementary.
- The choice to either attend lectures or watch them online has no influence on final grades.

with lower final grades (Fernandes, Maley & Cruickshank, 2008), higher final grades (Traphagan *et al*, 2010) or with no significant difference in grades (Babb & Ross, 2009; Brotherton & Abowd, 2004; Wieling & Hofman, 2010).

Here we argue that, rather than making broad claims about the impact recorded lectures might have on academic achievement, a more detailed understanding is needed on aspects of course design, learning objectives and the actual individual use of recorded lectures within the course and how these three aspects relate to its final grade.

Firstly, if recorded lectures have an impact on academic achievement depends, among other things, on the course design and alignment of the course. The principle of constructive alignment (Biggs & Tang, 2011) is based on the conception that learning behaviour can be influenced by the course design and the design of assessment in the educational process. To align the curriculum, one should define the intended learning outcomes (learning objectives), choose the appropriate learning and teaching activities to allow students to achieve the learning objectives and design an assessment that will determine whether these learning objectives have been reached. The more congruent the intended learning objectives, course content and assessment are, the more effective lectures will be. If the lecture does not align with what will be assessed, then the recordings of those lectures will also have lesser effect on academic achievement.

Secondly, the learning objectives of the course also determine whether recorded lectures have an impact on academic achievement in a course. Introductory courses are characterised by learning objectives with a focus on knowledge acquisition and comprehension to develop a knowledge base (Demetriadis & Pombortsis, 2007) in contrast to more advanced courses where higher order thinking skills, like concept connection or problem solving, are more dominant. Even within a single course, such an evolution from initial development of a knowledge base onto higher order thinking skills can occur (Lust, Vandewaetere, Ceulemans, Elen & Clarebout, 2011). For example,

a course starts with a knowledge base and works towards integrating this knowledge base into comprehension and analysis (Bloom, 1984). In cases where the use of recorded lectures led to a significant increase in exam performance, these courses were primarily introductory courses (Chiu, Lee & Yang, 2006; Maki & Maki, 2003). Most research on the effects of recorded lectures fails to consider these different learning objectives, while the type of learning objectives a course has may explain whether recorded lectures can be effective (Lust *et al*, 2011). Indeed, students have reported that recorded lectures are mainly useful for developing a knowledge base and less useful for higher order thinking skills (Hill & Nelson, 2011).

Thirdly, the duration of use of recorded lectures in direct relation to the actual lecture attendance should also be taken into account when exploring the effect on academic achievement. Current research emphasises either the availability of recorded lectures (Demetriadis & Pombortsis, 2007; Wieling & Hofman, 2010) or the use of recorded lectures (Grabe & Christopherson, 2008; Inglis, Palipana, Trenholm & Ward, 2011; Traphagan *et al*, 2010) without further analysis of the duration of the use of recorded lectures. The dichotomous approach disregards data about actual use and does not account for time spent on task, while time on task according to researchers is the most important influence on academic achievement (Chickering & Gamson, 1987; Slavin, 2015). After all, there is a difference between a student who uses a short amount of a recorded lecture for reference and a student who uses the recorded lectures to replay all the lectures from start to finish. Moreover, the actual use of recorded lectures should be explained in relation to lecture attendance. Although the initial objective of recorded lectures is to offer it to students as a supplement, some students will also use the recorded lecture as a substitute for the lecture. These different usages (supplement, substitution) and differences in duration of consultation of the recorded lectures are essential aspects when examining the possible effect recorded lectures have on academic achievement. We therefore distinguish four different groups when it comes to lecture attendance and the use of recorded lectures: students who neither watch recorded lectures nor attend any lectures; students who watch recorded lectures as a substitute and do not attend any lectures; students who only attend lectures and do not watch any lectures; and finally students who watch the recorded lectures as a supplement: these students both attend lectures and watch (part of the) lectures online.

The current study aims to provide insight into the added value recorded lectures have on academic achievement by examining specifically the individual use of recorded lectures and the relationship with actual lecture attendance, taking into account the different learning objectives of the course.

This leads to the following research questions:

1 To what extent do students make voluntary use of face-to-face or recorded lectures?
2 Is there a difference in exam performance (academic achievement) between the four groups in relation to different learning objectives (knowledge base vs. higher order thinking skills)?
3 What is the relationship between the duration of the use of lectures (either face to face or recorded) and academic achievement? Does *time on task* have an effect on exam performance?
4 To what extent does time spent on face-to-face lectures and recorded lectures contribute to exam performance when assessing the knowledge base and on an exam assessing higher order thinking skills?

Method

Participants

The participants were 396 first-year university psychology students (114 male, 295 female, mean $[M]_{age} = 20.9$, standard deviation $[SD] = 2.9$) attending a mandatory course on biological

psychology (BP). Students who were taking the course as an elective or doing a resit were removed from the results.

Materials

The course

The BP course consisted of 17 face-to-face lectures that were recorded integrally and made available directly after the lecture had taken place and were accessible until the exams had finished. Recordings consisted of audio, video of the lecturer and recording of the screen. Two lectures were question-and-answer sessions and were removed from the results. On completion of the courses, students received six European Credit Transfer and Accumulation System (ECTS) credits. The course took 8 weeks at the same location and same times of the day, but on different days. The recorded lectures were made available through the electronic learning environment (Blackboard); the electronic learning environment further contained mandatory weekly formative tests and course materials.

All of the recorded lectures were traditional university style lectures, with the teacher lecturing in front of the class (Gorissen, van Bruggen & Jochems, 2012). All the lectures had a duration of 90 minutes. During each lecture, one chapter from the course book was discussed.

Attending face-to-face lectures

During the entire time frame of the lectures, student attendance was registered on an individual level by scanning student cards upon entry of the lecture hall. The scanning continued until 15 minutes after the lecture had started. The presence of the students was registered for all lectures of the course. Students were informed that registration was used to research effectiveness of lectures in general and to avoid influence on their viewing behaviour, and were asked to consent. Three students did not consent and were excluded from the data set.

Viewing recorded lectures

The viewing of the recordings was monitored on an individual level and could be traced back to date, time, amount and part of the recorded lecture viewed. For each lecture, a separate recording was made, which made it possible to track the viewing trends for that specific recorded lecture.

Exams

During the 8-week course, there were two separate summative assessments, which were scored on a scale from 1 to 10 with 10 the highest and 5.5 as a pass mark. The first assessment covered the first 4 weeks of the course and had a focus on assessing the knowledge domain. The second assessment covered the last 4 weeks of the course and had a focus on assessing higher order thinking skills.

The first assessment contained items on topics such as neurons, synapses and the functioning of the visual system. The second assessment contained items on topics such as biology of emotion and learning and memory. Both assessments contained 20 multiple-choice questions and 2 short essay questions.

Constructive alignment and course design

The course had defined a clear learning objective for each lecture. During each lecture, a corresponding chapter from the course book was discussed. For each chapter from the course book, several questions were asked on the assessment. The exam's subjects and questions were specified in a test matrix. Because the learning objectives, course content and assessment design were aligned, the lectures were optimised for effectiveness and subsequently the effectiveness of the recorded lectures.

Data analysis

First, students were distributed in four groups based on their usage of recorded lectures and/or lecture attendance:

1 Non-users: students who neither attended lectures nor watched any online.
2 Viewers: students who only watched lectures online and did not attend any lectures.
3 Visitors: students who only attended lectures and did not watch any recorded lectures.
4 Supplementers: students who both attended lectures and watched lectures online.

Next, a graph was created in which for each separate lecture, what students have done was indicated: attending the lecture, watched the recorded lecture, did both or did neither.

Subsequently, group membership was determined throughout the course before the first exam and thereafter the second exam. Because membership of the groups may change for the second exam (ie, a student who attended lectures before the first exam may only have watched lectures for the second, etc), we have in essence two measurements and conducted two analyses of variance (ANOVAs) with a Hochberg GT2 post-hoc test.

Subsequently, correlations between time spent on lectures (either online or face to face) were calculated for the four groups in relation to the two separate exams. Because the time spent on lectures is slightly skewed to the left, a Spearman's rho was calculated.

Finally, linear regression analyses were performed in order to explore how time spent on lectures (either online or face to face) contributes to the final grade on either assessment.

Results

A total of 397 students completed the first assessment ($\alpha_1 = .66$; $M_1 = 5.67$; $SD_1 = 2.17$). The second assessment was completed by 367 students ($\alpha_2 = .60$; $M_2 = 5.63$; $SD_2 = 1.96$).

Figure 1 presents an overview of the frequencies of use of face-to-face and recorded lectures for each separate lecture.

Figure 1 shows a decrease in lecture attendance from the first to the second assessment ($t(396) = 7.99$, $p = .00$, $r = .69$). It also shows an increase of the use of recorded lectures from the

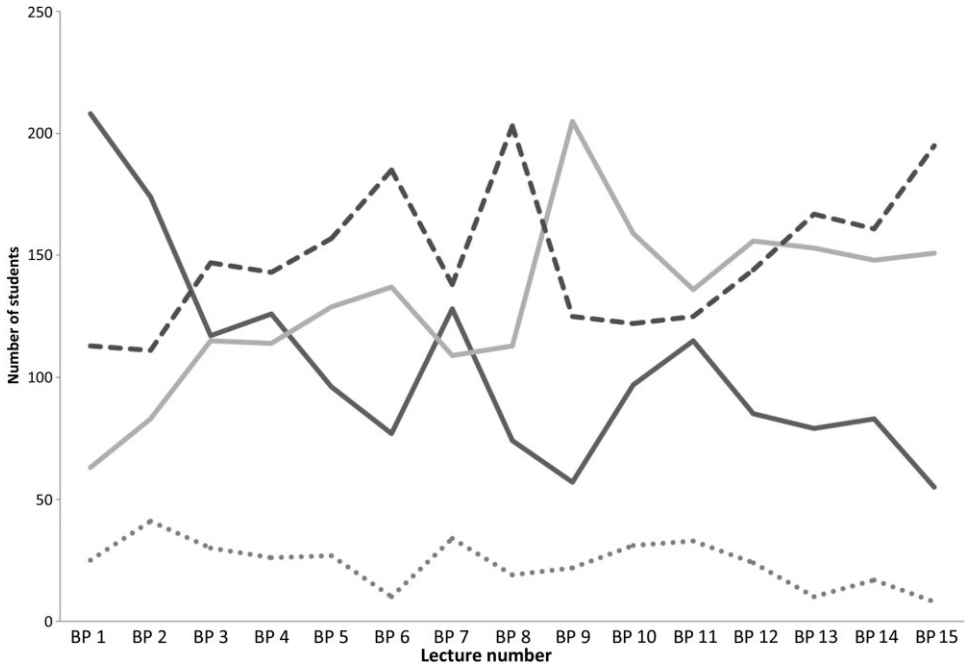

*Figure 1: Attendance in face-to-face lectures and usage of recorded lectures broken down by lecture (*n *= 397).* ——, *non-users;* ——, *viewers;* ····, *visitors;* – –, *supplementers. BP, biological psychology*

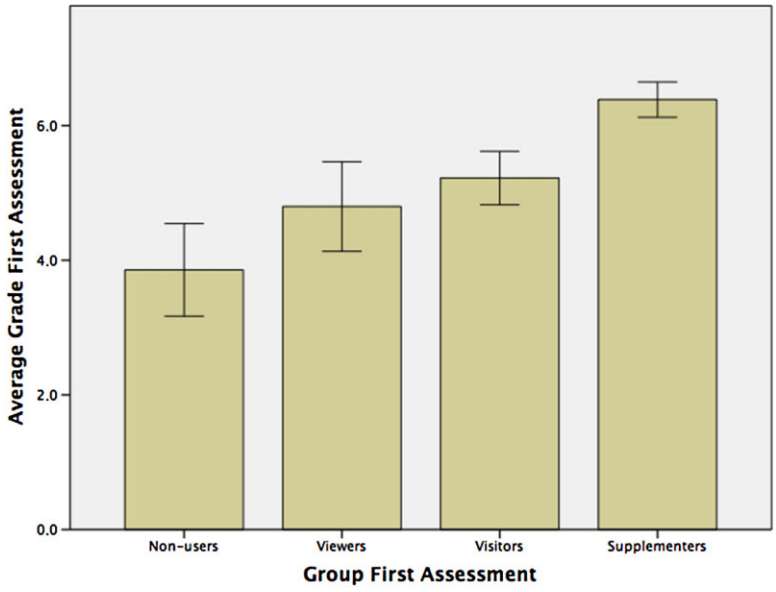

Figure 2: Average score on the first assessment for the four different groups

first to the second assessment ($t(396) = -7.16$, $p = .00$, $r = .68$). The amount of students who use the recorded lectures as a supplement to a specific lecture is rather small.

There was a significant difference between exam performance for the four different groups for the first assessment ($F(3,392) = 23.145$, $p = .00$) where the knowledge base was assessed. Because sample sizes differed among the four groups for the first assessments, a post-hoc Hochberg's GT2 was used to determine which means were significantly different from the others. The test indicated that mean scores for the non-users ($M = 3.86$, $SD = 2.00$), the visitors ($M = 5.22$, $SD = 2.04$) and the supplementers ($M = 6.37$, $SD = 1.93$) were significantly different. However, the viewers ($M = 4.80$, $SD = 2.26$) did not significantly differ from the non-user or visitor groups. Figure 2 shows these differences in final grade for the different groups.

Also for the second assessment, where the higher order thinking skills were assessed, a significant difference was found in exam performance ($F(3,362) = 11.00$, $p = .00$). A Hochberg's GT2 test showed that only the non-users were having a significant lower mean ($M = 4.24$, $SD = 1.99$) compared with the other three groups: the viewers ($M = 5.85$, $SD = 1.98$), the visitors ($M = 5.5$, $SD = 1.98$) and supplementers ($M = 5.99$, $SD = 1.82$). Figure 3 shows these differences in final grade for the different groups.

The data for both assessments are slightly skewed to the right for attendance and watching, which indicates that a relatively small amount of students were responsible for most visits and views, while relatively many attended a few lectures and watched few online lectures. We therefore used a Spearman's rho correlations to explore the relationship between the number of minutes of watched lectures, either online or face to face, and the final grade for either exam. The correlations, which can be found in Table 1, were calculated for the first assessment, where the knowledge base was assessed.

Table 1 indicates that only watching lectures online (viewers) has the lowest correlation between time spent and the exam score ($r_s = .16$, $p < .01$), while only attending lectures (visitors) correlates highest with the exam score ($r_s = .42$, $p < .01$). Students who use both forms of instruction (supplementers) show a lower correlation than expected, though the majority of

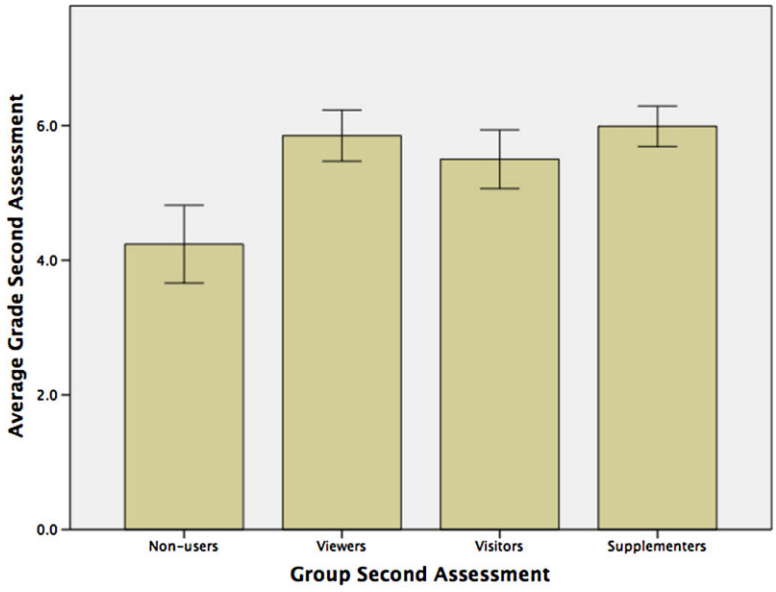

Figure 3: Average score on the second assessment for the four different groups

Table 1: Correlations between lecture time in minutes and exam score for the first assessment

			Minutes watched		*Minutes visited*		*Assessment*	
	rho	n	M	SD	M	SD	M	SD
Non-users	—	35	—	—	—	—	3.86	2.00
Viewers	.16**	47	345	249	—	—	4.80	2.26
Visitors	.42**	104	—	—	492	258	5.22	2.04
Supplementers	.35**	210	295	301	429	231	6.39	1.92
All students	.50**	396	197	277	356	281	5.67	2.17

**$p < .01$. *M*, mean; *SD*, standard deviation.

students are in this group. The increased time on task of the supplementers does not seem to lead to a higher exam score. When it comes to developing a knowledge base, face-to-face lectures contribute most to the exam scores.

Table 2 shows the correlations between minutes of watched lectures and the scores on the second exam, where higher order thinking skills were assessed.

Both the group of students who only attended lectures and the group of students who supplemented the lectures with recordings clearly decreased in size. The amount of students viewing a recorded lecture or supplementing a lecture shows an increase. As seen in Figure 1, the amount of supplementers per lecture is relatively low: supplementation on a lecture level hardly occurs. Students alternate their lecture attendance with online viewing. This explains the increase of minutes watched for both groups (viewers, supplementers), while class attendance shows decrease in minutes visited for both groups (visitors, supplementers).

As the ANOVAs showed before, correlations with exam scores go down for all groups for the second assessment.

Table 2: Correlations between lecture time in minutes and exam score for the second assessment

			Minutes watched		*Minutes visited*		*Assessment*	
	rho	n	M	SD	M	SD	M	SD
Non-users	—	48	—	—	—	—	4.24	1.99
Viewers	.24**	107	497	292	—	—	5.85	1.98
Visitors	.24*	68	—	—	448	231	5.50	1.80
Supplementers	.31**	143	312	212	343	208	5.99	1.92
All students	.36*	366	268	285	219	252	5.62	1.96

*$p < .05$; **$p < .01$. *M*, mean; *SD*, standard deviation.

Table 3: Association of students' grades for the first assessment with their duration of the use of face-to-face lectures for the first assessment and recorded lectures for the first assessment

	Viewers			*Visitors*			*Supplementers*		
Variable	*B*	SE *B*	*β*	*B*	SE *B*	*β*	*B*	SE *B*	β
Constant	4.18	.56		3.44	.39		5.067	.26	
Minutes online	.002	.001	.195				.001	.000	.167
Minutes face to face				.004	.001	.458	.004	.001	.424
R^2		.038			.210			.173	
F		1.775			27.115			21.579	

SE, standard error.

Table 4: Association of students' grades for the second assessment with their duration of the use of face-to-face lectures for the second assessment and recorded lectures for the second assessment

	Viewers			*Visitors*			*Supplementers*		
Variable	*B*	SE *B*	*β*	*B*	SE *B*	*β*	*B*	SE *B*	*β*
Constant	5.27	.38		4.59	.48		4.54	.42	
Minutes online	.001	.001	.171				.003	.001	.314
Minutes face to face				.002	.001	.255	.002	.001	.201
R^2		.029			.065			.094	
F		3.169			4.599			7.279	

SE, standard error.

To address the question to what extent time spent on face-to-face lectures and recorded lectures contributes to the scores on the two different assessments, we conducted linear regression analyses to identify associations, or predictive relations, of time spent on face-to-face lectures and/or time spent on recorded lectures to academic performance. The analyses were designed to establish whether differences in total time of students' use of face-to-face lectures or recorded lectures were associated with differences in their performance in the course. The regression analysis for the first assessment, which can be found in Table 3, shows that face-to-face lectures contribute most to the exam scores (21% of variance explained). Only watching recorded lectures seems ineffective, as it only contributes 4% to the exam score.

Table 4 shows that the explained variance for all forms of instruction shows a decline. This decline indicates that, when assessing higher order thinking skills, the form of education has no

significant contribution to the final grade. Attending lectures only accounts for 6.5% of the variance, whereas using the recording of the lectures as supplements does it slightly better as it accounts a bit more than 9% of the variance.

Discussion

The purpose of the present study was to assess the use of recorded lectures in an authentic setting by focusing on the actual time spent on the usage of recorded lectures in relation to lecture attendance and the effect on exam performance.

One of the most basic questions in this context was whether students will make voluntary use of face-to-face or recorded lectures. The data distributions show a considerable amount of students who do not attend the lectures or only used the recorded lectures. It is noteworthy that the use of recorded lectures is higher than the face-to-face lectures. While it is debatable whether the amount of students who do not use recorded lectures is high or low, the relative high amount of students, however, who do not attend lectures is remarkable.

During the course, there is a shift between lecture attendance and the use of recorded lectures. As lecture attendance decreases for the second assessment, the use of recorded lectures increases for the second assessment, suggesting that students increasingly use recorded lectures as a substitute for face-to-face lectures. This shift can be explained by the familiarisation of the students to the use of recorded lectures in their education and the experience that they no longer need to attend the face-of-face lectures with the same frequency. As this group of psychology students had not any prior experience with recorded lectures before the BP class, a familiarisation process can explain this shift in behaviour. The increasing use of recorded lectures during the course over the two periods contradicts the study of tool use of Lust *et al* (2011), in which they concluded that recorded lectures were mainly used at the early stages of the course to support the development of a knowledge base for students. The current research shows the opposite: students consult the recorded lectures even more throughout the course, also during the phase where higher order thinking is addressed. Students do not seem to adjust their tool use based on their learning needs as Lust *et al* (2011) assumed, but will base their tool use on familiarisation with these tools.

The results show a significant difference of the form of instruction on exam performance in the assessment of the knowledge base, but not in that of higher order thinking skills. When assessing the knowledge base, students who use recorded lectures as a supplement score significantly higher than the students who only attend lectures. They also spent the greatest amount of time on any form of instruction. Although their final grade for the first assessment is significantly higher compared with the other three groups, the correlations between time spent on task and the assessment score for the knowledge base, however, show that time spent by supplementers has a lower correlation with exam score than time spent by students who only attended face-to-face lectures. Their lower correlation can be explained by the diminishing returns of their extra effort. A large increase of time on task will necessarily lead to only a marginal increase in the final mark. This contradicts with earlier research from Cramer *et al* (2007) where the researchers found that if the recorded lectures were used longer in duration, students achieved significantly higher scores. Time on task is therefore not the mechanism that might explain the added value of supplemental use of recorded lectures in relation to academic achievement.

Though only attending face-to-face lectures correlates highest with exam scores, the number of face-to-face lectures attended explains 21% of the first exam's scores and decreases to 7% of the second exam. For supplemental use, we see the same decrease from the first to the second assessment with an explained variance of 17% for the first assessment and 9% for the second assessment. The predictive value of only watching the lectures online seems more stable (4% and 3%) but extremely modest. For higher order thinking skills, the form of instruction is currently

not influencing exam scores, as long as students participate in any type of instruction. For developing a knowledge base, face-to-face lectures seem the most effective teaching method of transferring knowledge.

In short, recorded lectures have added value for learning objectives that deal with developing a knowledge base, but only if these recordings are used sparingly and with restraint. For learning objectives that deal with higher order thinking skills, recorded lectures seem to offer less value, though neither do face-to-face lectures.

Limitations of current research

One limitation of the current research is that it only takes into account one specific course with one group of students. A replication of the current research within different courses and a different student population is necessary to make a more general statement about the effect recorded lectures can have on exam performance. Still, the present study shows that recorded lectures have a predictive value on exam performance, even when higher order thinking skills are assessed.

Another limitation of the current study is that it does not consider a more detailed individual use of the recorded lectures. It is not clear if students display different viewing patterns but it is not hard to imagine that some students will show continuous viewing patterns, while others will view several chunks of a lectures. It is currently not clear how those different viewing patterns affect academic achievement. With a more detailed insight in these individual differences, the possible influence on exam performance can be established on a more individual level. Preliminary work of Bassili (2008) revealed a relationship between the actual choice to attend lectures or watch them online in relation to used cognitive strategies like memory, elaboration and rehearsal. Differently used cognitive processing strategies might also account for the possible influence that recorded lectures might have on academic achievement.

The current study takes into account the relationship between lecture attendance and supplementary use of recorded lectures. The usage of recorded lectures or lecture attendance is determined throughout the course, during several weeks. It is likely that a student attends the lectures for the first couple of weeks and decides to watch the remaining part of the lectures online. In the current research, students will be placed in the group supplementers, while in fact the students belong to a different group. Figure 1 shows that the actual number of students who use the recorded lectures as a supplement is relatively low.

Recommendations for future research

When recorded lectures have a predictive value, it is important to explore which explanatory variables can cause this effect. Here are three points of interest. First of all, which kind of viewing patterns (how) students display when they watch the recorded lectures: do they watch them all at once or in small chunks? The latter can indicate that students are looking for certain additional information, for example, in their textbooks, when watching a recorded lecture. When they pause the recorded lecture and seek additional information, they may be trying to gain a deeper understanding of the material, which could not have been done in the lecture hall, as it is not possible to pause the lecturer if something is not clear. This assumes a more active approach to watching a recorded lecture or a more passive attitude in the lecture hall than previously assumed. A second point of interest that needs additional research is how often students watch certain parts (what). Previous research by de Boer, Kommers and de Brock (2011) showed differences in viewing patterns in a laboratory setting. Further analysis of the current data could determine whether the same behaviour is also observed outside of a laboratory setting that could explain the higher predictive value of recorded lectures for the second assessment. The third aspect that needs additional research is timing of consulting recorded lectures (when): is it to compensate for a

missed lecture the following week after the lecture or is it to use as exam preparation in the week before the exam? Future research should therefore further analyse what, how and when the recorded lectures were viewed in relation to class attendance.

Furthermore, to get a deeper understanding of student behaviours, future research should also supplement the data analysis with focus group sessions. These focus group sessions could elaborate if changing pattern of behaviour reflects a decrease in commitment, which causes eventually the different results for the second assessment.

Statements on open data, ethics and conflict of interest

Open data statement

The data on which this research is based are available on http://dx.doi.org/10.6084/m9.figshare.1144386. Records have been anonymised. Data are available to other researchers under a Creative Commons BY-ND 3.0 licence.

Ethical declaration

The research was conducted in accordance with the regulations set up by the University of Amsterdam's Psychology Department's Ethics Committee. Its proposal was approved by the Ethics Committee on March 19, 2013, and has been assigned project number 2013-EXT-2827. These regulations included an informed consent form and removal of subjects who refused to have their data used, as described in the paper. The Ethics Committee's website and contact persons can be found on https://www.lab.uva.nl/ce/.

Conflicts of interest statement

None of the four authors have a conflict of interest in this research.

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