Lecture Recordings in Higher Mathematics Education

Use and Impact on Academic Performance

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Abstract

This article presented a first explorative study of the relationship between the students' use of lecture recordings and their academic performance. For this purpose, statistics of access to the recordings of two lectures were analyzed and then compared with the results of the corresponding exam at the University of Education. Also, students answered a questionnaire in the way they used the lecture recordings in their learning process. A first look at the data conveyed the impression that frequent use of the lecture recording leads to worse results in the exam. However, at the same time, there has been a decrease in the failure rates for courses where lectures are recorded.

Keywords

ICT; Lecture recordings; Higher Mathematics Education; Academic Performance

Introduction

Lecture recordings have already become a regular feature at many universities around the world (Blumschein & Vögele, 2005; Verliefde, Vermeyen & Van Den Bossche, 2010). These are generally made available in addition to attending the lecture in person. Various terms are used in the literature: *lecture capture* (Veerami & Bradley, 2008), *lecture webcasting* (Traphagan, Kucsera & Kishi, 2009), *online video lecture recordings* (Wieling & Hofman, 2010), *webcasting* (Deal, 2007 and *weblecture* (Day, 2008). The term *lecture recordings* is used in this paper which means the video-recording of a lecture given by the lecturer, of the board and presentations slides.

There are now many studies and analyses of lecture recordings, but these generally only target the way they are used (e.g. Veeramani & Bradley, 2008), the influence of the recordings on the learning motivation or on attendance at the lecture (e.g. Traphagan, Kucsera & Kishi, 2009). However, there are hardly any studies that examine the effects of lecture recordings on the academic performance. At German universities this is due above all to the data protection guidelines and laws which are comparatively stringent.

This study first of all describes how lecture recordings are organized at the University of Education Ludwigsburg. Teacher training students of mathematics for secondary schools were the first to be offered this service. In the summer semester 2010 they answered a questionnaire designed to find out what role lecture recordings played in their learning process with the aim to provide insights into the learning role of the recordings in the field of mathematics. In addition, the still relatively uncharted territory of the impact of lecture recordings with regard to academich performance is now explored. The access figures for the recordings are compared and correlated with the exam results by means of the Learning Management System (LMS) log files, in compliance with the data protection laws and regulations.

Theoretical Background

Courses of study that include mathematics still have high dropout rates in Germany (cf. Heublein, Hutzsch, Schreiber, Sommer & Besuch, 2010). This is also a reason why the subject of mathematics is considered to be a way of "sifting out" students. In order to reduce the dropout rate at a particular campus, more and more "support programmes" for students have been established at many universities. As an additional service, the lectures are video-recorded and made available to the students (Verliefde, Vermeyen & Van Den Bossche, 2010; Blumschein & Vögele, 2005). However, up till now very little research has been carried out on this type of support programmes, so that it is not possible to say whether the lecture recordings assist or hinder learning and contribute towards lowering the dropout rate.

Both international and national studies show that students themselves feel that lecture recordings are

positive and helpful (Höver, Rößling & Mühlhäuser 2010; Veeramani & Bradley, 2008). Day (2008) has identified a positive effect on learning motivation as a result of recordings. The fear that the lecture recordings might lead students to dispense with attending the lecture personally was not substantiated in the studies. Making lecture recordings available has practically no effect at all on attendance at lectures (Deal, 2007). Rather, the students consider the recordings to be an additional service which is used chiefly for exam preparations and for revision work (Höver, Rößling & Mühlhäuser 2010; Deal 2007).

Despite positive evaluations of lecture recordings by the students, so far there have only been isolated studies of the extent to which there is a correlation between the use of the lecture recordings and academic performance, and what the effects of this are. Study results have been somewhat mixed, in part because they often focus on slightly different scenarios (William, Birch, & Hancock, 2012, p. 200). Most studies find no significant effects on the academic performance (Traphagan, Kucsera & Kishi 2009; Deal, 2007; Chiu, Lee & Yang, 2006). There are also results that indicate a positive effect for a series of law lectures (Wieling, & Hofman, 2009). However, there are studies demonstrating that lecture recordings can have negative effects on academic performance (Ross & Bell, 2007).

Overall, one can summarize that the current research on lecture recordings is still very limited in extent. Above all, there is a substantial variation in results regarding its effects on academic performance.

Lecture Recordings at the University of Education Ludwigsburg

A major problem, especially with first-semester mathematics students, is that proofs elaborated on the board are often not understood the first time they are presented. However, when the lecture is reviewed with the help of lecture notes, the verbal explanations and comments are especially important to reconstruct a proof and to make sure that it has been understood properly. These explanations are generally not noted down, in particular by new students. Thus the original idea of offering lecture recordings at the University of Education Ludwigsburg was always to make the explanations of the proof or the whole lecture available in an audio-visual format. A further advantage for the students is that they can catch up on a missed lecture almost as if they had attended it.

In the summer semester 2009 the course "Introduction

to Geometry" was recorded for the first time for students preparing for the state examinations to become teachers at secondary schools. The lectures were part of the Project SAiL-M, founded by the Federal Ministry of Education and Research (for further information visit www.sail-m.de). In this project, various learning scenarios were dedveloped and implemented to improve the quality of the mathematics vocational training at the beginning of their studies. Here the activating and competence-oriented environment was evaluated on the one hand regarding its role in the students' learning process and on the other hand as regards its acceptance (Bescherer & Zimmermann, 2013). A major innovation was that the students were provided with lecture recordings to support their individual learning process.

A normal video camera and a radio microphone were used for the first lecture recordings. The video camera was located at the rear of the lecture hall and the lecturer, the writing on the board and the PowerPoint presentations were captured on video. Depending on what was done, the recording focused on what was most important. After the lecture, the recordings were processed by a member of the project team and made available online on the university-wide LMS. Thus the students were able to view lecture recordings on the LMS at any time and any number of times. In spite of compression, the approx. 90-minute videos were approx. 150 – 200 MB in size. This was the reason why the students also wanted the videos to be made available to download, so that the replay quality did not depend on the bandwidth of the Internet connection.

The purpose of the initial trials in the summer semester 2009 and in the following winter semester 2009/10 was above all to establish the students' need for video recordings of the course and to identify technical shortcomings and possible improvements. The positive feedback and consistently good access statistcs meant that in the summer semester 2010 the lecture series "Introduction to Elementary Geometry", "Didactics of Geometry" and "Application-oriented Mathematics" for students aiming to become teachers at secondary schools was recorded for the first time by tutors from the Department E-Learning using the program *Lecturnity*[1]. Thus it was possible for every course in a module to offer a video-based recording that is synchronized with the presentations slides. The lecture recordings could once again be accessed via the

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[1] For further information visit http://www.lecturnity.co.uk

LMS as a video playback and were also available to download.

Study and Results

At the end of each lecture series in the summer semester 2010 and winter semester 2010/11, a questionnaire was distributed to find out how the lecture recordings were used, and also their importance and role in the individual learning process. In addition, as a result of providing the lecture recordings via the LMS, it was possible by using the log files to ascertain the number of times each student accessed the videos. This data was then used for a more precise analysis regarding the impact on the academic performance, in compliance with the existing data protection guidelines.

Use of the Lecture Recordings

For this purpose, a questionnaire[2] was designed to investigate the use of lecture recordings in the students' learning process in mathematics. Besides personal data, the students were also to make a rough estimate of the frequency of use of the recordings. Also they were asked to give details of the importance and role of the lecture recordings in their individual learning process. The questionnaire consisted of one page with multiple choice questions. In the summer semester 2010 a total of 67 students (48 female/ 19 male), in the winter semester 2010/11 52 (33/19) participated in the survey with an average age of 22.5 and 24.0 years respectively. The survey was taken after the last lecture of the semester online in the LMS. Response rates cannot be quoted, because there are students registered in the LMS which quit attending to the lecture after the first weeks.

In answer to the question about the role of the lecture recordings, the students could choose from five items describing how they use the recordings in their learning process, multiple answers were possible. Admittedly, it is worrying here that a relatively high number of students (30% and 38%; cf. Table 1) stated that they use the recordings as a substitute for attending a lecture. However, the number of participants attending the lecture personally did not decrease to this extent during the semester. First and foremost, the lecture recordings serve to review and revise work as well as partly to prepare for exams (cf.

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[2] A German version of the questionnaire is available at https://www.ph-ludwigsburg.de/fileadmin/subsites/8x-0003-t-01/user_files/Evaluationsfragebogen_video_v4.pdf

Table 1); this is also shown by the results of Höver et al. (2010) and Deal (2007).

TABLE 1 ROLE OF LECTURE RECORDINGS DURING THE PROCESS OF LEARNING OF THE STUDENTS

Role during the learning process	Summer term 2010		Winter term 2010/11	
	n	p%*	n	p%*
No role at all	67	34%	52	17%
In exchange to the lecture	67	30%	52	38%
For review or repetition	67	45%	52	42%
Reference work	67	18%	52	19%
Exam preperation	67	34%	52	8%

*) percentages were rounded off to integers.

Furthermore, evaluations of the figures for accessing the videos in the LMS per week show that the videos are viewed increasingly (cf. Fig. 1). After a first rise in the second week, the videos were viewed or downloaded constantely about 40 times a week. Unfortunately, the statistics do not yield whether the views or downloads were from a specific student nor if a student watched a video several times. Above all there is a further increase of views and downloads in the last two weeks before the exam (week 13 and 14). After that the figures for accessing the videos decreased in all eight weeks after the exam, which were combined to 'week 99'. Nevertheless, for just over a third (34%) of the students lecture recordings play no initially part in their individual learning process. However, in the following semester, this percentage drops by half (cf. Table 1).
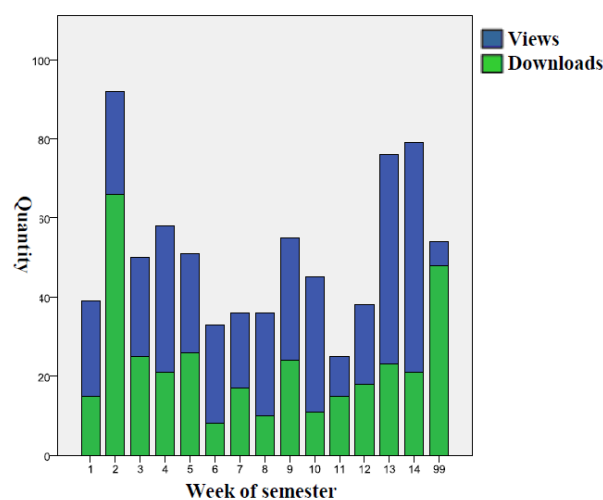

FIG. 1 NUMBER OF VIEWS AND DOWNLOADS OF THE LECTURE RECORDINGS PER WEEK OF THE SUMMER SEMESTER 2010

In addition, the students were requested to state to what extent they viewed the recordings and which technical components were important for them. Predominantly, students just view parts that are of

special interest to them (73%) and not the complete video (20%). Therefore it would seem sensible always to offer lecture recordings in such a way that the learners can find the various sections quickly. In the recordings, the video image of the board and the writing on the board are rated as important (78%), whereas the video image of the lecturer (45%) and the presentation slides (38%) play a subordinate but not unimportant role. A further role is played by the sound recording of the lecturer (36%) – a recording of a lecture without sound would make little sense. Only the sound recording of the students contributions (<2%) is of negligible importance.

In the last question, the students were asked to assess how useful in general the provision of lecture recordings was in their studies. Here only 3% of the students consider the offer to be superfluous. Whereas 24% of the students see the offer as a "nice extra", 73% stated that the service should also be extended to other courses, especially in mathematics.

Effects of Lecture Recordings on Academic Performance

To date, there are only isolated studies of the effects of offering lecture recordings. The reason for this is primarily that research in this area frequently comes up against the constraints of data protection, since personal data have to be used. With the LMS Moodle used at the University of Education Ludwigsburg, as with other learning management systems, all user activities for each course are stored for administrative purposes. This data can be viewed exclusively by the administrators of the learning platform; however, the data shows for each and every student how often they viewed or downloaded a file or a video. This data can be analyzed in greater detail, e.g. the number of times the recordings are accessed can be compared with the corresponding exam results at the end of the semester. In order to use this data without breaching privacy laws and so that no deductions can be made about any particular person, a procedure was developed for pseudonymizing the data (Fig. 2). A neutral person, the "key-keeper", is provided with a list of all the grades and matriculation numbers. In addition, the staff of the department of E-learning at the University of Education Ludwigsburg makes detailed log files showing access from the LMS along with the matriculation numbers available to the key-keeper. Using this, a list is generated with pseudonyms (TN01, TN02, etc.), the access statistics and the grade. Only the key-keeper has the key consisting of the pseudonym and the matriculation number. This

ensures that the authors cannot draw any conclusions about the persons concerned. This pseudonymized list is then made available to the authors for the evaluation.
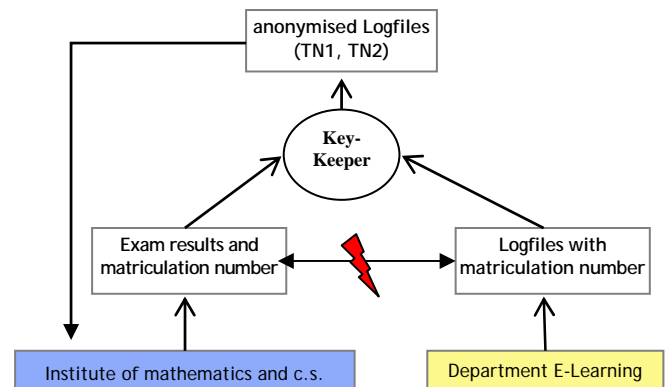

FIG. 2 PROCESS OF PSEUDONYMISATION

Based on the correlation of the access statistics for the recordings and the exam grades, the pseudonymized data can now be used to examine quantitatively what effect lecture recordings have on the students' performance. Here the mean values of the data are compared using a single factor variance analysis according to Spearmann.
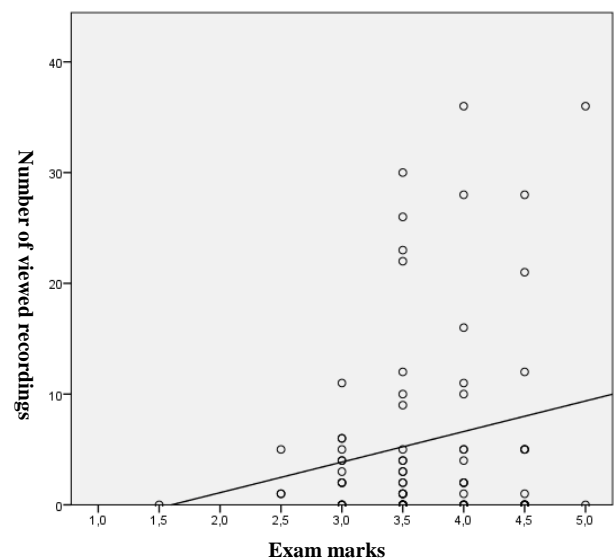

FIG. 3 CORRELATION BETWEEN THE NUMBER OF ACCESS TO LECTURE RECORDINGS AND EXAM MARKS (COURSE: INTRODUCTION IN ELEMENTARY GEOMETRY)

In the course "Introduction to Elementary Geometry" a significant correlation can be found between the lecture recordings and the exam grades regarding the group of students that viewed or downloaded the recordings ($r=0.372$; $p<0,01$). The correlation still remains when all the students who passed the exam are included even if they did not watch any recordings. However, the correlation between the two variables is weaker and no longer significant ($r=0.196$, cf. Fig. 3).

The same weak tendency (r=0.139, cf. Fig. 4) can be found in the course "Application-oriented Mathematics" one semester later.
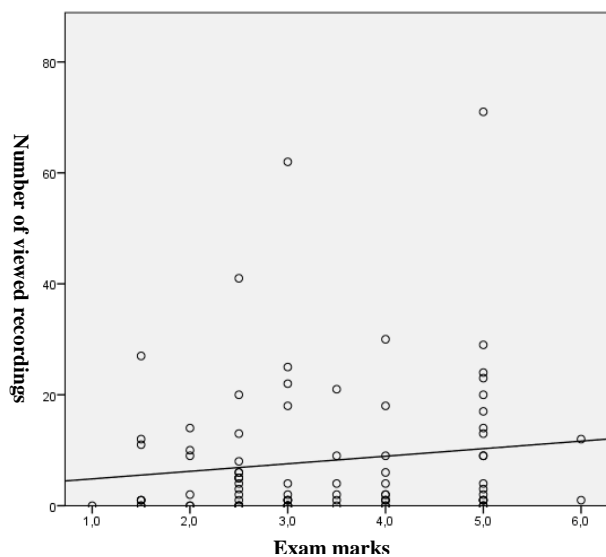

FIG. 4 CORRELATION BETWEEN THE NUMBER OF ACCESS TO LECTURE RECORDINGS AND EXAM MARKS (COURSE: APPLICATION ORIENTATED MATHEMATICS)

At first sight, analyzing the correlation tendencies, one can say that the more often a lecture recordings is watched by a student, the worse his or her exam grade will be[3]. However, in our opinion, this causality of the data can not be inferred. Normally, the more often you repeat and recap, or in our case review a content, it should have a positive impact on the learning process. With a differentiated view of the data, including the failure rate in the exams, the causality has to be disregarded. The failure rate in the exams of both investigated courses is about 23%, which is relatively low for mathematics courses at German universities. In Germany failure rates from 40% up to 60% are quite normal (cf. Heublein et al, 2010). Obviously, lecture recordings seem to help and support weaker students in particular. The exam can be passed successfully, even if the mark is not good. Without lecture recording, the exam might have been failed. For these reasons, a positive effect can be ascribed to lecture recordings.

Conclusion and Discussion

This study shows how lecture recordings at the University of Education Ludwigsburg are implemented and used in the subject area of mathematics, and also describes the current state of research regarding the question of the effect of lecture recordings on academic performance. The evaluation at the University of Education Ludwigsburg presented initial results for mathematics in the German-speaking regions; however, these results will be investigated further and in a more differentiated way in the coming semesters.

For the most part, the results of our study correspond with the findings in section 1. On the one hand, lecture recordings play a role in the lerning processes of the students, especially for exam preparations and for review or epetition. Regardning the effects on academic performance of the lecture recordings, the most correlations were neither significant nor positive. However, our correlations were all weak positive: good students hardly make any use of the lecture recordings, weak students use them more often (cf. Fig. 3 and Fig. 4). Despite of the data, it can not be concluded that lecture recordings have negative effects on the academic performance. Le et al. (2004) showed that the use of the recordings is associated to learning strategies of the students. In contrast to weaker students, good students adopted a deep learning strategy and did not need this kind of support or help in addition to the lecture. However, weaker students with a more surface strategy need this kind of support for their learning processes (Le et al., 2004). In addition, weaker students are more attracted to new technology and use it more often (Allert, 2004). For the time, the reasons for our positive effects of lecture recordings remained suppositions, but they were supported by the low failure rates in the corresponding exams.

After the initial experiences and further developments regarding the technology and quality of the recordings, this service is now also made available to other lecturers. This complies with the wish of the majority of the students that the service should be extended to other lectures, both in mathematics and other subject areas. In addition, the effect of the academic performance on exam results should be further investigated by evaluating other series of lectures. Further investigations will have to be carried out in this direction, and possibly other subject areas, should the indicated–weak–correlation be confirmed or become more pronounced in the current and the coming semesters. Thus the idea is, possibly, to conduct interviews with students who can provide further insights into the learning role of lecture recordings.

A further possibility for improving the service offered to students is the idea that recordings and/or in

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[3] In Germany the best mark is 1.0, the worst is 6.0. Normally you successfully pass the exam by reaching 4.0.

general materials that are offered as a podcast should not serve to entertain the students, but should be additionally combined with other learning activities (cf. Edirisingha & Salmon, 2007; Spannagel & Spannagel, in press). Initial developments go in the direction of combining the lecture recordings with wikis, annotation tools and other social applications (cf. Ketterl, Emden, Mertens & Vornberger, 2010).

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