Screencasting for mathematics online learning – a case study of a first year Operations Research course at a dual-mode Australian university

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ABSTRACT
This chapter presents a case study of technology integration to support student learning in a first year operations research course at a dual-mode university. The course is taken by on-campus and distance students at the same time. It is shown how both groups are treated the same in this course in terms of provision of course material, access to the course learning management system, and to screencasts of live classes and additional explanations. The only difference between the two groups is the on-campus students’ ability to attend live face-to-face classes and to interact with the lecturer. The chapter demonstrates how screencasting is used effectively in online learning. Its objective is to share good practice of technology enhanced learning.

KEYWORDS
Screencasting, tablet technology, distance education, technology enhanced learning, mathematics

INTRODUCTION
Distance learning in mathematics has changed enormously in the last forty years or so, from an entirely paper-based, isolated student experience, to the provision of online multi-media learning objects and the encouragement of collaborative learning of students in different time zones scattered across the globe (Loch, Reushle, Jayne & Rowe, 2010). Technologies have become available now that were not even dreamt of in the past, with opportunities to use them in new and innovative ways to enhance student learning. This has also meant that the difference in study experience between on-campus and distance students is getting blurred, as even traditional universities with only face-to-face enrolments are embracing online education.

This chapter takes a case study approach, describing a first year operations research course at an Australian regional dual-mode university (“the university”) in which various technological approaches were embedded to enhance the student experience. Some of these technologies are: web conferencing for one-on-one support, where students asking for help were walked through a problem by explaining on a shared whiteboard whilst talking; electronic assignment submission, including trials of digital note pens to enable students to electronically (hand-)write their assignments; and electronic marking of assignments with pen-enabled technology. In this chapter, we will discuss neither of those, but instead focus on screencasting, an asynchronous technology, to effectively support not only distance students but also on-campus students in first year mathematics. A screencast in this context is an audio and video screen capture recording of an instructor’s oral and computer-based visual explanation, also capturing electronic writing, for example on a tablet PC. These screencasts are recordings of live lectures, or they are created in
The chapter will commence with a discussion of the value of and concerns with lecture recording for on-campus and distance students, summarizing what is now becoming quite an extensive literature base. By placing this in a mathematical context, the use of screencasting in mathematics learning is motivated. This is followed by an overview of where distance education started at the university, to where it is now. It will then describe in more detail the context of the course being investigated, and briefly outline the course material production environment which provides a basis for effective integration of multi-media learning objects. The three ways screencasting is used in the course are then demonstrated and discussed. The chapter will point out implications of technology enhanced teaching, for instance on lecturer workload and training requirements. The objective of this chapter is to share good practice of technology integrated online learning in mathematics, and encourage others who are moving towards online instruction to explore the presented techniques and to go beyond.

BACKGROUND
Traditionally, the lecture model is the most commonly used teaching approach in universities, and this is particularly true in the mathematical sciences. Most current mathematics lecturers would have studied mathematics through face to face lectures and this model is the one they are familiar and comfortable with. However, while lectures accomplish important and valuable purposes (Ayers, 2002), they may not fulfill “learning potential of typical students today”, particularly from the Net Generation. These students want interactive approaches, using computers, but also with the lecturer and fellow students (McNeely, 2005). On the other hand, more flexible options should be investigated since many (Australian) university students are of mature age and combine studies with work and family commitments (Phillips, McNeill, Gosper, Woo, Preston & Green, 2007), and students’ learning styles and approaches to learning vary (Britain, 2004; Clow, 1998), even between on-campus and distance students (Diaz & Cartnal, 1999).

There is agreement that lectures can be made more effective and accessible for students by recording them (Williams & Fardon, 2007; Laurillard, 1993). While some disciplines lend themselves to the recording of video, for mathematics, in particular, it is vital that the visual component of mathematical explanation is captured together with the lecturer’s aural explanations as “writing the symbols down gives the student a chance to read what has been spoken and thus access the content via several senses” (Townsley, 2002). This means that some form of electronic capturing of writing is required, be it via recording of writing on a piece of paper and capturing with a document camera, or directly onto the computer via tablet technology. This type of recording (“screencast”), used in an online mathematics learning context, is the particular focus of this chapter.

The following is a summary of the discussion on lecture recordings, in part from a general Higher Education point of view, but equally applying to mathematics. Lecture recordings allow students to revise the material whenever they want, wherever they are, at their own pace, and to repeat for reinforced learning as often as they like. Students have also been found to ask fewer repetitive questions when provided with recordings (Kates, 2006). While not necessarily meant as a substitute for the face-to-face lecture for on-campus students, students may catch up on missed lectures, and this learner-centred approach puts students in control of their learning response to student enquiries on online discussion groups, or they are short recordings linked to the study material to explain topics students usually find difficult to understand.
experience. Concern has been voiced over the educational value of full recordings of live lectures to on-campus students (see, for example, Chang (2007)), and the question has been raised if recorded lectures result in lower class attendance, since students have more freedom to turn on or off, fast forward or backward the recorded lecture whenever they like. McCrohon, Lo, Dang and Johnston (2001) found that the flexibility of different modes of delivery offers more options for stimulating deeper approaches to learning. There seems to be consensus that making lecture recordings available online to students shortly after the lecture does not have a significant impact on lecture attendance (Larkin, 2010; Chang, 2007). An earlier study (Loch, 2010) investigated if mathematics students who were given a choice and purposely enrolled on campus would access live lecture recordings, and if so, for what purpose. Individual students were followed throughout a semester, observing lecture attendance, weekly screencast access, and taking into account survey responses. “While a number of students used the recordings to catch up on missed classes, the majority of enrolled students stated that they attended classes because they had decided to enroll on-campus rather than in distance mode, as they valued interaction with the lecturers and the ability to receive an immediate answer to questions” (Loch, 2010). The ability to ask questions and receive immediate answers from an expert is important to students as learning is facilitated through social interaction, by being in a class with peers (McNeely, 2005). Attending scheduled live lectures also gives students a structure and guidance to their study. Most importantly, students “realized that watching a recorded lecture takes as much time to absorb as a live lecture, without the opportunity to ask questions” (Loch, 2010).

What do students think of the impact recorded lectures have on the practice of learning and teaching in their courses? A comprehensive study (Gosper, Green, McNeill, Phillips, Preston & Woo, 2008) surveying students across four large universities found that 76% of students reported positive experiences. The flexibility of access and support for learning appears to be appreciated by students. Moreover, since according to a national survey of university students conducted by Universities Australia, about 25% of on-campus students regularly miss classes to undertake paid employment (Australian University Student Finances, 2006), the flexibility for an on-campus student to work through recorded material may provide the difference between dropping out and succeeding at university. Particularly in mathematics, where content is built in hierarchical order and missed lectures may hinder a student’s understanding of new concepts and halt their progress, providing the opportunity to “catch up” ought to be high on the agenda. This chapter focuses on enhancing the ways a lecturer communicates with students and on introducing more flexibility for students by complementing traditional face to face teaching with online learning in a blended approach, for example by providing a more authentic learning experience to students who cannot (or choose not to) attend lectures. One important example of this latter group of students are distance students.

A few questions could be raised here regarding good practice and student benefit: Can a full lecture recording be counted as good practice? Would it be more sensible to edit the lecture recording, and make the lecture available in shorter chunks, maybe focusing on some important topics rather than making available the whole lecture hour? Would it be better if the lecturer recorded the lecture (or components considered as very important and possibly difficult to understand without aural and visual explanation) in an office environment, most likely leading to shorter, more targeted recordings, and excluding student comments and questions? As will be described later in this chapter, such short recordings may prove to be useful when produced for self-paced study material.
In addition to recording lectures for students who don’t attend classes, other forms of communication are required to support students who struggle with some concepts. Asynchronous discussion forums, included in all current learning management systems (LMS), provide opportunities to address the traditional independence and isolation of distance learners, for example as described by Juan, Faulin, Fonseca, Steegman, Pla, Rodriguez and Tretholm (2009) in a statistics and operations research teaching context. Moreover, rather than being kept separate, on-campus and distance students may be brought together in the same environment and interact with each other. However, these features tend not to be used extensively in symbol-based disciplines such as mathematics where visual explanations are important for communicating concepts. These explanations require specialised tools for online communication not necessarily available through a standard LMS, for instance the option to write or draw on a (synchronous) shared whiteboard while being able to talk about a topic through a text or voice-based channel (Smith & Ferguson, 2004; Loch & McDonald, 2007). Web conferencing software has been trialled and then rolled out at distance education focused universities (Loch et al., 2010) to bridge this gap in mathematics education. This type of software allows synchronous communication including electronic writing on a whiteboard with students who may be located anywhere in the world, as long as they have at least a dial-up Internet connection. However, as a lecturer participating in a web conferencing trial commented, “flexibility comes from asynchronicity” (Loch & Reushle, 2008), synchronous tutorials may not meet all students’ study preferences or time tables. Also, asynchronous technological methods “continue to leave the students in charge of his own work times” (Galusha, 1997). As part of the case study described in this chapter, an approach to combine the benefits of the asynchronicity of a discussion board and whiteboard explanation will be demonstrated: The recording of handwritten explanations in a screencast in response to student questions on the discussion forum.

Heilesen (2010) sums up that the positive effects that have been observed from the use of podcasts (these include video recordings, although screencasts find no specific mentioning) in higher education most likely relate to the “use of the technology rather than the technology itself”, as the technology may support “well known techniques for improving academic performance, such as active engagement and revision”.

**CONTEXT: DISTANCE EDUCATION AT THE UNIVERSITY IN THE PAST**

The university described in this study is located in regional Queensland and is a major distance education provider in Australia, with about 75 percent of its students enrolled in distance mode. The university moved into distance education via dual mode teaching in 1977 as a viable alternative to the offerings at traditional universities (Reushle & McDonald, 2000). In these early times, “on-campus” students were instructed in face-to-face mode, while the typical learning package sent to a “distance” student consisted of print-based materials sometimes supported by audio, and later by video and computer-based resources (Loch et al., 2010). The learning package was designed to enable learners to interact independently with the materials. On-campus students would not necessarily be given access to distance study material as they were expected to attend classes, while distance students would not attend classes. These two groups of students were therefore treated quite differently. In addition the on-campus student would be able to access support from teaching staff or fellow students in person and face-to-face, while the distance student quite often would rely on phone conversations and, before emails, letters exchanged via the postal system. In some cases, distance students were supported by tele-tutorials and/or face-to-face workshops once or twice a semester, during “residential week”, the mid-semester break week (Harman & Dorman, 1998).
CASE STUDY: OPERATIONS RESEARCH

Operations Research (OR) is a first year course offered annually to about thirty to forty students from various programs such as teacher education, IT, science, and double majors in commerce and science. It is taught from a mathematical perspective by mathematics lecturers. About a third of these students are enrolled in traditional on-campus mode and can be expected to attend lectures and tutorials. However the majority study in distance mode, which means they usually never set foot on campus, and may be located in remote parts of Australia or somewhere else in the world. They are required to have access to a computer and an Internet connection. In the past, these distance students were provided with a printed study book, complemented by online, type-based discussion groups facilitated through an LMS and email and phone contact with the lecturer. Technological advances and reduced cost of equipment in the last few years have allowed a rethinking of course delivery mechanisms for distance students, from which on-campus students may also benefit. The major changes that have been implemented relate to the way study materials are created and presented to students, the way instructors interact with students, the way students interact with each other, and the capturing of the classroom experience for distance students or those students who have not been able to attend class.

Integrated Content Environment

Today, OR study material is produced in multi-modal format using the university’s Integrated Content Environment (ICE), which allows course writing in word processors such as Microsoft Word or Open Office (with MathType support for mathematical formulae), and will produce the material in printable format (PDF), and in web delivery as well as CD formats (HTML) (Sefton, 2006). Students receive their study book on a CD and no longer in print, but may print from the PDF document themselves if they prefer reading on paper. This move away from paper towards electronic materials has meant that lead times for material production and for updates to the material have reduced significantly, and that multimedia objects such as screencasts explaining difficult topics can now be embedded in a meaningful way to enhance student learning. Figure 1 shows a screenshot of a section of a study module in web (HTML) format. ICE facilitates breaking up of the material into learning activities such as watching a screencast, searching for information on the Web, or starting a discussion on the discussion forum.
In OR, screencasts were recorded on a tablet PC to enable electronic handwriting of mathematical explanation, with the screen capture packages Camtasia Studio and Camtasia Relay (Techsmith, 2010). This chapter describes three different uses of screencasting:

- Screencasting of live lectures;
- Screencasting in response to student enquiries in the online discussion group; and
- Screencasting of short “snippets”, explanations of topics students usually find difficult to understand.

The effective use and integration of all three are explained in detail in the next sections, including a description of the methodology behind the use of these technologies from a lecturer’s perspective, and a summary of student feedback on the value of screencasts. Suggestions of best practice for those who may be interested in implementing such an approach are provided.

**SCREENCASTING OF LIVE LECTURES**

In OR, three hours of lectures were offered to on-campus students each week, one in the morning and two consecutive hours in the afternoon of the same day, for 11 weeks in a 13 week semester. The remaining weeks were used to refresh material and prepare students for the final exam. All lectures were recorded and recordings made available through the LMS. Printed copies of the lecture PowerPoint or Windows Journal slides with blank spaces for writing were handed out to students attending the classes. These slides, together with the slides annotated in the lecture, were later made available to students via the LMS. Lecture recordings were usually produced in
flash format (SWF), to create small files while keeping a reasonable quality. On average, full screen recordings, taken in Camtasia Relay, then edited and produced in Camtasia Studio, were of the size of 1 MB for three minutes, resulting in 20 MB files for one hour of lectures. If requested by students, lecture recordings were made available for download in zip format for offline viewing.

Figure 2 shows a screenshot of a typical lecture screencast, to be played back through the web browser. A table of contents, automatically populated if a PowerPoint presentation was recorded, helped students navigate quickly through the recording.

Two distance students in OR commented on the availability and effectiveness of lecture recordings in the following way, on end of semester surveys or via unsolicited emails:

> Just wanted to let you know that I was struggling week 2, however watching the lectures you posted helped me so much and now I have a deep understanding of those topics. I would really appreciate it if you could keep putting them up, as I think this will be the difference between staying on track, and falling behind - for me anyway.

> To be honest, without these online screencasts, I would not have understood concepts or passed this course. I hope that all my future subjects have this online lecture material.
A distance student who had not seen screencasts in other maths courses commented that he felt that “this aspect of delivery was particularly valuable and well worth pursuing”, while another said that “simply working through material sometimes takes longer to grasp the point/understand the concept. It was good at times to hear and follow an explanation as provided in the lecture screencasts”.

Positive feedback was also given by on-campus students:

*The screencasts were extremely helpful. I wasn’t able to attend all of the lectures so this allowed me to go at my own pace.*

*I usually sit with a blank piece of paper and scribble down thoughts as I’m watching the lecture. The student questions provide little intervals of time to write down notes and reflect.* (Loch, 2010)

On the other hand, not all feedback from students regarding screencasts was positive. One distance student reported that he found the handwritten annotations difficult to read, and would prefer a PowerPoint animation, revealing content one line at a time. For tricky and complex steps and also as a reminder of rules, he asked for annotations. He also said he didn’t like watching the lecture screencasts because he could not fast forward until the whole recording was downloaded. He preferred short, targeted recordings rather than a complete lecture recording. Another on-campus student made it clear that she preferred interactivity in lectures and was concerned that recordings could replace lectures:

*I watched the first screencast, but I don’t really find this artificial environment useful to my learning. I require a more personal one on one exchange when learning allowing for feedback and gestures to assist in the message.* (Loch, 2010)

Attending scheduled live lectures gives students a structure and guidance to their study, for instance an on campus student commented: “I work better in a face-to-face classroom environment where I can’t day dream, get bored etc.”

To give an indication of student use and acceptance of the lecture screencasts, data from the teaching semester in 2008 is presented here. Out of the 20 distance students enrolled at the end of the semester, ten had engaged with the course and completed all assessment items (three assignments, final exam). One of these failed because of low performance, the other nine passed. Out of the ten students, four had stopped submitting assignments and failed. Six had not submitted any items; these will be disregarded in the following. The pass rate for students who had engaged at least for some part of the semester was therefore 64% (9/14). This is typical for a mathematics distance education course at the university. Student use of the lecture screencasts was as follows. On average, each student watched 14 of the 24 screencasts, and each screencast was viewed by six of the 14 students on average. It is difficult to deduce from the data if screencasts increased the retention rate, however the continued use does show that students regarded the screencasts as valuable. Students were certainly following different strategies – three students watched all recordings (all passed), but of those who watched less than 50% of the screencasts, five also passed.
Interestingly, the situation is quite different for on campus students, where the screencasts were used to catch up on missed classes or for revision, and 13 of the 14 students passed (for more detail, see Loch (2010)).

SCREENCASTING IN RESPONSE TO A STUDENT ENQUIRY ON THE ONLINE FORUM

A discussion forum was maintained in OR, where students enrolled in both modes could ask questions which were answered by the instructor or by other students. Students were encouraged to ask course related questions on this forum rather than via private email, so question and answer could be seen by all students. While most on-campus students used the opportunity of talking to the lecturer during or after a lecture or during consultation hours, distance students quite often utilized the forum. Rather than provide a static response to a mathematical question in the form of a typed explanation, in OR, responses were written on the tablet PC and recorded. The link to these screencasts was then posted on the discussion forum for all students to access.

This usually took less time than typing an answer (keeping in mind that mathematical symbols often require proper typesetting). Recordings were deliberately kept short, as they targeted a specific student question and focused on the explanation of this question. Figure 3 shows a typical online forum thread between student and instructor.

Figure 3: Forum post. A distance student asks for an explanation of a concept from the study material. The explanation is provided by an instructor in the form of a screencast, which satisfactorily answers the student’s question.
A frame from this recording is shown in Figure 4. The typed text, table and mathematical equations are screenshots from the material, to which was added by handwritten annotations to explain how to calculate the values of certain cells in the Simplex tableau. These values were blanked out for the screencast to create space for writing.

![Figure 4: Short screencast in response to a student enquiry on the discussion forum.](image)

The screencast responses have without exception led to students reporting they understand now. A typical student response is the third post in Figure 3. The use of screencasts to support students on the discussion forum has alleviated the previously experienced repeated exchange of forum posts between students and instructor because the typed explanation wasn’t clear or detailed enough.

One of the benefits of responding to students via the discussion group is that the question and answer sequence is available to all students, not just to the student who asked the question. Other students might have had a similar question which is now answered, or weren’t thinking of this question but appreciate the discussion. Screencast responses to student questions may also be used in study material for future semesters, as the topics explained in the screencasts are those that students have identified as difficult and requiring further explanation. To create the short screencasts, a section of the screen was recorded in Camtasia Studio, leaving “private space” on the desktop for typed mathematical formulae or screenshots taken from the material to be moved into the recording area when needed. Writing was typically done in Microsoft PowerPoint, and the recordings were produced in SWF format.

There were two types of student responses to the end-of-semester survey question of what they thought about these screencasts in response to forum questions. Students either hadn’t looked at the screencasts, or they commented very positively, i.e. that the recordings “really cleared things up”, but also that they pointed the student to where they had gone wrong, “The screencasts… in
response to my questions were very helpful as I could see at what point I had begun to get off track, or not understand.” Another student commented:

Yes, I watched them all. They are fantastic, much better than a typed response.

No quantitative data is available on student access of these screencasts.

SCREENCASTING TO PROVIDE SHORT SNIPPETS FOR STUDY MATERIAL

The first time that the OR study material was made available in ICE was in 2008, and in the same semester lecture screencasts and screencasts in response to student questions were introduced to the course. Students were asked at the end of semester if they thought there should be short screencasts in the study material to further explain algorithms, or concepts students find difficult to grasp and which may need to be understood before a student can proceed in a course (“threshold concepts”; e.g. Galligan, 2010). On-campus students attending one of the last lectures in the semester, seemed to be divided as to the purpose for short screencasts in the study material. Out of the nine students who answered this question, five said they would like to see these recordings embedded. One said he would appreciate screencasts but not embedded in the material. The remaining three appeared to be concerned that an increase in the number of available screencasts might lead to a reduction of face-to-face classes on offer. Of the distance students who responded, most students said that they thought short, targeted screencasts would be beneficial. One student said that shorter snippets in the material meant no distraction by student questions and answers, as experienced in the lecture recording.

In the teaching semester in 2009, the course material was updated and screencasts were recorded while the course was being taught to explain all algorithms introduced in the study material, and additional concepts that students had struggled with in that year. It was decided to focus on individual topics, and produce very short recordings rather than cover all material with a long recording, which would have copied a lecture style. This type of screencast is an approach to provide only information important to students at this point in learning, and concentrates “on the pedagogical design of podcasts, rather than just repeat lecture content”, for which there is a need to focus on (Sutton-Brady, Scott, Taylor, Carabetta & Clark, 2009). These short “just in time” recordings also put students in control of what they watch, as students can directly target concepts they may struggle with while leaving out others.

Figure 5 shows a frame of the screencast corresponding to the example printed in the study material shown in Figure 1. While the study material gives the algorithm in abstract form and expects students to be able to apply it to the given example, leaving out intermediate steps, (in this case, only the final table was shown), the screencast walks students through this example, step by step, and allows them to watch for initial understanding of the algorithm, for reinforcing their already gained understanding, or to compare where they might be going wrong in their approach if their solution differs from that given in the material. It is the walking through, with voice and visual explanation, that gives additional information which cannot be captured easily in printed study material. Short snippets are produced in Flash format (SWF), with an additional option to download in iPod video format for playback on a portable multi-media player. “Mobile learning, which utilizes such technologies, offers educators a means to design learning activities and resources that allow students to individualise their learning” (Sutton-Brady et al., 2009; Kukulska-Hulme, Traxler & Pettit, 2007).
In 2009, these snippets were available to students for the first time, and students were asked on the official student evaluation form if they would prefer more short screencasts in the material. The three students leaving comments did not agree – one wanted more, one thought there were sufficiently many recordings, and the third wanted “more screencasts demonstrating methods”, and “summaries of material covered”. Asked the same question as part of an informal student evaluation, most students commented that the number of recordings available was sufficient, and that they found them very useful for their studies. A distance student remarked:

*Early in the semester I watched everything but as I fell behind in my study I only used them if I was having trouble grasping something.*

**IMPLICATIONS OF INTRODUCING SCREENCASTING**

The use of the technologies described in this chapter may have an impact on a lecturer’s workload, as flexibility comes at a cost and this is often underestimated. While the recording of live lectures delivered to on-campus students may fit into a lecturer’s existing workload (the lecture will be given anyway), the creation of short snippets for study material does take additional time, and if new to these technologies, training and experience. Time and opportunity for professional development need to be made available to lecturers, and this includes training in the effective use of these tools, rather than just focusing on the technical side. Such workload allocation will need to be factored into course delivery time.
It should also be noted that none of the described technology implementations were designed to replace or reduce face-to-face contact with students. It was clear from student comments that they feel quite strongly about the service that is provided to them when they are enrolled on-campus. The reason for introducing technologies was to provide more flexible learning options to on-campus students, and to attempt to bridge the gap between what is available to distance students and on-campus students. The technologies were not meant to make teaching more efficient or to reduce the cost of course delivery. An encouraging outcome following local success stories of tablet and recording technology use such as described in this case study (and also, for example, by Galligan, Loch, McDonald and Taylor (2010)), is that most mathematics lecturers at the university are now recording screencasts of their lectures, with electronic writing on a tablet PC. It is clearly worth noting that screencasting for mathematics teaching “has opened up for new ways of integrating classroom teaching and net-based learning on the basis of pedagogical concerns rather than mere administrative convenience” (Heilesen, 2010).

When moving towards multi-media recording of narration and/or image, an important consideration is how provision of offline and online screencasts differs. A screencast that is played back through a web browser online, and requires authentication to access via the LMS, can be accessed only by authorized viewers such as students enrolled in a course. It cannot easily be downloaded by a student, handed to a friend, uploaded in modified form to YouTube or copyright-violated in other ways. On the other hand, a screencast that is available for download and playback off-line, either via a computer or portable multi-media player, provides students with the flexibility to play back wherever they are, but the further use of the recording is out of the hands of the lecturer. Copyright expectations, i.e. what students are allowed to do with a recording, need to be made clear to students before screencasts are made available.

Also, from a lecturer’s point of view, copyright of the presented material may need to be observed. For example, video playback of protected content in the class may need to be removed from the lecture recording. Alternatively, recording could be paused while this material is shown. While this issue has not yet found widespread discussion in Australia, UK academics have been deliberating actively how student contributions to a lecture, recorded as part of the screencast, should be dealt with, and what needs to happen when a student withdraws consent to have their contribution recorded (ALT, 2010).

CONCLUSION AND FUTURE RESEARCH DIRECTIONS

This chapter has provided a demonstration and discussion of the use of screencasting in a first year Operations Research course taught to on-campus and distance students at a dual-mode university. It has shown how all students are treated the same in OR in terms of provision of course material, access to the course learning management system, and to screencasts of live classes and additional explanations. The only difference between on-campus and distance students is the ability to attend live face-to-face classes and to interact with the lecturer and students.

What are the implications of using screencasting for mathematics online learning? Some of the implications drawn out of the work discussed above are

- Online students may remain engaged and overcome a feeling of isolation when the instructor is given a voice and becomes a “real person”, rather than an impersonal technology-facilitated entity.
• Screencasts may be downloaded to portable devices, enabling students to study wherever they are, whenever they like, e.g. while travelling on a train or while other family members are playing on the computer next door. This increased flexibility would appeal to part time students juggling study and personal/work life.

• Particularly in mathematical sciences, guided “walks” through solving of difficult problems by an expert are a common face to face approach, and screencasting allows an extension of this to online education. Whilst this idea has been in use for decades in the form of recorded videos of a presenter writing on a whiteboard, the ease of creating these recordings from a desk without the help of technical staff makes it more accessible and appealing, and allows “just-in-time” creation of material.

A thorough analysis of how (when, how often, for what purpose) distance students used the lecture recordings, and comparison of these results with those reported in Loch (2010) for on-campus students is currently being undertaken. This may take a similar shape to the investigation of the impact of the use of lecture recording and engaging students with tablet technology in a first year finance course at the same university (Phillips & Loch, forthcoming). Other studies to gauge if a student understands better by watching a screencast rather than just reading through material have commenced in mathematics Master and secondary school teacher training levels. Future research may explore the benefit of student generated screencasts to explain topics to each other, to include in study material or as assignment tasks. However, particularly when communicating mathematics, these students may need to be given access to appropriate hardware for electronic handwriting. A trial of student mini tablet PCs is currently being undertaken at the university to identify the feasibility and pedagogical value of electronic handwriting by students, both in face to face classrooms and in online education (see Loch, Galligan, Hobohm and McDonald (2010) for preliminary results).

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REFERENCES


Key terms and definitions

Screencast – A screencast is a video file. It contains a recording of audio and video screen capture of an instructor’s oral and computer-based visual explanation, also capturing electronic writing, for example on a tablet PC.

Lecture recording – any form of recording to capture a live lecture. This can be an audio-only recording; a video recording of the lecturer plus whiteboard, document camera or electronic writing; or a screencast of the lecture.

Snippet – in this context, a short screencast of the path to the solution of a mathematical problem, written on a tablet PC.