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Screencasts – are they the panacea for dealing with students' diverse mathematical skills?

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BACKGROUND

In this study the implementation of screencasts (video of computer screen with voiceover) as a strategy to address the diversity in mathematical backgrounds of students undertaking a third year surveying unit in both on campus and in distance modes, was investigated. This cohort of students did not have strong mathematical backgrounds, either at high school or university level, a reflection of a national sector wide trend. Barrington (2009) reported between 1995 and 2007 the number of students in Australia studying the highest levels of mathematics in Year 12, Intermediate and Advanced mathematics, declined by 22% and 27%, respectively. Correspondingly, there was an increase of 30% in students studying Elementary mathematics, and this situation is often compounded by a lack of retention of mathematical concepts between high school and university (Jennings, 2009).

PURPOSE

Identify the mathematical background of students enrolled in a third year surveying unit, then determine if screencasts are easy to use, help students understand mathematical concepts and are helpful for revision.

DESIGN/METHOD

To overcome the difficulty of teaching students with different levels of mathematical background screencasts were embedded into this unit from 2009. To determine the background mathematical level of the cohort and the effectiveness of this teaching strategy, each year students were asked to voluntarily participate in a questionnaire from 2009 to 2011, which included qualitative and four part Likert scale (strongly agree-disagree) questions.

RESULTS

Of the 53 students completing the questionnaire over three years, it was apparent the cohort included students with diverse educational background, as 25% had not completed the Higher School Certificate (or equivalent); 32% had studied mathematics at Year 12 Elementary level or School Certificate level; and 25% had studied mathematics at advanced Year 12 level. Screencasts were well received with 84% user rate; and of these students, 95% found screencasts easy to use, 98% found they made the steps in the calculation easy to follow and 93% found they were beneficial when studying for the quizzes and exam in the unit.

CONCLUSIONS

Use of screencast in information literacy and computing has been previously investigated in the literature but it is poorly researched in mathematical concepts. In this case students found these resources easy to use and very helpful in assisting their understanding of mathematical concepts, especially for distance students.

KEYWORDS

Diversity, numeracy, distance

Introduction

University cohorts are heterogeneous and for most universities can no longer be seen as just school leavers. Due to a wide range of entry paths into universities, students have a diverse educational background (Brodie & Porter, 2009). Students in classes not only include school-leavers who are called "Net generation" (Howe and Strauss, 2007 cited in Carr and Ly, 2009), but also mature-age students who have a diversity of educational and work-based backgrounds. Currently there are a diverse range of students attending university with a wide range of learning preferences and perceptions due to their cultural, economic, social and past experiences (Burton, Taylor, Dowling, & Lawrence, 2009).

It is anticipated that with changes in government policy the diversity in student populations will continue to increase. The Australian Government has set targets that by 2020 20% of undergraduate students will be from low socioeconomic backgrounds, and by 2025 40% of 25-34 year olds will have a qualification at bachelor level or above (James, Krause, & Jennings, 2010). By increasing university participation through these targets it is probable that cohorts of students will be even more diverse, and with more varying requirements that need to be catered for to ensure their success. These changes will "lead to a focus on enhancing the quality of higher education" (James, et al., 2010); which will be even more complex for universities teaching both on campus and distance students. Overarching this has been a decrease in the number of students studying higher order mathematics at school.

Decreasing mathematical ability

In Australia the background of mathematical ability has been declining. Nationally between 1995 to 2007 the proportion of students studying Advanced mathematics in Year 12 decreased by 27% to 10%; Intermediate mathematics declined by 22% to 21% of the cohort; and Elementary mathematics increased by 30% to 48% of cohort, with 20% of Year 12 students not undertaking any mathematics (Barrington, 2009). As the content of each mathematical subject differs between states this has been summarised in Table 1, where Advanced shows students wishing to enrol in engineering, Intermediate more for agriculture and Elementary in 2004 included 73 subjects across Australia, but these students do not anticipate studying mathematics at university. In a Queensland study the statistics above were confirmed and also the amount of time on topic in mathematics was found to have decreased due to the curriculum expanding and loss of time on task through excursions, and other activities (Jennings, 2009).

Table 1: Definitions of the levels of mathematics across Australia adapted from Barrington (Barrington, 2009)

Parameters	Advanced	Intermediate	Elementary
Definition of students taking this level can proceed to tertiary studies that require -	*"strongest of mathematical preparations, such as engineering, actuarial studies, mathematics, statistics and physical sciences"*	*"significant but not extensive mathematical preparation, such as science, medicine, economics/ commerce, dentistry and agricultural science"*	Do not *"require Intermediate or Advanced mathematics subjects"*
NSW	Mathematics Extension 1 and possibly Mathematics Extension 2	Mathematics	General, etc. *"other"*
Qld	Mathematics C	Mathematics B	*"other"*
Vic, Tas, ACT	Specialist Mathematics	Mathematical Methods	*"other"*
SA, NT	Specialist Mathematics	Mathematical Studies	*"other"*
WA	Calculus	Applicable Mathematics	*"other"*

To successfully understand the discipline of surveying at university students require a good basic understanding of arithmetic, algebra, plane geometry (angles), trigonometry, and coordinate geometry (Zimmerman, 1991), which are mainly taught in junior high school. Through a diagnostic test of mathematical abilities of mainly 17-18 year old first year engineering students at the University of Queensland, it was found that topics taught at junior school were much more strongly consolidated than senior school, as students had more exposure to these topics (Jennings, 2009). Therefore university students should have the ability to successfully complete surveying, but not all students have the strong mathematical backgrounds of this cohort. The diversity of students now attending university results in a wide range of attitudes and abilities to mathematics being demonstrated (Taylor & Galligan, 2006).

Some students studying surveying suffer from mathematics anxiety, which causes psychological and/or physiological effects. This then impacts upon their ability to perform calculations and solve mathematical problems. The reasons for mathematical anxiety have been researched through many studies and in summary can be due to attributes of the student, family, teacher and instruction, and characteristics of mathematics itself (Cavanagh & Sparrow, 2011). Within this context the problem of mathematics anxiety can be complicated by the nature of distance education, where the observation and intervention into such issues is hampered by the geographic divide between teacher and student. To overcome this problem and the wide variation in mathematical ability of the cohort screencasts have been trialled.

This paper presents the results of an investigation of the implementation of screencasts in a surveying unit taught in both on campus and distance modes at a regional university. Where the cohort not only includes engineering students, but also archaeology, environmental science, geographic information science students, and others, where there is a large diversity of mathematical backgrounds. The aim of this paper is to identify the mathematical background of students enrolled in a third year surveying unit at the University of New England, then determine if screencasts are easy to use, help following the calculations, help students understand mathematical concepts, and are helpful for revision. Results will then be analysed to determine any differences between on campus and distance students.

Methodology

Social and analytic scaffolding

A scaffolded approach can be used to provide initial high levels of targeted support to students, and as their knowledge and confidence increases the scaffold is gradually removed. Within mathematics both a social and analytic scaffold is required to ensure the student has resources that enable them to successfully complete the unit. A social scaffold is a collaborative learning environment where students work with each other (Baxter & Williams, 2010; Figure 1); and for on campus students, this occurs through individualised discussions in class tutorials. Creating an equivalent collaborative environment for distance students is more difficult, especially for those students who only attend campus for four days of intensive training. However, this is achievable through online discussion boards within Learning Management Software (Blackboard/Moodle).

Social scaffolding needs to be complemented with analytic scaffolded support that includes additional mixed media materials such as PowerPoint slides, podcasts and practical exercises (represented in Figure 1 below). The use of screencasts (called Jings by the students as this is the recording program) represents one unique element of this analytic scaffold.

Screencasts

Screencasts are brief videos comprising a computer screen capture with audio voice-over which can be embedded online or sent to students with poor internet connections as a CD. They do not require as much concentration as podcasts and appeal to visual learners (Williams, 2010). Although around since 2003, Udell (2005 cited in Betty, 2008)was the first to use the term ‘screencast’. As the software is free and easy to use such as Jing, screencasts can be made quickly and easily, allowing content to be created and uploaded when required (Tagge, 2009).

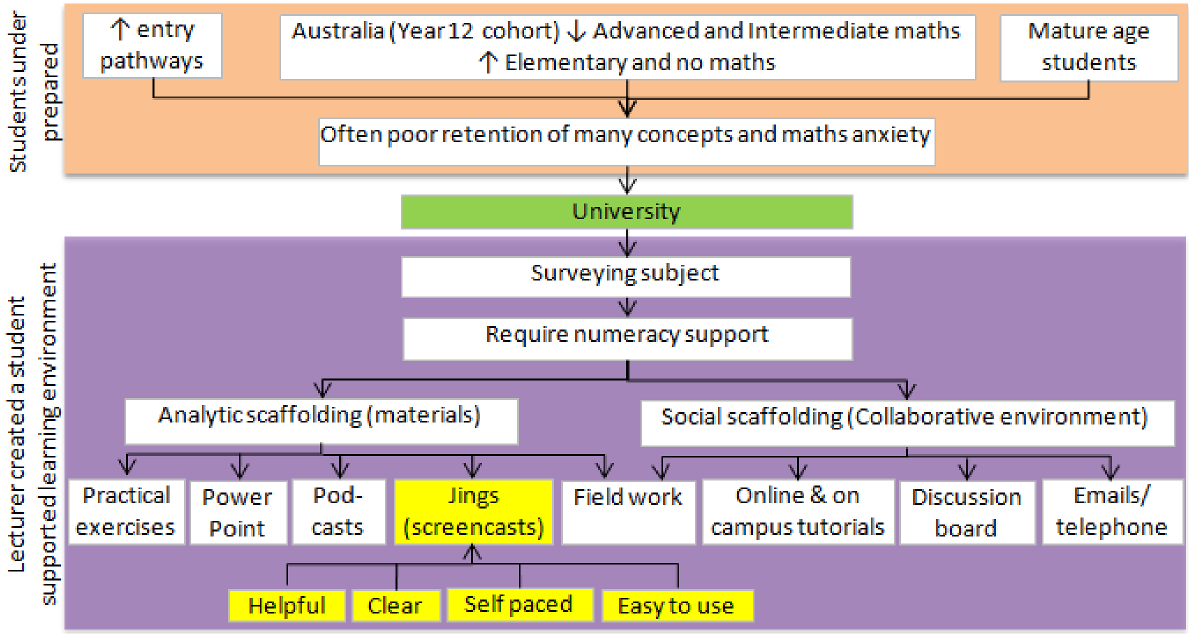

Figure 1: The context of students shown in orange, entering the University of New England and the purple section shows the analytic and social scaffolding including screencasts (Jings)

Screencasts have been used extensively in information literacy and computer science, for example reference librarians use screencasts to show steps in how to find information in databases, searching tools and writing citations (Betty, 2008; Carr & Ly, 2009; Gravett & Gill, 2010; Williams, 2010). They are placed at the point of need, and may show steps in how to use a database or software leading to more satisfied clients, as seen with librarians in the USA (Tagge, 2009). In a study by Carter (2009), screencasts were used in a computing science unit to replace the traditional component of lectures for one lecture period per week. Students watched the screencast before class and were assessed on the material at the start of class, after allowing time to answer any questions. The remaining time was used for formative assessment and active learning exercises rather than lectures. Feedback from the students was positive.

More recently screencasts have been used in mathematics and material science and engineering units, and best management practices have been developed. In a study at James Cook University screencasts were used successfully to supplement mathematics lectures (Mullamphy, Higgins, Belward, & Ward, 2010). In a material science and engineering unit screencasts were used to give feedback on homework and quizzes and mini-lectures that explain topics identified by students as unclear (Pinder-Grover, Millunchick, & Bierwert, 2008). Best management practices have been suggested by Oud (2009)and these were used when producing screencasts for this surveying unit.

Questionnaire design

This project has University of New England Human Ethics Approval 10-089. All students enrolled in this surveying unit in 2009-2011 were contacted via email and asked to volunteer to participate in the anonymous online questionnaire to determine their background schooling, mathematics and the usage of screencasts (Jings). Questions asked included:

Background education

- Are you studying this unit on or off campus [distance]?
- What are the highest levels of mathematics and science you studied at school level?

Screencasts – use and effectiveness in learning

- They were easy to use
- They made the steps in the calculations easy to follow
- The explanations helped me to understand the concepts more clearly
- They helped me study for the quizzes and exam

Survey data was supplemented with observations of students in class, student comments posted in the online discussion board and access of screencasts by students online.

Results and discussion

Two main areas were focussed on in this questionnaire including gathering of student's background information including education and mathematical background; and the usage of the screencasts and self assessment of effectiveness in learning.

Student's background

There are a number of entry pathways into university and therefore 17% of the cohort had not completed their Higher School Certificate (or equivalent); and this was both on and distance students (Table 2). Of the 83% of the class that completed Year 12, 17% studied mathematics at elementary level or none in their final year (Table 3). Therefore 31% of the cohort (16 students) studied Year 12 mathematics at elementary level or lower, or left in Year 10 (Table 3). Within this context there is a strong need for mathematical concepts to be scaffolded to ensure the success of the students participating in this unit to ensure they have a chance of success. The unit description includes a comment advising students that Year 12 intermediate to advanced mathematics is required and to contact the unit coordinator for specific resources for revision or bridging courses before the start of semester.

Table 2. Highest secondary school qualification of students in the engineering subject expressed as a percentage (n=52)

Secondary school qualification	On campus	Distance	Total
School Certificate (Year 10)	6	12	18 (n=9)
Higher School Certificate or equivalent (Year 12)	34	48	82 (n=43)
Total	40	60	100 (n=53)

Table 3. Level of Year 12 mathematics studied of students in the surveying unit expressed as a percentage (n=43)

Type	On campus	Distance	Total
Nil	0	5	5 (n=2)
Elementary	5	7	12 (n=5)
Intermediate	21	33	53 (n=23)
Advanced	12	19	30 (n=13)
Total	37	63	100 (n=43)

Use of screencasts (Jings) and their effectiveness in learning

The response rate to the anonymous online questionnaire varied between 12-66%. Although in 2009 18 students responded (35% response rate), 27 (66%) in 2010 and 6 (12%) in 2011, by tracking the usage it has been shown that 80% of students accessed the screencast files at least four times during their specific unit enrolment, so these results can be extrapolated to the majority of the class.

It should be initially identified that all students were encouraged to participate in the questionnaire including those that did not use the screencasts. The number of students responding with an NA was 3 in 2009 (17%), 5 in 2010 (19%) and none in 2011. Students were asked "if you did not access the "jings" [screencasts] please explain why not?" The main response was computer problems including slow internet connections and thus found the files difficult to open (5/9 responses). As the .swf files require flash to work they are not able to be played on some Macintosh machines. This has been addressed in 2012 through a generic server being used at the University of New England which has the ability to convert files to suitable format to be downloaded onto all mobile devices such as desktop and laptop computers and ipads and smart phones. Also where students informed staff they had slow internet connections they were sent a CD; *"You sent me the jings* [screencasts] *on CD, which I found helpful"* (Student 2009). The other major reason was they already understood the concept (3/9 responses), "*I understood the concepts through the on campus tutorials"* (On campus student 2010). Therefore those that did not use the screencasts have been excluded from the following data analysis.

Using Chi-square test there was no significant difference between the 2009, 2010 and 2011 year data, nor due to differences in mode (on campus and distance), or level of mathematics (elementary, intermediate and advanced). This shows that these resources have been well received by each group and have been used as needed over the duration of the study. Therefore the data presented in Figure 2 has been summarised to show on campus and distance students together, but has been divided by year to show the positive responses have been sustained with time.

Easy to use and follow

Of the students responding to the questionnaire that used the screencasts 95-100% agreed or strongly agreed that they found them easy to use (Figure 2a). However, it must be noted again that 5 students found the files difficult to open as discussed above. Students commented that they were able to stop and replay the file: *"They* [screencasts] *are very good as you can repeat areas that are confusing"* (student 2009). This was confirmed in a study using screencasts in mathematics too (Mullamphy, et al., 2010).

Students overwhelmingly agreed or strongly agreed that screencasts "made the steps in the calculations easy to follow". The screencasts captured the author's computer screen using Microsoft Excel to show the steps in the surveying calculations. In some cases there were over 100 computations required to complete the calculations and so a spreadsheet was used so students could follow along. This gave the students knowledge of Excel but more importantly as they needed to use a calculator in their final examination there was a reinforcement that occurred as the students used a calculator to follow the steps. Each screencast was between 2-5 minutes so students could choose which file to download if they understood most of the calculation, rather than downloading a large file. In their comments students stated:

> *"Jings* [screencasts] *were awesome. I liked how I could stop the jing* [screencast] *and go through the steps slowly until the concept of what I was doing had time to Jing!! with me"* (student 2009)

Helped students understand concepts more clearly

When asked if "the explanations helped [them] to understand the concepts more clearly" 91-100% of students who used the screencasts agreed or strongly agreed (Figure 2c). It is extremely important for distance students to understand concepts before they come on campus so the time can be spent on the practical component rather than revising mathematics that could be prepared for before the intensive school. Since the introduction of screencasts there have been fewer mathematical questions at the residential four day school for distance students allowing more time to be spent on task using surveying equipment as confirmed by this student:

“I think they [screencasts] *are a useful component and should be continued I couldn’t have got the concepts before coming to the residential school so it meant once at the residential school I could focus on other aspects of learning”* (student 2010)

The reason for this change at the residential school is because of the supplementation of resources with screencasts:

“I found “jings” [screencasts] *very helpful in guiding me through mathematical concepts. As an external student you do not have that face-to-face time with lecturers. So when you have questions, “jings”* [screencasts] *help to convey an idea/concept”* (student 2011)

This was confirmed in a number of comments from distance students, where the ability to both see the working and hear the lecturer is important to ensure concepts are understood. This was confirmed by another student:

Screencasts *“helped me learn a lot, I wouldn’t have passed without them as I like to see problems worked through so it helped my learning style immensely. They were great!! Thanks”* (student 2010)

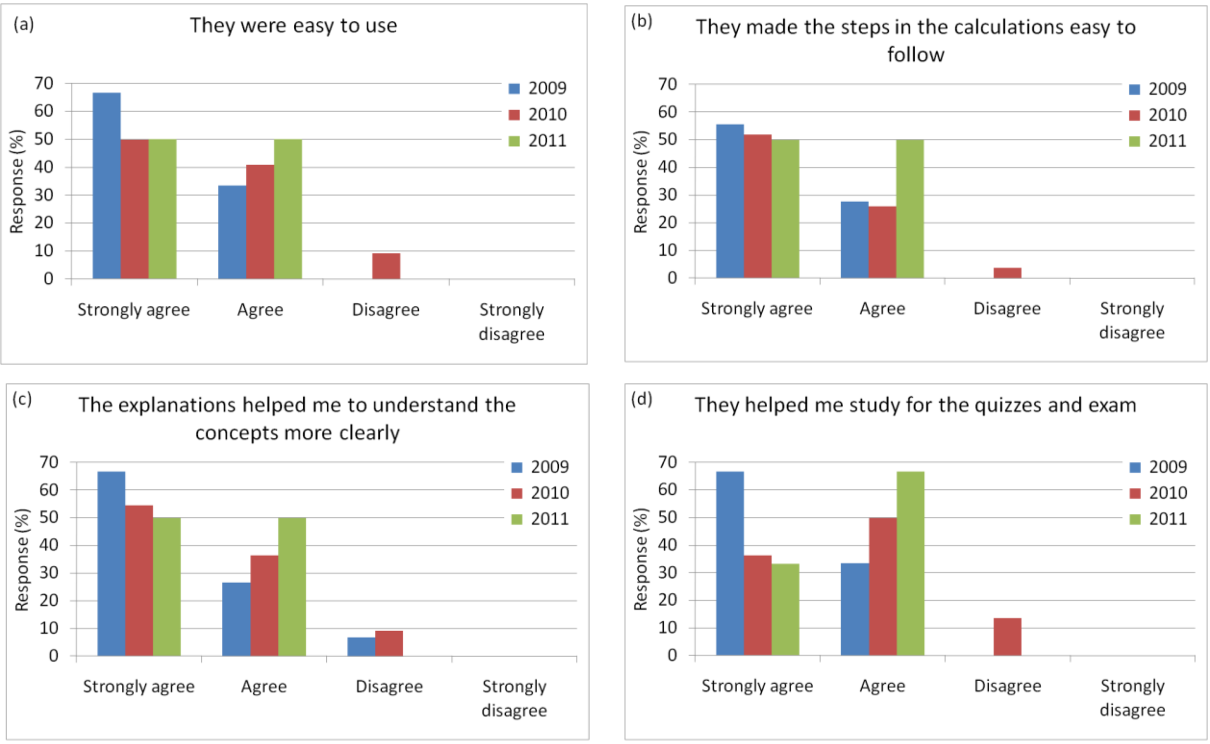

Figure 2: Summary of student feedback for students using screencasts where n=15, 22 and 6 students for 2009, 2010 and 2011, respectively

Helped with revision

To ensure students attempt the mathematical component of the unit before coming to campus three online quizzes worth 15% of the total mark must be attempted before the intensive school; then a final examination worth 40% at the end of semester. Of the students who used the screencasts, 86-100% agreed or strongly agreed that screencasts helped them revise for quizzes and exams (Figure 2d).

“I was able to pass my exams and enjoy the unit without the stress of struggling with another mathematical concept, the bane of my life” (student 2009)

The results above are supported by other studies where screencasts have been successfully used in mathematics and materials engineering. In a study at James Cook University of mathematics students of the 33% who responded to the questionnaire, 98% of students found screencasts were quite useful to extremely useful as a learning tool and 87% of students thought they were a good supplement for lectures (Mullamphy, et al., 2010). In another study in a material science and engineering unit, at the end of the lecture students were asked to write on a blank piece of paper what their “muddiest point’ (concept/topic finding difficult to understand) was so the lecturer could create a screencast to address the concept, 6 screencasts were made during the semester. In an online survey of the use of screencasts >60% of respondents found only two of the concepts covered by screencasts difficult but they still viewed almost all of the topics and found them helpful (Pinder-Grover, et al., 2008). This is supported in the current study where one student wrote:

> *“I did not necessarily need them* [screencasts]*, but I did use them and feel that they would have aided a lot of students who were not as confident in their mathematical knowledge.”*

This is probably the reason that the mathematics studied at school or confidence in mathematics did not influence the usage of the screencasts. As each individual was able to take from the screencasts what they wanted, from revision, to being taught a concept that they needed to rewind and listen to a number of times.

Conclusion

Increasing diversity of students attending university, including engineering technology degrees, leads to within unit variation in mathematical ability and background. Of the cohort sampled 32% had studied mathematics at Year 12 Elementary level or School Certificate level; and 25% had studied mathematics at advanced Year 12 level. Student learning needs to be supported through scaffolded resources such as screencasts. Screencasts have been successfully used in a number of studies and this is the first which has shown how screencasts can be used when teaching surveying calculations. Data was collected over three years and although sample size was small as response rates ranged from 12 to 66% of the cohort; on investigation of student usage profiles, 80% of students accessed and used at least four screencasts during the semester. Therefore these results can be extrapolated to the majority of the class.

Students were positive towards the use of screencasts, often independent of mathematical background. There was no significant difference in the responses of students to the questionnaire based on their level of mathematics at school or whether they were studying on campus or distance. Students were overwhelmingly positive towards the use of screencasts to help them understand mathematical concepts, and for revision. To increase the ease of use files have been loaded into a central program run by the university that allows downloads to be successfully made to all mobile devices and computers.

In terms of whether screencasts are the panacea for dealing with students with diverse mathematical ability; it is not the software that will yield positive results, it is the producer. If the lecturer is effective in face-to-face tutorial sessions then these techniques can be used when producing screencasts to create valuable resources for the students to use at the point of need. Thus allowing face-to-face sessions to flow more easily as students can revise parts they do not understand after class when and if required; and those who understand concepts do not become disengaged. Importantly for engineering academics screencasts have been found to be valuable by all students, even those who are very good at mathematics.

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