Students Using Digital Technologies to Produce Screencasts That Support Learning in Mathematics

Linda Galligan
University of Southern Queensland
<linda.galligan@usq.edu.au>

Carola Hobohm
University of Southern Queensland
<carola.hobohm@usq.edu.au >

This paper reports research on student produced screencasts to support learning. Participants in a Mathematics for Teachers course were asked to create and peer critique screencasts to explain concepts (year 4 to 9 level). They were also asked about their experience with screencasting and its impact on their own teaching and learning. This paper will discuss preliminary results of a pre-survey and highlight features of initial screencasts and their critiques. The paper concludes with an outline of future directions.

For almost ten years, research has been undertaken on the use of various digital technologies (e.g. tablet computers that allow handwriting on a computer screen) to support mathematics learning and teaching at the University of Southern Queensland (USQ). During this time tablet technology has become cheaper and easier to use. At the same time various forms of screencasts have been developed to support learning. Screencasts (movies that capture screen content) have been described as "folksy, intimate experiences that feel as if you were sitting shoulder-to-shoulder with a friend" (Kanter, 2007). Sugar, Brown and Luterbach (2010) suggest that screencasts were originally developed to provide procedural information to students. Many of today's students studying mathematics at university now have access to their own lecturers' recordings as well as free access to public screencasts such as the Khan Academy (www.khanacademy.org/) and YouTube videos, which provide a multitude of explanations for mathematics concepts from basic number to high level mathematics. Some screencasts today are being developed based on pedagogical issues (Heilesen, 2010). The focus of many of the recordings, however, still appears to be more on procedural knowledge rather than any other form of mathematical knowledge. Yet screencasts have the potential to do much more. In particular, the focus in this research is on student produced screencasts as a tool for reflective learning.

This paper will summarise some of the research undertaken to date and outlines a research project undertaken in 2012 with 50 internal and external students (preservice and graduate teachers) who were enrolled in a Mathematics for Teachers course at USQ, where students were asked to create screencasts to explain mathematical concepts. It will provide preliminary results from the data and discuss future research directions.

Background and Relevant Literature

In 2010 (Galligan, Loch, McDonald, & Taylor, 2010) wrote about the experiences of using tablet and related technologies in mathematics teaching in various modes: one-to-many (i.e. lectures); one-to-few (i.e. tutorials and small groups); and one-to-one, drawing from research conducted at USQ from 2004 to 2009. This research highlighted the benefits of tablet technology, which was being reflected in other similar research, particularly at university level (see e.g. Cromack, 2008). In 2010 this research was extended to a learner-centred approach (Loch, Galligan, Hobohm, & McDonald, 2011) in an on-campus environment. Both this and other emerging research is suggesting that tablet technology benefits students particularly with active learning (Donovan & Loch, 2013). Our research

In V. Steinle, L. Ball & C. Bardini (Eds.), Mathematics education: Yesterday, today and tomorrow (Proceedings of the 36th annual conference of the Mathematics Education Research Group of Australasia). Melbourne, VIC: MERGA.

expanded in 2011 to include external students (Galligan, Hobohm, & Loch, 2012) and aimed to facilitate improved interactivity, including writing and submission of assignments electronically. Smith and Ferguson (2005) commented that the asynchronous e-learning model relies heavily on threaded discussions and that this does not work well for mathematics. Based on this premise, our research in this external environment in 2011 attempted to improve the asynchronous experience and interactivity of students studying a mathematics course through the use of student-created screencasts. Students in this study could see the potential of the technology for learning if it focussed on the student themselves creating the screencast. For example, one student wrote:

> I can see that it would be a great advantage if I were struggling with the subject and needed to show a lecturer or tutor what I was doing so that I could get some help. (p. 374)

However, the success of this asynchronous interactivity between the lecturer and students was limited by two factors. Firstly, availability of simple, easy-to-use devices was imperative. Secondly, students needed to be willing and able to expose their incomplete level of cognitive and metacognitive understanding of mathematics. Both factors were addressed in this current research through the provision of devices that were easy to use, and the cognitive and metacognitive issues were embedded into students' assessment tasks. Our previous research had been with students who were learning mathematics and were enrolled in a variety of programs; and our aims were much broader, in line with other research (e.g. Reins, 2007). Now we were interested in addressing how digital technology could assist in students' thinking about mathematics. In this current research students were all enrolled in a program related to teaching mathematics. Hence, incorporating the use of digital technology was justified since investigating technology in the teaching of mathematics was part of the objectives of the course, and teachers need to "become more effective, confident, and creative users of technology in their teaching" (Goos, 2003). The research reported here aimed at investigating students' use of screencasting to explain and reflect on mathematical concepts. While some direction on what constitutes a good screencast is emerging (Sugar, et al., 2010), we wanted to find out what constitutes a good student created mathematics screencast, with this research still being in its infancy (e.g. Kosiak & LeDocq, 2008; Shafer, 2010).

Our current research has resulted in a rich and diverse set of data based on students creating, producing, explaining, and evaluating screencasts on various mathematics concepts. The results of this research may be of significance to two audiences. First, it is for practitioners wanting to use screencasts as a digital tool for learning and teaching; and second, for researchers wanting to explore preservice teachers' depth of understanding of mathematics and their approach to explaining mathematical concepts. Early findings in our analysis have already prompted us to expand this research, which will be discussed in the conclusion.

Method

In Semester 2 2012, 50 students were enrolled in a Mathematics for Teachers course (MAC1901) at USQ. Ethics clearance was obtained to ask students to use their assignments as part of this study and for them to participate in two surveys. Twenty three students agreed. As the first part of an assignment, they were asked to use one digital device (borrowed through the library) to explain a mathematics concept in conjunction with recording software. On-campus students discussed the use of technology during tutorials, whilst external students made use of a dedicated online discussion forum to critique each other's screencasts. The second part of the same assignment required students to record a presentation on how to teach a mathematics concept, using their device (students recorded this in software such as Power Point). Specifically they were asked:

- Choose a mathematics concept that is troublesome
- Discuss the development of this concept (related to the Australian Curriculum)
- Discuss why it is troublesome (refer to literature)
- Discuss methods to assist in understanding the concept in terms of proficiencies
- Include screencasts of you actually solving problems that you could give to students to aid in the understanding of the concepts

In addition, all students undertook a 30 item Self-Test (based on Taylor, 1998) at the beginning of the course, aimed at asking students to reflect on their competence, confidence and knowledge of particular mathematics concepts (at about the year 9 level). This included specific advice on items such as: confidence, misunderstanding, unfamiliarity, use of their calculator, a prediction of school students' errors in the question, if /why the student was incorrect, method used to solve the problem; and where each question was found in the Australian curriculum. They were also given a written survey at the beginning and end of the semester about their experience with watching or creating screencasts, and their perceived value of using screencasts to articulate and convey mathematics communication. While this was a new survey, it was based on feedback from surveys from our previous research on tablet technology. Students were offered training in the use of the technology throughout the semester as needed. Data from student assignments (Self-Test and the screencasts from the assignments), discussion forums, the two surveys, and any other communication about using the devices is being entered in NVIVO, and will be analysed by coding for themes and subthemes (both open coding and coding based on the suggestions in the assignments). Any identified feedback has been de-identified.

Preliminary Results

This paper will discuss some of the results from the preliminary survey, the initial screencasts produced by the students for the first part of their assignment, and related reflective comments and critiques on discussion forums.

Preliminary Survey

Twenty three of the 50 students completed the preliminary survey. Eleven identified themselves as extremely or very computer literate, and 11 were moderately literate. Eleven students had never had access to any inking device and 14 had viewed screencasts before with only three students having created screencasts in the past. All students, except one, were enrolled in some form of teacher education, with five students at the graduate level.

Of the 23 students who completed the preliminary survey, seven explicitly commented on reduced interaction as a perceived disadvantage with creating screencasts, suggesting it was *not very personal…less human* (Student D who had no experience with screencasts before) and Student L (who had some experience in viewing and using screencasts): *you miss some of the interaction of the class and things like facial expressions, which can also communicate the information*.

One question from the first survey was: *How do you see the VALUE of screencasts in mathematics learning?* Twenty one students had an opinion ranging from usefulness for reviewing and catching up due to absence, to removal of ambiguity and availability of the process to get to answers. One student saw the advantage by using the "Flipped Classroom" (Álvarez, 2012) approach (described the approach rather than naming it).

Another question was: *How do you see the VALUE of screencasts in mathematics teaching?* Answers focussed on school students' learning style, screencasts being tailored to their needs, and allowing for more flexibility in teaching. One student (with little expertise in screencasting) was particularly insightful.

> [Student C]… I've not experienced them but immediately I can see the transformative power of them in UNDERSTANDING the stages of an answer. I remember in primary and high school things were written up so quickly, I wouldn't have even known if the teacher understood what they were writing or not, let alone how to explain it. Breaking down the moments in maths in real time seems a great alternative to backward mapping an answer that already exists.

In comparison to our previous cohorts, teachers and preservice teachers in this study appeared to tune into the pedagogical advantages of screencasting from the onset. We have not yet analysed the post survey, but are hoping that more critical analysis by students will occur.

The Screencasts

In the first part of the students' assignment, they were encouraged to create a screencast as soon as possible and post their attempt online. It was suggested they choose one question from the Self-Test and create a short (<5 minute) recording of themselves solving this problem. It was emphasised that the importance was on simply creating a screencast without spending too much time deliberating on accuracy and professional appearance. However, students were asked to articulate their thoughts whilst writing the process of solving the problem. An example of an 'unpolished' screencast was provided.

They uploaded their recording to the discussion forum and were asked to comment on their own and others' recorded solutions. This resulted in 38 initial screencasts, 27 self-reflections and 56 specific comments on other students' screencasts. Three examples are provided below.

Figure 1 shows a screenshot of an on-campus student's (Student E) recording (1.25 mins total length), created during a tutorial with an iPad and "ScreenChomp" (a free App).

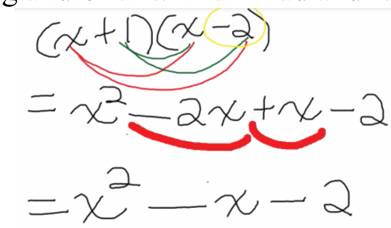

Figure 1. Screenshot of on-campus student's first attempt explaining how to expand.

Several issues emerged from the evaluation of this screencast: appropriate use of language, tone and mathematical processes; procedural nature of the screencast; and structural elements such as the use of colour, size, and readability. Importantly, Student E herself identified critical aspects of her screencast:

> … enjoy my 'warts and all', spur of the moment screencast I recorded. The main issue I pick up on my screencast is the misuse of terminology. Firstly I use the term 'equation' where I should be using 'expression' and I think I said solve rather than expand. I also mention the mnemonic F.O.I.L which I don't think is quite right for this circumstance ... Then I fall into the dreadful use of English with

the word 'timesing' rather than multiplying. Finally there is the tricky negative versus minus... it would be good to take advantage of the range of colours to help show how all the *x*'s need to go together. I'm also not sure what year level/prior knowledge I was assuming …, so feel free to comment if you think I've explained something too thoroughly, some things too skimpily (if that is a word...)

Figure 2 is a screenshot from an external student's explanation of a different question.

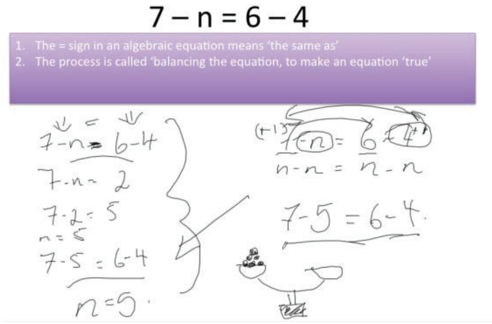

Figure 2. Screenshot of external student's first attempt explaining how to expand.

This screencast was more typical of the external students' approach. It was evident there was more preparation of the recording and many of the screencasts involved both procedure and concept development, and more in-depth thinking.

Figure 3 shows another external student's attempt (same type of example as the first student). It should be noted that the screencast contained minimum use of handwriting and the typed preparation was done beforehand. Furthermore, both students' use of the "FOIL" method for expanding an expression highlights the procedural nature of the screencast.

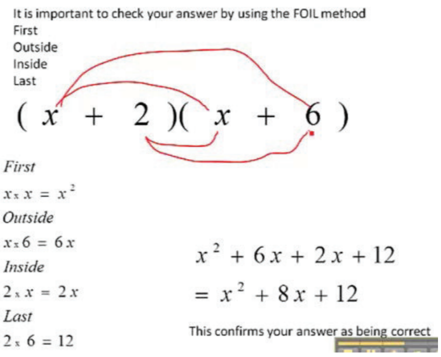

Figure 3. Screenshot of external student's first attempt explaining how to expand.

While there were some issues with the technology, most were dealt with via the discussion forum. However, it is unclear whether the unfamiliarity with the technology prevented students from starting this assignment in the first place as 12 students chose not to submit at all.

The reflective comments

There was great variation between the students' self-reflections and peer reflections. While these comments have not been analysed, a p reliminary read of the comments suggests themes such as structuring the screencasts for visual impact and best instruction, different approaches to solving the problem, metacognition, language and affective issues.

The following shows one student's [Student B] initial self-reflective comments on the first screencast, followed by peer interaction and a comment by the lecturer. The question was: *Peter had a bag of marbles. He gave one third of them to Rebecca. He then gave a quarter of the remaining marbles to Jack. If Peter ended up with 24 marbles, how many did he start with?*

> I've had a think about what I may have done differently upon reflection and reviewing other peer's trial submissions. I will try and incorporate these points into screen recordings for part B of Assignment 2… I could have computer typed the question and included images of stacks of marbles … to improve the visual and professional impression - I should have indicated (as this is year 9 level), the points where it would be appropriate to use a calculator - I could have displayed actually working out 1/3x6/1 and 1/6x6/1 instead of just describing them, in case students have difficulty with this concept/procedure. I could have stressed the importance and potential for error in multiplying all components of an equation by 6 to eliminate the fraction 1/6. All things considered I was satisfied with my recording, as the necessity to demonstrate multiple steps created a time pressure to contain the recording to 5 minutes (Jing's limit) - hence I had to prioritise within the presentation, and Linda stressed she didn't want a 'perfect' recording (I succeeded in that!)

This was a response from a Student (D) who had also created a screencast on this question:

> I like the way you start the screencast by saying that you struggled …. Already, you ease students and make them feel comfortable if they too are struggling with the question. I thought your recording was really well done, I like how you used the data and placed it into an algebraic expression then checked it at the end to see that it was correct…..Overall, I thought it was very informative and helped me in thinking more about how I did my recording. I really liked the way in which you concluded your presentation with substituting back in the value that you found to assure yourself (and possibly the students who were to do this question as well) that the answer is correct.
>
> this is one question I got wrong on the first assignment and didn't for a minute consider constructing it the way you did.…, you do a great job of demonstrating how you got from one stage to another (right at the beginning), however when it gets to the more complex stages, you simply just state them. From practical experience, when you do a mathematical example with the students on the board, then ask them to complete some example (leaving my example on the board), if they can't see how I got from one line to the next, it creates areas of confusion and misunderstanding. So just a suggestion, write down everything you are doing 
>
> Other than that I found your presentation quite appealing, and interesting to listen to. Thank you

The lecturer commented on the student's use of the words "simply" and this was picked up by another student who reported:

> [Student W] It was only yesterday that I said something along the lines of "Follow the procedure - it is simple.' Immediately, having said that, the little voice in my head said "it might be for you but for them, not so sure". I felt rather displeased with myself, and aimed not to say it again … but if I manage to keep reflecting, I should continue to move in the right direction.

Further comments by the lecturer on students' use of language prompted these responses from two external students:

> I think at this stage I'd make a poor maths teacher because I've never spoken this language. I read it at school, but never 'said it aloud'. BIG difference [Student C]
>
> …what may make sense to one student, may not make any sense to the remaining twenty-four, and it is our responsibility to find the best possible manner for all to achieve success. [Student W]

A few students hesitated to create the screencasts and the reasons may be found in Student Y's remarks:

> I first must say that I was absolutely terrified at doing this, not the math writing part but the talking part. For a couple of days I would sit down to do it, but lost all my nerve. A few days went by and I decided that maybe if I practised that would help, because I didn't have to submit those ones…so I sat down today, (nobody at home, much easier) and started to talk into the microphone and just kept

going blank after a couple of seconds, that went on for a couple of hours, ok it was more like five hours. Then all of a sudden, I just started talking and didn't stop. I must have forgotten all about the microphone until about the last minute or so when I thought about it again and got a bit panicky, but was able to finish it. Besides all that I have actually enjoyed doing this and getting result.

Discussion and Conclusion

In this research we wanted students to think about how they would explain a mathematical concept to their pupils by recording it for use when the teacher was not present. We also aimed to highlight their metacognitive and cognitive processes, encouraging them to reflect on the mathematics concept and how to teach it. From an initial analysis of students' first attempts at this, we are really pleased with many students' screencasts. While not perfect (and this was not the aim), they were willing (when prompted by assignment marks) to create and evaluate their own and others' screencasts. Themes from the screencasts and the reflections that have already emerged are around: appropriate use of language and tone; procedural nature of the screencast; structural and visual elements such as the use of colour, size, and readability; structuring for best instruction, different approaches, and affective issues.

We have learnt that some of the technology was more difficult to use than anticipated, and some applications were unreliable. We also underestimated the time it to ok some students to create screencasts and focus on the assignment, particularly as some students were still in their first year. This was the first time such an approach had been taken in this course. Findings from this research will prompt changes that will be made for the next course offering.

Our approach will be much more defined in the future. We are considering the inclusion of specific structural elements (perhaps through a rubric) and instructional strategies for producing good screencasts (Sugar, et al., 2010) to facilitate the production of screencasts, and fewer device choices. In addition, future research aims to investigate the impact of preservice teachers incorporating their screencasts in their teaching.

References

Álvarez, B. (2012). Flipping the classroom: Homework in class, lessons at home The Education Digest, 77(8), 18-21.

Cromack, J. (2008). Technology and learning-centered education: Research-based support for how the tablet PC embodies the seven principles of good practice in undergraduate education 38th Annual Frontiers in Education Conference, 2008 (pp. T2A-1-T2A-4). Saratoga Springs, NY.

Donovan, D., & Loch, B. (2013). Closing the feedback loop: engaging students in large first-year mathematics test revision sessions using pen-enabled screens. International Journal of Mathematical Education in Science and Technology, 44(1), 1-13.

Galligan, L., Hobohm, C., & Loch, B. (2012). Tablet technology to facilitate improved interaction and communication with students studying mathematics at a distance. Journal of Computers in Mathematics and Science Teaching, 31(4), 363-385.

Galligan, L., Loch, B., McDonald, C., & Taylor, J. A. (2010). The use of tablet and related technologies in mathematics teaching. Australian Senior Mathematics Journal, 24(1), 38-51.

Goos, M. (2003). Learning to teach wth technology: A study of beliefs-incontext. In L. Bragg, C. Campbell, G. Herbert & J. Mousley (Eds.), Mathematics education research: innovation, networking, opportunity (Proceedings of the 26th annual conference of the Mathematical Education Group of Australasia (pp. 404-411). Sydney: MERGA.

Heilesen, S. (2010). What is the academic efficacy of podcasting? Computers & Education, 55(1063-1068).

Kanter, B. (2007). Introduction to screencasting, from http://www.idealware.org/articles/introduction-screencasting-0

Kosiak, J., & LeDocq, R. (2008). Connecting preservice teachers' knowledge of mathematics, pedagogy and technology through learning object design. In K. McFerrin, R. Weber, R. Carlsen & D. A. Willis (Eds.), Proceedings of the Society for Information Technology and Teacher Education International Conference (pp. 5263-5270).

Loch, B., Galligan, L., Hobohm, C., & McDonald, C. (2011). Learner-centred mathematics and statistics education using netbook tablet PCs. International Journal of Mathematical Education in Science and Technology, 42(7), pp. 939-949.

Reins, K. (2007). Digital tablet PCs as new technologies of writing and learning: A survey of perceptions of digital ink technology. Contemporary Issues in Technology and Teacher Education, 7(3), 158-177.

Shafer, K. G. (2010). The proof is in the screencast. Contemporary Issues in Technology and Teacher Education, 10(4), 383-410.

Smith, G. G., & Ferguson, D. (2005). Student attrition in mathematics e-learning. Australasian Journal of Educational Technology, 21(3), 323-334. Retrieved from http://www.ascilite.org.au/ajet/ajet21/smith.html

Sugar, W., Brown, A., & Luterbach, K. (2010). Examining the anatomy of a screencast: uncovering common elements and instructional strategies. The International Review of Research in Open and Distance Learning, 11(3).

Taylor, J. A. (1998). Self Test: A flexible self assessment package for distance and other learners. Computers and Education, 31, 319-328.