Student perceptions of screencast feedback on mathematics assessment

Mike Robinson, Department of Engineering and Mathematics, Faculty of Arts, Computing, Engineering and Science, Sheffield Hallam University, UK

Birgit Loch, Department of Mathematics, Swinburne University of Technology, Australia, bloch@swin.edu.au, +61 3 9214 8216

Tony Croft, Mathematics Education Centre, Loughborough University,
Loughborough LE11 3TU, UK

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Abstract

Although feedback is a very important component of assessment in higher education, there is substantial evidence that students view traditional methods of feedback as deficient in a number of respects. In this paper we explore how students perceive generic feedback on a mathematics assignment provided via screencasts. Our study is based on a Differential Equations module taught to first and second year students at a UK university. Our analysis of a student survey of this novel approach to feedback indicates that some students prefer screencast feedback to written feedback for a number of reasons: it is perceived to be more personal, it provides a richer experience than handwritten comments, it can be accessed anytime and replayed and paused as needed, it assists with learning how to communicate mathematics and it helps develop mathematical thinking skills. In fact, we show that this form of feedback is effective according to Sadler's (1989) definition of effective feedback.

Keywords
Feedback, screencast, solution, commonly made mistakes

Introduction

Feedback to students on their work is an important component of their education. It encompasses information about how students perform, how their performance compares to other students and to certain benchmarks such as a correct solution, and also how students can improve. Traditionally, feedback in undergraduate mathematics courses consists of ticks or crosses with brief comments provided by a marker on assignments or exam papers, short or completely worked solutions in written form, and sometimes the working through of questions step by step by a lecturer in class.

Hattie and Timperley (2007) go as far as saying that good quality feedback is the single most powerful influence on student achievement in higher education. Indeed Black and Wiliam (1998) reviewed around 250 studies and showed that formative feedback had a positive benefit on student learning in almost all circumstances, across a range of subjects, levels, situations and student abilities. Whilst few might doubt the above, there is much less certainty about the effectiveness of feedback actually provided in universities. In the United Kingdom, attention has been focussed on this in recent years following the introduction of an annual National Student Survey (NSS) of final year students, conducted by the Higher Education Funding Council for England ("The National Student Survey," 2012). In the 2012 survey at least two of the three questions relating to feedback[1] were ranked in the bottom three of the 22 questions asked, for over three-quarters of the undergraduate mathematics courses, with similar results reported in 2013 (HEFCE, 2013). The year-long project *Improving Feedback in HE Mathematical Courses* (Robinson, 2014), funded by the UK's National HE STEM Programme ("National HE STEM Programme," 2013), was established as a direct consequence of the NSS scores on feedback and the students' responses on feedback for the More Maths Grads (MMG) study (Robinson, Thomlinson, & Challis, 2010). The project involved staff from engineering, mathematics, physics and chemistry departments, teaching mathematics, across the UK, who were invited to complete an online survey in which they described their typical feedback practice, any atypical activities, and their opinions about the merits of each. A group of seven departments then worked with the project to evaluate either a current or innovative approach to providing feedback. The evaluation was twofold: discussion with the relevant staff members (via phone or email) about their experience of the feedback, and an online or paper survey of students. The survey aimed primarily for open-ended qualitative responses with the intention of seeing (a) what aspects of the provision students considered as 'feedback', (b) which of these they found helpful, and to what extent, and (c) what action, if any, students undertook to use the feedback (Robinson, 2014).

This paper investigates student perception of screencast feedback implemented as one of the innovative approaches of the above mentioned overarching project in a Differential Equations module at a research-intensive UK university. For the purposes of this paper we define a screencast as a video recording of an explanation of a mathematical concept or a worked solution to a mathematical problem recorded by a lecturer

[1] The three questions on feedback. Students are asked to respond on a 5 point Likert scale.
Feedback on my work has been prompt.
I have received detailed comments on my work.
Feedback on my work has helped me clarify things I did not understand.

using screen video capture software and accompanied by an audio commentary. After a written coursework was marked, feedback was recorded as a detailed screencast by the lecturer who worked through the solutions to the questions, but also pointed out the common errors students in this class had made. Once the marked coursework had been returned to the students, the link to the screencast was made available to them. This screencast feedback replaced the feedback that previously had been given during lecture time. We particularly investigate the four research questions:

1. *Do students access screencast feedback?*
2. *Is screencast feedback effective feedback?*
3. *What are the additional gains if feedback is given in screencast form?*
4. *How do students rate screencast feedback?*

Literature

In this literature review, we will first look at feedback in higher education in general, then focus on feedback in mathematics education followed by student views on feedback provided, particularly in mathematics education. We then move to literature on learning mathematics from screencasts, and finally summarise research on screencast feedback.

Feedback

In this paper, we will use Sadler's (1989) definition of effective feedback: For feedback to be effective, it must encompass three components. Firstly, it must enable a student to understand what is, or was, required. Secondly it must enable them to make an accurate comparison between the required work, and their own performance. Finally, and most importantly, it must prompt some action which will help the student to close the gap between their work, and the expected standard. Hattie and Timperley (2007) suggest that effective feedback must answer the three questions: 1) Where am I going; 2) How am I going; and 3) Where to next? Effective feedback also provides cues and is in line with goals and objectives. Gibbs and Simpson (2004) place emphasis on timing of feedback, content and quality of feedback and student engagement with feedback, as important conditions under which assessment supports learning.

Feedback in mathematics education

Whilst feedback which is available to students informally in classes is undoubtedly important, the word 'feedback' more often prompts consideration of what is provided to students in relation to their assessed coursework. Here, we believe that the following description is typical of many practitioners:

> *"Feedback on formal written assessed coursework is given in multiple ways for any one assignment. Generally all or most of the following are used for any one piece of work: (i) short comments on scripts (ii) model answers (iii) review of common errors in class (iv) written summary of common errors (v) follow up one-to-one discussion in practical classes following the return of work."* (Robinson, 2014)

With reference to Sadler's tripartite description of effective feedback, we have observed that it is common in many university departments that tutors focus on the first two: namely students may gain knowledge of what was expected, usually through the provision of model solutions, and they may identify their work's shortcomings by a variety of written tutor comments, discussion of common errors, and comparison with the model solutions. *Student engagement* with the feedback, the subsequent action which a student needs to undertake to close the gap between the two is often left to undirected, independent study. However, as Thompson and Lee (2012) comment, "the problem with traditional margin comments isn't necessarily in the marks themselves, but in the disconnect between what teachers communicate and how students interpret that feedback." If on top of this students sometimes cannot read a marker's handwriting (Crook, Gross, & Dymott, 2006), the usefulness of feedback given is limited.

To what extent do model solutions provide an effective means for students to understand what was really required? Well written and model solutions can certainly show clearly what the tutor was hoping the student would submit. As such, where they are provided they are often highly valued by students (Robinson, 2014). However, this is not always the whole story. Students may not always understand the important differences between their own work and the model solutions; for example if the tutor places significant value on the

development of a logical argument, and on a well-written explanation of this, a student whose work contains a correct general method but is poorly written or lacks a logical structure might not see clearly how they need to improve. Perhaps more crucially, students see little, if any, of the *process* of producing the final model solutions. The thinking behind why a particular approach is used, or any initial exploratory work, is usually omitted from the finished 'product' of solutions to an exercise. There is a fundamental issue here, about the nature of mathematics and the desired student learning; namely that although much of the content of mathematics courses relates to specific mathematical topics ("solve this type of equation") there is inherent in this other ideas about the key mathematical skills and attitudes that a student ought to develop (for example, analytical thinking, logic, creativity, an ability to verify solutions, etc). A set of model solutions to exercises will reflect these ways of thinking, but they may be hidden in the final product, especially to an inexperienced learner, rather than being explicitly discussed.

Perhaps a more fundamental question is: does this typical feedback model lead to student engagement by provoking suitable further work by the students to close the gap between the required standard, and their current performance? Gibbs and Simpson (2004) identify that feedback needs to be received, taken notice of, and acted upon to have any impact. Whilst one might hope for this in motivated students - indeed, believe that these are key skills of an independent learner - many staff report (for example to the MMG study, and to the Improving Feedback project) that some students never collect the feedback on paper-based assignments, whilst others collect it but "only look at the mark". Indeed, “if it is collected, marked work often goes into a drawer or is otherwise misplaced, such that the student can’t find the work when preparing for a subsequent essay“ (McLaughlin, Kerr, & Howie, 2007).

Student views on feedback provided

In the UK National Student Survey, students consistently rate both the quality and timeliness of the feedback they receive poorly, compared to other aspects of their student experience. The survey asks them to what extent they agree with a series of 22 statements, three of which relate to feedback:

- Feedback on my work has been prompt
- I have received detailed comments on my work
- Feedback on my work has helped me clarify things I did not understand.

The mean score (students who "definitely" or "mostly" agree) for these three statements in the 72 undergraduate mathematics courses covered by the 2012 survey was around 67%, compared to a mean for the other 19 statements of 82%, resulting in the bottom three ranks out of the 22 questions.

Similarly, as part of the MMG project, students asked in open-ended questions to identify the least satisfactory aspect of their course cited issues around coursework and feedback more often than any other (Robinson et al., 2010). The same study showed that staff also often recognise problems with feedback, focussing primarily on three aspects: the staff time which is taken to provide effective feedback, the poor quality of some of the feedback given whether because of inexperience or lack of time, and whether students engage with the feedback. Indeed, Kerr and McLaughlin (2009) question whether the form of feedback itself, usually written, could be part of the problem, and report on their findings that students rated the overall quality of feedback more highly if it were in video form.

Learning mathematics from screencasts

Educational psychology research by Atkinson (2002) and Mayer (2003) shows that learning from a video with animation and verbal commentary is more effective than learning from on-screen text, narration or animation alone. It therefore comes as no surprise that students have reacted very positively to screencasts of mathematical content to support their learning (Loch, Gill, & Croft, 2012). It has also been shown that student performance on mathematics problems may improve once they have watched revision screencasts (Loch, Jordan, Lowe, & Mestel, 2014). Students have said they appreciate being able to replay, fast-forward and pause videos when they study for assignments or exams (Loch et al., 2012). They do not want their lectures replaced by screencasts (Mullamphy, Higgins, Belward, & Ward, 2010). One study calls for caution if students do not attend lectures because they know they are being recorded, and they then also don’t watch the recordings. If this is the case, the availability of lecture recordings can have a detrimental effect on the grades of some student groups (Yoon & Sneddon, 2011). While screencasts may have been criticised as too passive and that they cannot challenge student misconceptions (Muller, Bewes, Sharma, & Reimann, 2008), it has also been argued that “there is a place for screencasts to supplement learning, particularly when previous alternatives for revision have been the

study of text books" (Loch et al., 2014). This indicates that screencasts could be an effective mode to provide feedback to students, maybe even more effective than learning from written comments and solutions.

Screencast feedback

The non-mathematics education literature contains several studies on student perception of screencasts for feedback on assessment, mostly in disciplines such as language education and creative writing, but also in chemistry education. For example, Ghosn-Chelala and Al-Chibani (2013), in English language classes, trial individual feedback on assignment drafts. Students appreciated the clarity of feedback in the video, also because the audio narration helped decipher the instructor's handwriting and editing symbols. Earlier, again in English language teaching, Stannard (2008) reports on two case studies: In the first, individual videos were provided; In the second, one generic video was produced for all students, highlighting common errors. While recording individual videos was seen as time consuming, tutors did not think the time commitment to record the generic video was onerous and they were able to use the video as a reference in the future on the issues that had occurred in that year. Students also reported revisiting the generic video several times. Students reacted very positively to the videos provided.

In chemistry education, both final year project students and first year students regarded screencast feedback on their submitted work as "effective and highly personal", commenting that it is easier to understand the marker's reasoning when an audio-visual explanation is given compared to written comments (O'Malley, 2011). On the other hand, the time commitment required by tutors to create feedback screencasts was comparable to more traditional forms of providing feedback. O'Malley suggests providing more generic feedback to a whole cohort of students in addition to the more personal approach he describes. Haxton and McGarvey (2011), in contrast, found that production of generic screencast feedback for chemistry assessment was more time consuming than typing model solutions. While students commented that it took longer to identify specific areas of interest in the video and some students preferred written feedback, the videos were well received by students, particularly since they addressed common mistakes.

Finally, in the context of the teaching of writing, Thompson and Lee (2012) found that screencast feedback on essays (which they name veedback), showing no written comments, creates rapport and provides better support than traditional written comments as it creates "a sense of availability", and is better suited for in-depth explanations. Negative feedback came from students averse to a change in feedback approach, and from those who struggled to play back the videos. Silva (2012), trialling assignment draft feedback in writing in the form of individual videos, also suggests that "students may feel more of a social connection", as listening to the teacher's voice results in teacher presence being felt inside and outside the classroom. Vincelette and Bostic (2013) confirm that these students prefer video feedback to traditional feedback. Edwards, Dujardin and Williams (2012) find that it takes considerably less time to produce screencast feedback than to type comments for Master level essays in communication. Screencasts are perceived as more personal, and better, and are quicker to capture than typed comments.

Although Thompson and Lee (2012) highlight that students engage actively in learning when they write their own comments while they interpret video feedback, one question remains unanswered: whether video feedback is more effective in improving student performance. Brick and Holmes suggest the need for more extensive trials of video feedback, to establish "whether all learners respond equally well, irrespective of individual learning style or other factors" (Brick & Holmes, 2008), but also to investigate in more depth the level of acceptance of tutors of this type of feedback provision, and to establish a clear methodology.

We identify the following encouraging themes repeatedly coming through from these previous studies: Screencast feedback is seen as

- More personal, creating a teacher presence (Edwards et al., 2012; O'Malley, 2011; Silva, 2012; Thompson & Lee, 2012; Vincelette & Bostic, 2013)
- Easier to understand/clearer than traditional handwritten/typed comments (Edwards et al., 2012; Ghosn-Chelala & Al-Chibani, 2013; Haxton & D.J., 2011; O'Malley, 2011; Stannard, 2008; Thompson & Lee, 2012; Vincelette & Bostic, 2013)
- Not necessarily more time consuming (Edwards et al., 2012; O'Malley, 2011; Silva, 2012; Stannard, 2008)
- Better than/preferable to traditional feedback (Edwards et al., 2012; Ghosn-Chelala & Al-Chibani, 2013; O'Malley, 2011; Stannard, 2008; Vincelette & Bostic, 2013)

Returning to mathematics, students appear to access feedback when it is *provided online*, as Stoneham and Prichard (2013) found in a study also motivated by student dissatisfaction with feedback on the UK National Student Survey. They found that three quarters of students in computing and mathematics courses accessed feedback that is provided online, most of them within a day of release. Stoneham and Prichard call for more research on the provision of (online) feedback to students to establish best practice, so staff time is put to best use. We argue that there is an urgent need to investigate particularly the role screencasts may play in this arena, since there is a dearth of studies in the mathematics education literature on providing feedback to students via screencasts. The very positive student perception reported in the non-mathematical literature is mostly from essay feedback, which is naturally of completely different nature to assessment feedback in mathematics.

Context of the study

This study was situated in a research-intensive UK university mathematics department, one of the seven departments involved in the *Improving Feedback* project (Robinson, 2014). Students on the single honours B.Sc Mathematics and MMath study the module Differential Equations in the second semester of Year 1. Some students taking joint-honours courses (e.g. in B.Sc. Mathematics and Economics) can choose to take the module in their second year. The module is assessed by a final examination (70%), an in-class test (10%), and four courseworks (5% each), two of which are assessed by computer and two of which are written pieces. The marking of the two written pieces of work is performed both by the lecturer and a postgraduate assistant. Due to the size of the cohort, here 220, and the need for a rapid turnaround of marked scripts, comments written on the scripts are minimal and have been restricted traditionally to indicating correct/incorrect answers or steps in a calculation. In the past, further feedback has been given in written form by supplying worked solutions and by pointing out some common errors during a lecture. This last mechanism for providing feedback is less than ideal as some students may be missing from that lecture, it is irrelevant for some, and by the time this takes place the course has moved on and both students and lecturer are considering other topics during the lecture. The course consists of two 50-minute lectures and one 50-minute tutorials, in each of 12 weeks. For the tutorials the students are provided with a set of unassessed exercises, mostly with answers but not worked solutions. Whether the students complete the exercises or not is entirely up to them; students are expected to monitor their own progress by checking their answers with their peers and by consulting the answers on the exercise sheets. They can seek help in the tutorials as necessary. This formative self-assessment has been supplemented in recent years by the preparation of screencasts for some of the exercises (**reference removed to preserve author anonymity**). In the screencasts the lecturer works through the problems accompanying his working with an audio commentary. Informal feedback gathered from students indicated that they valued the screencasts.

As part of the *Improving Feedback* project (Robinson, 2014), the module leader of the Differential Equations module agreed to implement a novel form of feedback for one of the written courseworks for the 2011/12 cohort. This took the form of preparation of two screencasts in which two coursework questions would be worked through by the lecturer in detail and common errors made by the students would be pointed out. Additional "asides" which the lecturer thought to be helpful and relevant were included. The two questions on this particular coursework focused on the solution of first order differential equations. Figure 1 shows an early frame of the first screencast in which the problem as posed was discussed and salient features pointed out. Figure 2 shows a later frame taken with the worked solution in progress. The complete screen cast is available on-line here: [URL needed] The screencast was prepared by the lecturer following discussions about common errors with the postgraduate marker.

The questions themselves were typeset using LaTeX and PDFs thereby generated. Freely-available software for PDF annotation was acquired and used on a tablet PC. Proprietary software for recording on-screen activity and audio was used to capture the lecturer's working and audio commentary. Preparation and recording of each screencast took typically two hours, allowing for setting up equipment, re-recording of slips of the tongue or pen, and generating the final files for upload. The two resulting mp4 files were approximately 24 minutes and 10 minutes long respectively. These were made available on the module pages of the university's VLE. Once the coursework had been marked and returned, the students were emailed by the lecturer who invited them to watch the screencast and then follow a link to the survey questionnaire. About two weeks later a reminder email was sent. The survey – and hence the results presented below - did not distinguish between the screencasts available for formative assessment (those related to the tutorial sheet exercises) and those for summative assessment (the coursework).

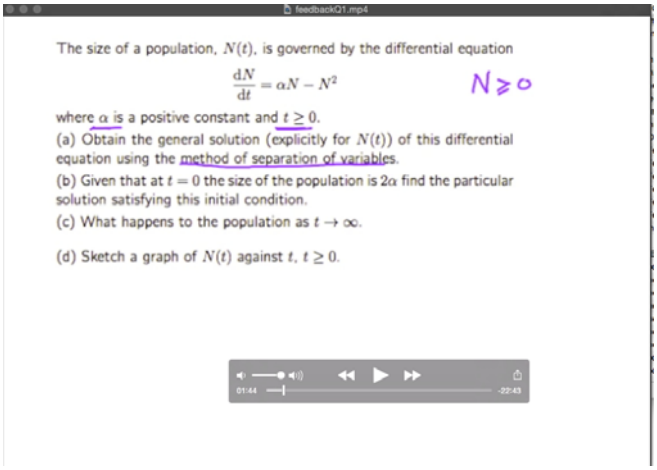

Figure 1 An early frame from the screencast showing the problem as posed to the students.

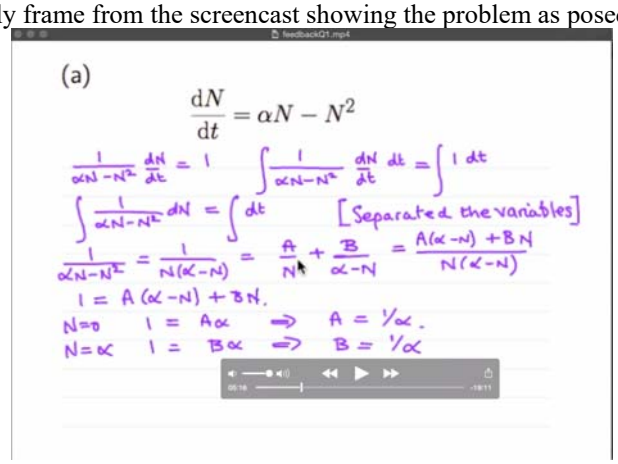

Figure 2 A frame from the screencast showing the worked solution in progress.

The research questions

As stated in the introduction, we are addressing four research questions in this paper. In order to answer the question about effectiveness of the feedback we need a definition of effectiveness. We use Sadler's (1989) definition of effective feedback, which results in three sub-questions. We therefore now have the following research questions:

1. *Do students access screencast feedback?*
2. *Is screencast feedback effective feedback?*
   a. *Does screencast feedback enable students to understand what was required?*
   b. *Does it allow them to make a comparison between their own work and what was required?*
   c. *And does it prompt action which helps students close the gap?*
3. *What are the additional gains if feedback is given in screencast form?*
4. *How do students rate screencast feedback?*

Methods

We use the student perspective together with data from VLE access records to answer the above four research questions in the context of the screencast feedback provided as part of the Differential Equation module. As soon as students had accessed this feedback they were invited to complete an anonymous on-line survey. The survey contained both qualitative (open-ended) and quantitative questions (see Appendix 1 for details of the survey). The open ended survey questions included questions directly related to the three sub-questions of research question 2 (see part 4 of the survey in appendix). However, we included all qualitative questions in our analysis of responses using a grounded theory approach (Glaser & Strauss, 1967) through which three principal

themes emerged as they had been repeatedly addressed in student descriptions of their views of the screencast feedback:

- the *process* involved in doing mathematics – this theme is concerned with mathematical communication, learning to behave like a mathematician, thinking mathematically, mathematical and more general skills development.
- *student engagement* – ways in which the screencasts encouraged: interactions with the mathematics or with others; more and deeper learning; reflection; self-awareness and independent learning.
- *richness* of video screencasts as a form of feedback – the ways in which the screencasts provided an enhanced learning experience, the ways in which they complemented, supplemented and encouraged combination of existing forms of feedback.

We then matched research questions 2 and 3 with the themes. *Process* applied to all three sub-questions of research question 2, student engagement directly related to the second and third sub-questions (as both require an action), while richness related to the additional gains in research question 3.

Results

1) Do students access screencast feedback?

Access statistics show that out of the 220 enrolled students, 153 accessed the screencast on the first question, and 47 accessed the screencast on the second question. It should be noted that the first question is regarded as more complicated.

To enable a comparison between different types of feedback, students were asked in the survey about the extent to which they had used not just the screencast videos, but all types of feedback available on this module - see Figure 3. In total, 34 of the 220 students taking the module participated in the survey.

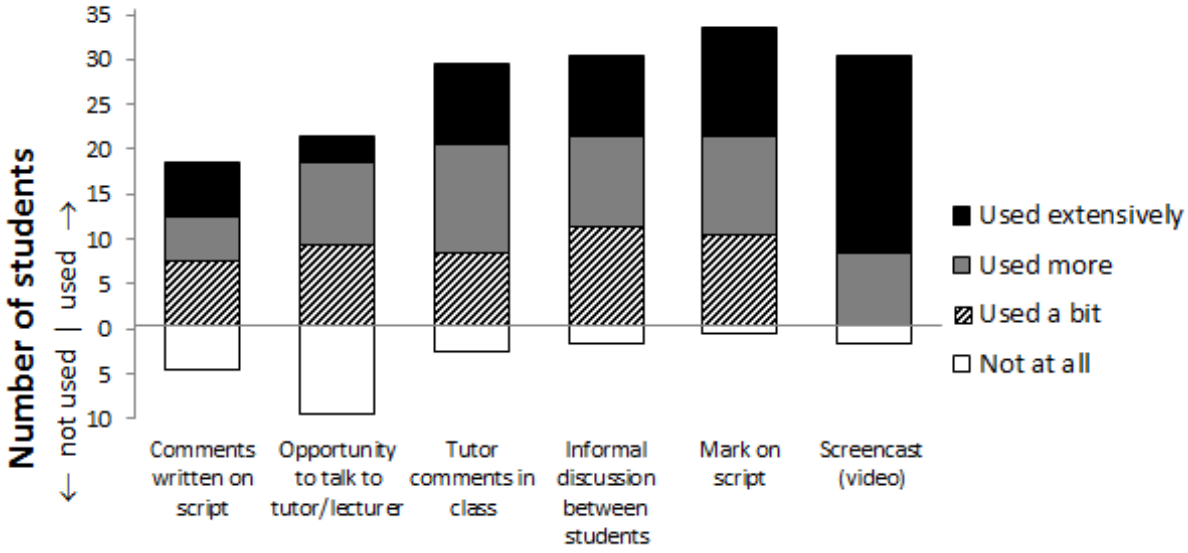

Figure 3: The extent to which students said they used different types of feedback (number of students, excluding those who did not answer and those who said this feedback was unavailable)

We note that firstly, comments written on scripts were the least used form of feedback overall, but this is partly because a substantial proportion of the students (over one-third) reported that these were unavailable to them. This is not surprising since comments written on scripts were limited to indicating correct/incorrect answers or steps, as described earlier. The same is not true for the opportunity to talk to the tutor; all but two students acknowledged that this was a possibility, but this type of feedback was the one students were least likely to take. Of the other four forms of feedback, all were used to some extent by the vast majority of students, but the striking difference is in the degree to which screencasts were used compared with the other three; around 70% of students reported that they used screencasts "extensively", and none reported that they used them "a bit". In other words, this suggests higher levels of student access of video feedback compared to other types of feedback by those students who responded to the survey.

Unsurprisingly, then, asked to identify the single most used type of feedback, most identified the screencast videos, as shown in Figure 4.

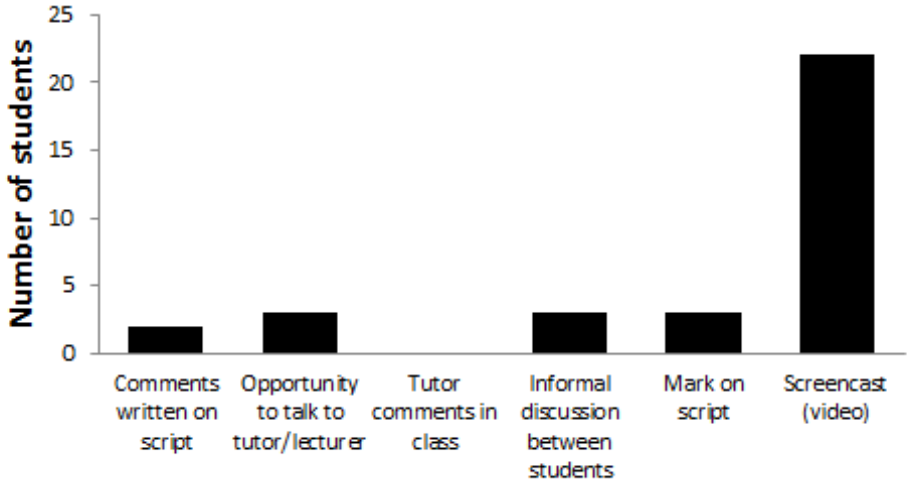

Figure 4: The most used type of feedback as identified by the students.

In summary, our analysis of the quantitative data shows that the students who responded watch the screencasts more than they access other forms of feedback.

2) **Is screencast feedback effective feedback?**

Does screencast feedback enable students to understand what was required? Does it allow them to make a comparison between their own work and what was required? And does it prompt action which helps students close the gap?

Several students provided details about how the screencasts showed them improvements in how to communicate mathematics. They demonstrated that they gained an understanding of what was required. The screencast feedback showed them "the ideal way to set out and answer our coursework", and "how to lay out answers in future coursework/exams." Other students commented on the screencasts:

> *…they show how the questions need to be answered rather than just being given a solution.*
>
> *It helped me to improve my writing of the answers by setting it out very neatly so you could [see] the answer very easily.*

Some comments referred to ways in which the videos provided insight into the lecturer's way of thinking, ways which students could then learn from and emulate:

> *…. See if my thinking followed the same path if I laid it out in an easy way to follow.*

Several students compared their work to the solution provided, and also said they were learning from this for the future,

> *I compared it with my own work, noticed some silly mistakes and how to best avoid them in future.*
>
> *I did understand where I went wrong after watching the video and in the future I will be more vigilant in checking the logic and relating previous answers to the next part.*

Improving general skills and techniques and strategies from mistakes made by others as to avoid making them as well were also mentioned,

I just wanted to find out about where people commonly lost marks because that could potentially be something I do in the future by accident or it might have been luck that I didn't make that mistake myself.

It explained a common error which I would have carried through to the exam if it hadn't been highlighted.

In addition to this, there was a substantial body of quotations that indicated the potential for screencasts to improve student engagement, i.e. students actively doing something with the feedback they received. So a student who believed they had their attention drawn to things that they would otherwise have missed wrote:

It explained the method which would have given me the marks I lost – which I would have normally overlooked as it is not explained on the paper [model solutions]

Rather than being a passive form of tuition these students were able to interact with the video in a way that would not be possible in a traditional lecture. In particular they are able to intersperse the lecturers' presentation with time for them to actually think:

Videos were helpful … if you needed to stop to think.

I could pause the video when I wanted to write things or to think things through.

The potential for promoting reflection and deeper learning and time-on-task came to the fore. This student in particular seems to have been inspired to devote a great deal of time and energy:

Before watching the videos I read over my coursework again and then whilst watching the video compared it to how I had done the question and where it was similar or where I had gone wrong. I then watched the video again and wrote down notes of how to do the questions and additional comments and tips. After reading my coursework and watching the videos I discussed with friends to talk about where I had gone wrong and where they had and to talk about the correct way that the question should have been completed.

The ways in which students can be encouraged by this feedback to become independent learners was evident too:

I watched the video numerous times, and used it not only to understand any problems or mistakes I made but also as an aid to tackle other problems of a similar nature…..

It allowed me to make my own notes from the feedback and to use this for future reference and revision purposes.

This student was encouraged to use the feedback to recap and to revisit the lecture notes:

I worked through the question again where I had lost the marks and recapped the topics covered using lecture notes

whilst on the other hand….

It also meant that instead of staring at my notes I could recap in a different way in order to further enhance my understanding.

More than one student commented that there had been more feedback in this module than in any other they had taken.

3) What are the additional gains if feedback is given in screencast form?

Students described ways in which the provision of feedback through the screencasts led to an enhanced learning experience. They were particularly keen to emphasise additional gains for them. For example, screencasts provided an opportunity for staff to provide richer *detail* that might not be covered within the constraints of a lecture or in standard written solutions. Many students commented that they appreciated that they could pause the video. A student commented:

> *…. Because sometimes you don't always gain every single bit of information from a lecture and having a video which goes through slowly, step by step, I find really useful because you can take it in at your own pace.*

Compared with written feedback, the benefit of being talked through a mistake or solution was mentioned as this provides clarity as to what is meant, and why a solution is incorrect. Completeness of the steps towards a solution, level of detail and depth were mentioned, as there were "no small parts […] missing" in the video feedback. In particular, one student wrote:

> *… really helpful as sometimes in written solutions I can struggle to follow where a step has come from. With a commentary alongside the workings it is clear exactly what is going on.*

For students who have been largely successful in the coursework, but who need help with isolated parts the screencast can be an efficient way of providing this. These students do not need to sit through parts of a feedback session when the lecturer is going over material that they could already do. Instead they can scroll ahead to problematic parts:

> *It was helpful to see the video as you could just look at the parts you struggled with and got wrong instead of listening to feedback on the whole coursework as other lecturers would do in a lecture, and modify the pace accordingly*

The above quotes highlight ways in which a screencast can be better than a traditional feedback lecture or feedback provided in writing on a script. For others, the richness came from feeling they are personally addressed by the lecturer, and from being able to choose how, when and where they worked:

> *It makes you feel like the lecturer is explaining everything to you personally.*

> *The videos were particularly useful as it gave an environment to learn and understand in the comfort of my own home. Being comfortable and being at my own pace is very important for learning.*

As an enhanced form of feedback, the screencasts were particularly popular:

> *I had made some errors in the first question on the coursework and on the marked script it was highlighted where the error was but it didn't explain why it was an error… with the video commentary the lecturer could talk you through the problem and could point out where most students made mistakes and perhaps even say it was a common mistake but then explain why it's a mistake…*

The vast majority of responses were positive. This is not altogether surprising given that those students who had responded to the survey were most likely those that had chosen to watch the video feedback. However some of the students who watched the videos found that they did not live up to their expectations or were unhelpful. With specific reference to the screencasts, dissenting comments, or comments that suggested there was room for improvement, seemed to come from students who prefer to read through solutions on paper, those who did not think they needed to see all the steps, and others who do not always study in front of a computer. Specific comments included

> *I would have preferred to have a marking scheme with answers and workings for the questions; this would allow me to look through the coursework at my own pace. It does not help to have the answers written before me on a screen whilst listening to the narrative. I am quite capable of following decent working on a sheet of paper (an on-line pdf).*

> *Explaining in too much detail sometimes i.e. how to calculate partial derivatives step by step.*

> *The video system was useful although I would have liked a printable Word-like document as well as then I could read ahead if [I] needed to, or had a hard copy when a computer wasn't available.*

We note that the issue of a marking scheme and a printable document are not criticisms of the screencasts per se, but we will take them as suggestions for the future. The issue of whether there was too much detail is an

individual and personal one. We contend that too much detail is better than too little as students can always fast-forward through detail they are already confident with.

4) How do students rate screencast feedback?

Students were asked to rate the quality of each type of feedback which they said they had received (Figure 5), and to identify the single best type of feedback for them (Figure 6). The survey aimed not to prejudge what was high quality by including the statement:

> *Whether you like or dislike particular sorts of feedback might be for a variety of reasons, which will depend on your opinions.*

Figure 5 shows that over 80% of the students rated the quality of the video feedback as "excellent", more than double the proportion who said the same about any other type of feedback; Figure 4 shows that the vast majority of students felt that it was the best feedback they received.

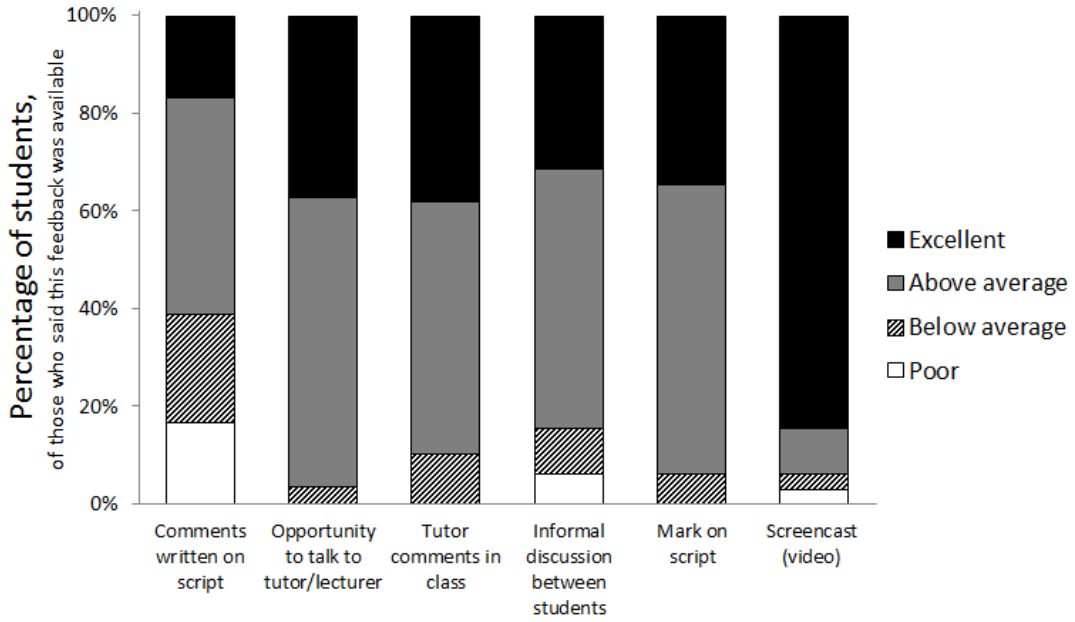

Figure 5: The proportion of students who rated feedback from excellent to poor, (excluding those students who said this feedback was unavailable, or responded "don't know").

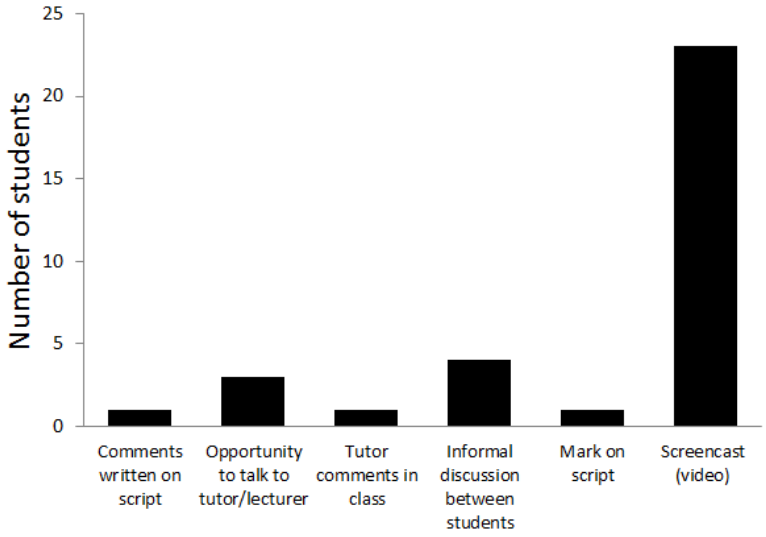

Figure 6: The number of students who identified each type of feedback as the best.

In summary, our analysis of the quantitative data shows that the students who responded watch the screencasts more than they access other forms of feedback, and they rate them higher than other forms.

Overall, our results would indicate that students found this method to be particularly helpful, which is exemplified by this student comment:

> *It is by far the most useful way of providing feedback and help.*

Discussion and Conclusions

We acknowledge that one of the limitations of our study is the number of students who completed the survey compared to the total number of students who were enrolled in the course: 34 of the 220 students responded. However, since students were only prompted to respond to the survey after watching the feedback screencasts, our target population is not the entire class cohort, but students who had decided to watch the videos. It is likely that those who did respond were feeling more positively about the screencasts than others. The comments suggesting improvement show that not only students who were in favour of screencast feedback voiced their opinions. While we can only report in this paper on the sample of the class that responded, our outcomes still have implications for the larger body of students.

Our study confirms that the students who responded think screencast feedback is more personal and easier to understand – a finding consistent with other studies reported in the literature. The students regarded them as an appropriate and helpful form of feedback.

Do students access screencast feedback? From the access statistics, it is clear that not all students have watched the screencasts, however a large proportion did watch the first video. Nearly all students who responded said that the videos were the type of feedback they had used most. So compared to other types of feedback, screencast feedback is preferred by these students.

Is screencast feedback effective feedback? Students certainly have engaged with the videos, in terms of controlling the content of video when they pause, revisit and think about an answer. Some said they reflect on their own work, and on other methods. They transfer what they have learnt from the video to other examples. This is the type of engagement we need to see from feedback.

What are the additional gains if feedback is given in screencast form? It appears that the screencast feedback adds another dimension to feedback in mathematics. Many students commented upon the detail in the screencasts and that all the stages were shown without taking shortcuts. Perhaps a message here is that depth is very important when producing screencast feedback as students will appreciate and benefit from this. Students also commented that the screencasts helped them not just develop skills, but also to learn to communicate mathematics like a mathematician. Students thought that the feedback screencasts were giving them more than the short screencasts they had seen to help with exercises, as the feedback screencasts were of direct relevance to the questions they had just been marked on. The commonly made mistakes were seen as feedback on how the whole cohort was doing.

How do students rate screencast feedback? Students rated screencast feedback as the best feedback they had received.

In summary, we believe that screencast feedback has become a learning tool that students use actively to improve their understanding, as it goes beyond dissemination of what is right or wrong and allows students to close the gap. Looking ahead, we believe there is scope for further studies into screencast feedback on mathematics assessment, particularly to establish if students indeed take on board this type of feedback and if it is more effective in improving student performance. It would be of interest to contrast effectiveness of various uses of screencast feedback. Taking into account some of the negative comments, a combination of types of feedback could be the most effective form of feedback provided on mathematics coursework: highlighting where an individual student has gone wrong, for instance on the actual script, giving the fully worked solutions in PDF form, but also giving a detailed solution as a screencast, with additional commentary on common mistakes, why these are mistakes, and on other misconceptions. This should please the students who commented they were more comfortable reading through a solution rather than watching its development. We also suggest that future research should include the tutor/lecturer perspective, since the production of a video resource is time consuming and editing requires a certain level of technology expertise.

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APPENDIX

SURVEY QUESTIONS

Part 1: (Open-ended initial question)

Please briefly describe all the feedback that was available to you during your degree course.

Was any feedback particularly helpful or useful ? (please give brief reasons; what was helpful or useful to you, and why ?)

Was any feedback particularly unhelpful ?

Did you feel you received enough feedback ?

Part 2: what feedback do students use.

Listed below are some forms of feedback that might have been available on your degree course.
In each case please indicate how much you looked at it/ read it/ used it in any way.
If the feedback was not available, or you didn't know that it was available, then please click that option.

- Mark on your coursework script
- Comments written on your coursework script
- Opportunity to talk to tutor/lecturer about the work
- Screencast (video) of worked solution with commentary
- Screencast (video) with commentary about common errors and misconceptions
- Comments from the tutor/lecturer in class (lecture or tutorial)
- Informal discussion between students.

You have said that you used X the most. Please tell us what you did with the feedback.

Part 3: the quality of the feedback

For each of the following items which you said were available, please rate the feedback.

(Whether you like or dislike particular sorts of feedback might be for a variety of reasons which will depend upon your opinions. We will ask you about what counts as "good" for you in the next section).

Options: Poor; Below average; Above average; Excellent; Don't know

- Mark on your coursework script
- Comments written on your coursework script
- Opportunity to talk to tutor/lecturer about the work
- Screencast (video) of worked solution with commentary
- Screencast (video) with commentary about common errors and misconceptions
- Comments from the tutor/lecturer in class (lecture or tutorial)
- Informal discussion between students.

Please select the item which you think was the BEST feedback. (If you rate two or more things equally just pick one of them. If you think most of the feedback was poor, we'd still like you to pick the one that was the "least bad").

You have said that you rated X most highly (or least badly!) What was it about this feedback that made it your highest rated ? Why was it the best ? What was good about ?

Part 4 Miscellany

Please tell us roughly what marks you got for the coursework.

Thinking about the screencast (video) in particular: did watching it help you to understand what was required ? Did it help you to understand where you went wrong ? Would you do anything differently in the future (exam or future coursework) as a result of watching it ?

Finally, are there any other comments you would like to make about the feedback for your degree course ?