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Heidi Hulsizer

Hampden-Sydney College, USA,
hhulsizer@hsc.edu

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Student-Produced Videos for Exam Review in Mathematics Courses

Heidi Hulsizer*

Hampden-Sydney College, USA

Abstract

Videos have been used in classrooms for decades, but student-produced video has recently become a viable, economical option to enhance learning. Students were asked to create videos to be used for their exam review in two different undergraduate mathematics courses: Differential Equation and Complex Analysis. Students were then surveyed about their opinions on the project and its helpfulness for exam review. Students enjoyed the project, found it engaging and most of them viewed the videos again outside of class. Students agreed that creating videos helped them learn the material better. However, students still preferred instructor-led review over student videos for exam review.

Key words: Student-produced video; Worked examples; Active learning

Introduction

The rapidly changing technology environment requires educators to reevaluate teaching methods as students are increasingly more comfortable with and engaged by technology. Students can view podcasts, video-lectures, or Khan-academy style videos as supplements to their courses; also, these tools have been used inside of classrooms across disciplines. Students may view videos when they would not be willing or able to seek out help from a tutor or instructor; or students may miss a class and need to rely on videos for course content. One example is Khan Academy (www.khanacademy.org), it uses low-tech video presentations (between 10-15 minutes) to explain one topic at a time (for background see Kaplan, 2010). While this virtual school has many advantages there are skeptics. One critique is that viewing videos may lead to a passive learning process rather than an active process, and this is one reason that some researchers propose having students produce the videos themselves (Schultz and Quinn, 2014). With an increased emphasis on active learning in the mathematical sciences (MAA, 2015), there is a way to utilize this technology in an interactive way to help students learn.

In mathematics classrooms and beyond, assigning students the task of creating their own videos can lead to many benefits. Creating videos allows students to perfect their presentation skills and gives them experience with video creating/editing technology that they might have to use in our increasingly technological workforce (Martin, Coleman, & Hughes, 2013; Shewbridge & Berge, 2004; Swain, 2003). It provides an opportunity to hone communication skills, which are essential to college graduates looking for jobs. Furthermore, Siegle (2009) states that communication and literacy are evolving and effective educators must incorporate video technology into the learning environment. Also, producing videos gives students the opportunity to express creativity, to work in a team, and to be part of a motivating experience. In a math classroom it also gives students a chance to use mathematical language in a more formal setting. It is the hope that video creation will promote retention of knowledge and a deeper understanding of the material. It is an active, deliberate, and cooperative exercise to create a video on a classroom topic. This innovative exercise also allows for reflection and feedback. As Fisher and Baird (2006) remark, "Students no longer want to be passive recipients of information, but to be joint participants in the creation of knowledge with their instructor and peers."

In mathematics, before students learn formal proofs, instructors expect that they can explain their answers or show their work. Without the formal language of proof however this can be difficult as students can use a sort of visual component in their explanations (Loomes, Shafarenko & Loomes, 2002); for example, it might be easier for a student to draw what a complex map does than rigorously prove it. Using video gives students, the opportunity to showcase their knowledge with a method they might be more comfortable using while learning the technical language required for a more formal proof.

* Corresponding Author: *Heidi Hulsizer, hhulsizer@hsc.edu*

In this paper we will focus on using student-produced videos for exam review. As a tool for exam review this method forces students to take a more active role in the process and places the responsibility on them for preparing the class for the exam. The audience is their peers which should be an incentive for high quality work. Creating and viewing others' videos might help students see these problems from a different perspective and teach them how to communicate their understanding of the course material to their peers.

Literature Review

A large amount of literature exists discussing the use of video for teaching and learning. This research began with audio podcasts and has transformed as technology has become more accessible. The overarching question in all of this research should be: Does this technology actually help students learn? Video podcasts have increased student *perceptions* of improved learning (Hill & Nelson, 2011; Martin et al., 2013), but in Hill and Nelson's research (2011) there were no significant differences in exam grades after using them. This contrasts with the findings of Lazzari's work (2009) in which students created their own video podcasts and had higher performance and, what he calls, *competitive agency* compared to other groups. Lazzari believes:

... the public performance compels students to an extra-effort which acts on what we define as their *competitive agency*, that leads them to a more intense and effective learning process, well beyond the simple assimilation of concepts or even their re-elaboration, up to the search for the meaning of what they are studying. (Lazzari, 2009, "Discussion," para. 16)

Student-production seems to have been the key in Lazzari's work in multimedia communication and human-computer interaction courses. However, having students produce their own videos or podcasts has been documented in several undergraduate courses: Communications classes (Communication Ethics, e.g. Lehman, DuFrene, & Lehman, 2010), Pharmacology (Frenzel, Skoy, & Eukel, 2013), Foreign Language (Russian, e.g. Nikitina, 2009), Management courses (Schultz and Quinn, 2014), Computing courses (Martin et al., 2013), and Information Technology (audio podcast e.g. Lee, McLoughlin, & Chan, 2008).

Video production can foster deep thinking and understanding of content (Martin et al., 2013) and has been highlighted in constructivist learning theory for its knowledge building capabilities (Jonassen, Peck, & Wilson, 1999). Students displayed a recorded improvement in knowledge of course material (Frenzel et al., 2013). Maloney, Storr, Morgan, and Dragan (2013) report higher clinical test scores for students creating self-videos with guided reflection than students with class teaching alone. Miller and Redman (2010) found video demonstrations provide online Astronomy students with educational benefit. Boster, Meyer, Roberto, Inge, and Strom (2006) reported that sixth and eighth grade mathematics students performed significantly better because of viewing video podcasts than those who did not.

In mathematics or the sciences, worked example video podcasts can provide step-by-step explanations of problems. Worked example podcasts have been shown to be well-used and useful in Pre-Calculus classes; and helped students learn the material better and were more engaging than textbooks (Kay, 2014). Information and Communication Technology students found podcasts quicker for exam review than notes and more helpful in reviewing for exams than textbooks (Evans, 2008). Also, in Evans' research (2008) students believed they were more receptive to material delivered by podcast than traditional review lectures or the textbook. Students also found viewing video podcasts as a useful resource in a science course (Hill & Nelson, 2011) and geography course (Jarvis & Dickie, 2010). Other research has shown podcasts are helpful for reviewing (Evans, 2008; Jarvis & Dickie, 2010). Having students create audio podcasts have been shown to provide a medium for collaborative, cooperative learning and knowledge creation (Lee et al., 2008).

Student video production has been encouraged at the K-12 level (Kearney & Schuck, 2006; Niess & Walker, 2010; Yildiz, 2002) in response to changes in culture. Kay and Edwards (2012) studied students in grades six to eight and found the use of worked example video podcasts increased learning performance. They also found no gender or grade level differences in the students' attitudes surrounding the use of podcasts and no difference in learning performance based on these factors. Kearney and Schuck report that the video production process and presentation created high levels of student autonomy and task ownership (2006), similar to what Lazzari (2009) calls *competitive agency*.

Prosperpio and Gioia (2007) discuss how the current generation of students is not only a group of verbal or visual learners but also virtual learners. They emphasize how learning is enhanced when students are actively involved in the learning process and when the process includes social interaction and problem solving. Also,

the blending of new technology is worth the effort to connect to students by speaking using their language of technology (Prosperpio & Gioia, 2007). In their text, *Learning with Technology*, Jonassen, Peck and Wilson (1999) speak to the motivation of this research. They state that, “Real learning requires *active* learners...” (p.9) and so much so that physical, real activity is a necessary but not sufficient condition for meaningful learning. They assert that technology must not be used as simply a delivery system for knowledge to students, but a means for them to represent what they know and way to teach others. They also claim that “The major reason that students do not successfully learn from watching televised instruction is that they are not mentally engaged by it.” (p.54) However, “producing videos requires learners to be active, constructive, intentional and cooperative.” (p.55) Brian Goldfarb (2002) makes a case for the use of student video production as a pedagogical strategy. He advocates for student production of videos to allow for critical thinking (p. 72).

Student-produced videos are valued by the students participating because of the required creativity, the application of the course material, the use of technology and teamwork (Frenzel et al., 2013). Students consider such activities as enjoyable (Martin et al., 2013; Nikitina, 2009) and authentic (Kearney & Schuck, 2006). One of the main advantages of instructional videos (like podcasts) is that students have control over when and where they can study the material and the pace of that learning (Evans, 2008; Hill & Nelson, 2011; Jarvis & Dickie, 2010; Winterbottom, 2007). Also, viewing video lectures and worked example podcasts can help students review for exams (Kay, 2014; Kay & Edwards, 2012; Lazzari, 2009; Roshier, Foster & Jones, 2011; Whatley & Ahmad, 2007; Winterbottom, 2007). Lazzari (2009) reports that students did spend time reflecting on their work in general and not only on the topic of their student-produced podcast recording.

The length of videos must be considered to keep students’ attention and, in the literature, this time varies. Whatley and Ahmad (2007) used videos between 5-10 minutes for students to review classroom lectures. The middle-schoolers in Swain’s research (2003) created videos between 10-20 minutes. At the undergraduate level, Roshier et al. (2011) suggest that videos should be between 5 and 8 minutes in length. Miller and Redman (2010) showed videos between 3-5 minutes. Lee, McLoughlin and Chan (2008) had undergraduate students create 3-5 minute podcasts.

Brecht (2012) mentions some limitations to instructor-created video lectures: the type of class may not be conducive to video lecture (e.g. classes where complex decision making is required), cost to instructor’s time in creating the videos especially if using technology like this is not rewarded by the institution, the institution’s capacity to store and stream video files may be limited, and finally videos may not be a good idea if they encourage bad student behavior – like skipping class. Frenzel et al. (2013) also mention the varying quality of student-produced videos as a limitation to this type of project. In addition, Norton and Hathaway (2010) also list lack of teacher education on the technology as a limitation in the K-12 classroom. It is natural that these limitations extend to the college-level, however many colleges and universities have more access to technology and experts on-staff to help with training and troubleshooting. Many institutions have Instructional Technologists housed in a library or a technology center – this type of resource is essential for students (Martin et al., 2013). While some instructors might be afraid that students’ technology skills might be lacking, some researchers have not provided formal technology training and found success by providing examples and giving students time to do many practice runs with group members (Lee et al., 2008). Martin, Coleman, and Hughes (2013) also highlight that anxiety and embarrassment might make students uncomfortable with a student-produced video. They also mention that students in their undergraduate computing course were concerned that their perceived lack of, or fragile, knowledge on the content would be exposed by creating the video. However, creating a video could reduce the anxiety compared to a live class presentation and improve performance (Kearney & Schuck, 2006).

In Practice

An image is worth a thousand words, but the image must be clear to convey the necessary information. Let us take a moment to discuss some of the technical issues that need to be addressed to make a student-produced video project successful.

Of foremost importance, lectures/demonstrations need to be recorded in a space where sound and light can be managed to produce the best video quality available. Encouraging students to actually watch the videos they create before submitting them can help with this. Kay (2014) provides a framework for creating effective podcasts which can help with student-produced videos as well. One key point mentioned in Kay’s framework is the selection of the problem type; the instructor must select meaningful and effective questions for students to present. Other points mentioned by Kay include: use of visuals, readability, writing down key reference

information, clear presentation, highlighting key areas of focus for the viewer, engaging voice, pace, length of clip and distractions. Students in this research project were encouraged to keep videos short, between 5 and 10 minutes, and to use a camera with tripod, and also to be creative and take risks that do not distract from the content. Students should be encouraged to speak clearly and at a reasonable pace for easy listening. Have them choose clothing that is not too bright and does not have small patterns that appear to move when filmed. Also, they should be instructed to edit out dead air space and other mistakes.

For this research, videos were shown during the class period before the exam and took up the entire 50 minute period. However, videos do not need to be shown in class on a specified “review day” but could be posted in a place accessible to the students for viewing at their leisure, like video servers or library reserves. Also, not all videos need to be posted; if instructors have a large class, multiple groups can be assigned to the same topic or problem and the best video could be selected for viewing by the class. Instructors must give themselves time to view the videos before they are shown to the class. If mistakes are found it could be helpful to announce before viewing them in class that there are mistakes to look for while viewing them. It is further engaging to have the students point out the mistakes at the end of each video.

The Institutional Review Board (IRB) process related to student-produced videos and their dissemination is unique to each institution. However, students need to be notified as to how their videos will be used. There might also be concerns surrounding the Family Educational Rights and Privacy Act (FERPA) if a student appears on camera, so a consent form might be needed if the videos are to be shown outside of class. It is possible that videos (or edited pieces) can be used for potentially malicious reasons (Schultz & Quinn, 2014). However, with the number of videos on YouTube and available privacy settings, students might not be worried about that possibility. For this project, students were instructed to post their videos to the course management page on Blackboard dedicated solely to the class so that only students enrolled could view them. Other course management systems, like Moodle Rooms or Canvas, can be used in a similar manner to the way Blackboard was used in this study.

Purpose of the Study

This is an exploratory study that seeks answers to the following questions:

1. What are student attitudes toward worked example videos that they create for exam review?
2. As a review for exams, which do students prefer – their own student-produced videos or a traditional instructor-led problem session?

Method

Participants

Data was collected first from a 200-level Differential Equations class and subsequently from a 400-level Complex Analysis class at a small liberal arts college for men. An introduction to proofs course was not a required prerequisite for either class. Five of the same students were in both classes.

Procedure

In the Differential Equations class, groups of students were assigned problems from different sections of the textbook to present in their videos before the first exam. The videos were to be between 5 and 10 minutes in length. The student-produced videos were then viewed by the students during the class period before the exam. Before the graded tests were returned, students were given a survey about the activity. The second exam review was an instructor-led presentation of problems from the text. Students were then surveyed again at the end of the semester about their preference for exam review.

In the Complex Analysis class, groups of students were given freedom to create videos over material from sections of the text; but no specific problems were assigned, so they chose the material for the video. Students were required to create videos for the first two exams, and for the third exam students were given the option of creating videos for extra credit. Only two students opted to create videos for the third exam, so some of the exam review day was instructor-led. Students were required to work in groups for the first video project, but were free to work alone or in groups for the final two projects. Several students chose to work alone for the

second exam review video production. At the end of the semester students were surveyed about their attitudes related to the exam review video projects.

Results and Discussion

Attitudinal questions were given to both classes (see Table 1 and Table 2).

Table 1. Attitudes from differential equations class

Differential Equations (n=9)	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Watching the peer videos helped me review for the exam	0	0	3	5	1
Creating the video helped me learn the material better.	0	0	1	6	2
I don't think other students should have to create an exam review video.	2	3	4	0	0

Also, students from both classes were asked about their preference for exam review (see Table 3 and Table 4). The data from the Differential Equations class in Table 1 was collected after the first exam review and exam, while the data from Table 2 was collected at the end of the semester in the Complex Analysis class. The Differential Equations class was assigned problems to present while the Complex Analysis class had the opportunity to choose the problems/topics presented.

Table 2. Attitudes from complex analysis class

Complex Analysis (n=7)	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Watching the peer videos helped me review for the exam	0	1	1	4	1
Creating the video helped me learn the material better.	0	0	1	5	1
I don't think other students should have to create an exam review video.	0	1	5	0	1

Students were also asked an open-ended question on what they liked best about the activity. From the Differential Equations class, four students mentioned a deeper understanding of the material. One of these students acknowledged, "It required us to explain our understanding of techniques in full." One student stated that it covered all types of problems on the exam. Another mentioned it was a low-pressure way to have students present solutions to the class. Two students stated that they liked that it was different from a normal exam review. Two students mentioned that it helped the students get to know each other better, for example, "it brought camaraderie to the class...". From the Complex Analysis class three students affirmed the deeper understanding gained by preparing their section. One student pointed out that it allowed him to be creative.

Table 3. Exam review comparison for differential equations class

Differential Equations (n=6)	Student Videos	Instructor-led Review	No difference
Which method of exam review did you find most helpful in preparing for an exam?	0	6	0
Which method of exam review was the most engaging?	4	1	1
Which method would you prefer to use for future exam review class periods?	0	3	3

Students were also asked the worst part of the activity. Two students from the Differential Equations class mentioned recording issues; namely, it took a long time “to get a suitable camera position” and one group had a hard time “making the voice match the PowerPoint.” One student recalled that as a viewer it was hard to follow some of the presentations. Three students commented that the assigned textbook problem as the worst part, because it was difficult. Two students mentioned it was hard to record a presentation without making a mistake. Finally, one student stated that other members in his group did not allow him to be as creative as he would have liked. From the Complex Analysis class three students mentioned that it took a lot of time to create a good video. One cited problems with posting the video to Blackboard.

Table 4. Exam review comparison for complex analysis class

Complex Analysis (n=7)	Student Videos	Instructor-led Review	No difference
Which method of exam review did you find most helpful in preparing for an exam?	1	5	1
Which method of exam review was the most engaging?	2	2	3
Which method would you prefer to use for future exam review class periods?	1	4	2

Unfortunately, three students missed the second exam review in the Differential Equations class when the assessment questions were asked (Table 3). Of those that stated that they preferred instructor-led review in the Differential Equations class their reasons were: so the class can focus on more than one topic of discussion, because the instructor understands the material more and can answer questions more effectively, and finally that they “get more out of it.”

After the video project was completed, students from the Differential Equations class were asked if they would recommend this activity to be continued in future courses, all students agreed that it should be continued. Four of these students explained that it forces students to have a complete understanding of the concepts. One mentioned that it was interactive. Another stated that it was a relaxed way to give a presentation. Two said it was helpful for learning. One student explained, “it allows students to think outside the box and have fun while learning at the same time.” The Complex Analysis class was not asked if the project should be continued in future courses. Students from the Differential Equations class were asked to provide any comments that might assist in making the project more helpful to them or other students. One student commented about the topics presented and asked to “have questions that encompass multiple ideas if possible from what we’ve gone over.” However, most students did not have any response to this prompt.

When asked the hypothetical question, only one student (11%) from the Differential Equations class would be unwilling to post their video on YouTube. This question was not asked of the Complex Analysis class. Due to issues with technology, a couple of groups did post their videos on YouTube and included the URL into the Blackboard site instead of posting their video directly to the Blackboard site. When asked if the students had re-watched any of the videos on Blackboard 66% of the Differential Equations class had looked at them again and 71% of the Complex Analysis class had.

Limitations

The first limitation to this study was the sample size. However, as a preliminary study the results do demonstrate promise for future work. The second limitation was student-induced. According to the campus instructional technologist, none of the students in either class requested aid on this project from library staff, even though they had ample opportunity to do so. Students might have enjoyed the project more and had fewer technical difficulties had they taken advantage of the resources available to them.

Conclusion

Overall there appears to be a positive attitude surrounding the video creation. Students perceive these types of projects as different compared to traditional class work (see also Kearney & Schuck, 2006). This research shows that students’ perception was that the video production was helpful in learning the material and for exam review. However, students did prefer that the instructor lead the review sessions in the future. There appears to

be a trend that the video production was a more engaging form of review, however more data is needed to make a conclusive decision.

This activity could be a great way for students from many grade levels to review for an exam. Since time was a concern for several students a class period could be dedicated to the creation of these videos. It is still unclear why students prefer instructor review while they find the video projects a more engaging form of review. This would be an interesting issue to address with further research. Also, it would be interesting to see how introductory students in larger classes would handle the project. Future research could examine how the production quality of the students would change if there was a wider audience.

This type of project is something that could be a highlight for students over the course of a semester and there are many issues to explore in its implementation. In this research the Differential Equations students were required to present a specific problem rather than a topic area; students appeared to be limited by this method. A suggestion for those trying out the project is to have students create videos for specific topics.

The benefit of a deeper understanding obtained by the video creation was anecdotal; however, the added benefit of utilizing a creative, active learning outlet in a traditionally mechanical course makes video-production an appealing activity.

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Appendix - Grading rubric for video projects

Category	Points	Excellent A	Good B	Average C	OK D	Poor F
Clarity – clear audio, non-distracting visuals, conciseness	5					
Correctness – steps, final answer	10					
Creativity	5					
Overall Quality – overall impression, timing, helpfulness	10					
Total Possible	30					