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ORIGINAL PAPER

Lessons Learned from Creating Videos for Online Video-Based Instructional Modules in Mathematics Teacher Education

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Abstract
Video can be a powerful tool, with a long history of use in teacher education. Despite the increased popularity of using video in teacher education over the years, questions remain about effective ways to create and use video in online video-based instructional modules. Given this, in this paper we describe some lessons learned creating videos for online video-based instructional modules for secondary mathematics teacher candidates, as a part of a National Science Foundation (NSF) IUSE program (Award No. 1726543) funded project. We specifically focus on how we recorded interviews with middle and high school students, and iteratively developed the online platform used for the project. We conclude with implications for practice.

Keywords Video · Design-based research · Instructional design · Instructional intervention · Secondary mathematics · Attentiveness · Teacher education

Introduction

Video can be a powerful instructional tool, with a long history in the field of teacher education (Baker 1970; Coles 2019; Cuenca and Zaker 2019; Gaudin and Chaliès 2015; Major and Watson 2018; Sherin 2004). For instance, video has been used in teacher education classrooms (Copeland and Decker 1996; Franklin et al. 2018; Wang and Hartley 2003), professional development settings (Borko et al. 2008; Borko et al. 2011; Derry et al. 2007; Seago et al. 2018; van Es and Sherin 2008), as well as a tool to conduct research on how teachers teach (Ball 1993; Cobb and Whitenack 1996; Cobb et al. 1992; Stigler et al. 1999; Stigler and Hiebert 1999). The power of video in teacher education lies in its ability to capture what is happening in classrooms (which are inherently complex environments) and then to be able to enable others to watch, pause, slow down, and rewatch the recording at a later date (Hollingsworth and Clarke 2017; Lampert and Ball 1998). Given this, instructors, and the instructional designers who might support them, continue to experiment with ways to incorporate video into the lessons that they teach and to use it across multiple educational settings to improve student learning.

Despite the increased use of video in teacher education, questions remain about effective ways to use video in online video-based instructional modules (cf. Johnson et al. 2019; Major and Watson 2018). We have been working on a National Science Foundation IUSE program (Award No. 1726543) funded project, titled Video Case Analysis of Student Thinking (VCAST), during the past few years focused on developing online video-based instructional modules to improve the mathematical preparation of secondary mathematics teachers (i.e., teacher candidates). In the following paper, we describe some lessons we learned from creating online video-based instructional modules, with a specific focus on how we recorded interviews with middle and high school students for the modules and then iteratively developed the online platform used for the project.

Video-Based Instructional Interventions in Mathematics Education

We have found that literature on video in mathematics teacher education rarely describes the instructional interventions used

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in enough detail to either replicate or learn from others' experiences. More specifically, too often educators and researchers fail to describe how they recorded and selected the videos they ended up using or how they presented the videos for learner engagement. In this section, we use examples from the literature along with our own experience to highlight these issues and to outline important decisions that need to be made when developing video-based interventions from scratch.

Video Selection

The effectiveness of video-based instructional interventions depends largely on which videos (i.e., the actual recordings) are used. For instance, when developing video-based instructional interventions, some instructional designers or curriculum developers record their own videos while others use pre-existing videos. However, when using pre-existing videos (e.g., the videos available from the TIMSS video studies http://www.timssvideo.com), we have found little explanation on how and why particular videos were used. Further, when recording their own videos, developers rarely describe the process of creating the videos they ended up using. We contend that future developers need more details on how video is recorded and selected when developing video-based instructional interventions. While the literature as a whole is largely missing details on video recording and selection (which is not surprising given word count limits for most journals), there are some notable exceptions.

One example is the TIMSS video studies that were conducted in 1995 and 1999 and focused on using video to record, analyze, and compare how teachers teach mathematics across different countries (cf. Hiebert et al. 2003a, b; Hiebert and Stigler 2000; Stigler 1996; Stigler and Hiebert 1997, 2009; Stigler et al. 1999; TIMSS Video Mathematics Research Group 2003). While not focused on creating video-based instructional interventions, or specifically online video-based instructional modules, the TIMSS reports provide some details on how the researchers recorded the videos they used for analysis. In one report, Stigler et al. (1999) explained how they decided to only use one camera to simplify the recording and data analysis process as well as to save money when recording across the multiple schools and countries involved in the study. They acknowledged that while this decision might have simplified the recording process, it did mean that it was impossible to see all of the students in each recording (p. 15); but they were comfortable with this choice given that the focus of their study was what the teacher did and not necessarily on the students. Further, they explained that they made a pragmatic decision to record only one lesson in each classroom. Each of these decisions has inherent consequences on their project as it would for any project.

The TIMSS videos were later made available for other researchers and educators to use as they see fit. This as well as other video series–such as, video clips in *Children's Mathematics: Cognitive Guided Instruction* (Carpenter et al. 1999)–have provided educators and researchers with 100s of videos of teachers teaching in authentic settings. Thus, educators and researchers no longer have to record their own videos but rather can simply select already created videos from one of many repositories. But whether one creates their own videos or uses readily available videos, there is a process in which one decides which videos to use, and likely which parts of the videos to either use or highlight, when developing an instructional intervention. While a large part of video selection is determining whose perspective (e.g., that of teachers or students, or both) to emphasize, developers must also decide which type of classroom activity (e.g., a single lesson, a series of lessons, small group activities) is of interest, and when they have more than one recording available to them, which recording(s) should they ultimately decide to use.

Based on the literature that does exist on this topic, coupled with our own experience creating a video-based instructional intervention, we have found that educators and researchers make a series of decisions in terms of video selection when creating video-based instructional interventions, such as:

General Instructional Intervention Decisions that Influence Video Selection

- What is the purpose/goal of the instructional intervention?
- What concepts will the intervention and, in turn, the videos focus on?
- What grade level?
- Will the video(s) show teachers, students, or both?
- Will the video(s) show whole class, small group, or one-on-one interactions?
- Will the video(s) show one exemplar/situation or more than one (e.g., one teacher or one classroom or more than one)?

Decisions about Video Content that Influence Video Selection

- Do you record an entire lesson?
- Do you record more than one lesson?
- Do you use one camera or more than one camera?
- Do you focus on the teacher, the student(s), or all involved in the lesson/activity?
- How do you identify the teacher/students/classrooms to record?

It is easy to conclude that the purpose of an intervention should dictate all of the answers to questions like these. But we have found that in practice, the development of instructional interventions, or educational resources in general, (whether as a part of a research study or not) does not always happen in a linear process, nor does it always end up the way it was originally conceived. For instance, a developer might begin by finding a great video that demonstrates ideas associated with a targeted learning goal really well and then develop an instructional intervention around the selected video. Alternatively, an intervention might grow out of an opportunity to reuse selected videos from another project. Regardless of the situation, we have found that thinking through questions like these, and when appropriate, documenting and sharing the process for decision-making can be helpful in both informing one's own work and the work of others. However, we caution that there is no one-size-fits-all approach. We have found that success comes from being willing to repeatedly revisit these questions to refine and improve upon both our processes for development and the end products. The video selection, though, is only part of the process. Developers must also decide how they will engage learners with the video(s).

Video Presentation

The instructional content design of video-based interventions for teacher education is well documented (Blomberg et al. 2014; Johnson et al. 2019), whereas developers' decisions around the presentation of video is not as well-known. Increasingly, though, video-based instructional interventions are created in some type of web-based self-contained environment. In these situations, video presentation is often thought of in terms of the instructional intervention's interface, interface design, or even simply the "look and feel." In our experience, the presentation of video(s) in video-based instructional interventions is influenced not only by the research questions and the context of the study but also by the amount of funding supporting a given project. Some video-based instructional interventions–such as video clubs that depend on the ability to quickly record a lesson and watch it later with a group of teachers–simply use a TV, monitor, or projector to display the videos and therefore take a low tech and pragmatic approach to how video is presented to learners and are not necessarily in a self-contained environment (e.g., Sherin and van Es 2009; van Es and Sherin 2008; Walkoe et al. 2020). We posit, though, that how video is presented to learners influences not only how they use the video but ultimately how they learn from it, thus it is important to think through how video is presented to learners. For example, watching a video alone (e.g., at home on YouTube) is very different from watching the same video in a group; when one is alone, a learner can pause and rewind a video in ways that are not possible in a group. At the same time, a learner might benefit by watching a video of teaching and learning with other professionals who can point out things that might have been missed when watching the video alone.

With advances in technology, educators and researchers now have the ability to control the look and feel of video-based instructional interventions. For instance, streaming video platforms, such as YouTube and Vimeo, allow one to easily upload, edit, and share video; other platforms, like Panopto or TechSmith Relay, make it easy to add interactive elements (e.g., quizzes) to videos. But long before these advances, the development of hypertext and the World Wide Web inspired educators and researchers to develop video-based instructional interventions that were self-contained self-paced interactive learning environments. For instance, Goldman and Barron (1990) used hypermedia text to show video clips of expert and novice teachers, while also linking to related research, to highlight the mathematical knowledge required in teaching (e.g., recognizing students' ideas based upon students' use of representations). In another early study, Lampert and Ball (1990) designed a multimedia environment that included a year's worth of videos from two teachers' classrooms and supplemental materials, including notes of what the teachers were thinking to help teach elementary teachers to teach math. Over the years, as technology advanced, educators and researchers have continued to develop different types of video-based instructional interventions. More recently educators and researchers have experimented with creating web-based video models of exemplary teaching as well as animations of classroom teaching (e.g., Chazan et al. 2012; Chieu et al. 2011; Herbst et al. 2011).

Video Case Analysis of Student Thinking (VCAST) Project & Lessons Learned

Mathematics teachers today increasingly focus on ensuring that students understand the mathematics behind the problems that they are trying to solve (National Council of Teachers of Mathematics 2014). Research suggests that to significantly advance student understanding of mathematics, teachers must pay careful attention to students' mathematical ideas (Charalambous et al. 2020; Stein et al. 2011). More specifically, teachers must learn to respond to students in ways that enable students to move forward without removing ownership and authority for doing mathematics from students (Ball et al. 2008; Murata et al. 2017). Learning to attend and respond to students' mathematical ideas in this way, though, requires a specialized knowledge of mathematics that includes knowing how mathematical ideas are related, how to represent mathematical ideas in meaningful ways, and how students might develop certain mathematical ideas over time (Ball et al. 2008). As a result, both new and experienced teachers need experience in developing this type of specialized knowledge for teaching. The VCAST project aims to leverage research on professional noticing (Jacobs et al. 2010), attentiveness (Carney et al. 2017), mathematical knowledge for teaching (Ball et al. 2008), and the use of video (Llinares and Valls 2009; Santagata 2014; Sherin and van Es 2009) to improve secondary mathematics teacher candidates' ability to attend to student thinking, specifically in the area of functions and mathematical modeling.

Using a design-based research approach, the VCAST project created a video-based instructional intervention that consists of online video-based learning modules to engage prospective secondary mathematics teachers (i.e., teacher candidates) in examining artifacts that document secondary students' work and reasoning when solving functions and mathematical modeling problems. Each online module centers around a series of video clips of secondary students solving the same problem; the video clips were intentionally selected to illustrate a range of productive approaches and reasoning associated with solving a given mathematical problem. For more on the instructional content design of the VCAST modules, see Cavey et al. (in review) and Cavey et al. (2020). In this section, we discuss how we iteratively improved upon the recording of student interviews and the online platform for the instructional delivery during the first two years of the project.

Recording Student Interviews

Given the focus of our project, we were interested in creating videos of individual secondary students talking about their thinking process as they solved mathematical problems. We began by identifying four mathematical tasks (i.e., one task for each module) that we wanted students to work on. We decided to focus on four tasks (i.e., rather than three or five tasks) simply because we thought it would be more realistic and manageable for other college instructors to integrate four modules on functions and modeling into their own classes. Further, each task was selected for its potential to elicit a range of secondary student ideas about a key topic related to understanding functions and mathematical modeling. For instance, we adapted Hendrickson et al. (2012) popular "hexagon task" (see Fig. 1) for one of the modules.

Once we had the mathematical tasks identified, we prepared for our first phase of interviews.

First Phase of Interviews with Secondary Students Solving Mathematical Tasks

We scheduled 17 interviews, over two days, at a local high school, where we had an existing relationship with a math teacher. The math teacher helped to schedule the interviews as well as obtain the required signed informed consent forms. The school placed us in a workroom in the library to conduct the interviews. The room was spacious and had multiple outlets to power our devices.

To record the interviews for this first phase of interviews, we printed out hard copies of the mathematical tasks and used two iPhones to record the interviews. The first iPhone was attached to a small tripod close to the student to capture the student's written work (see Fig. 2 as an example of the camera perspective). We ended up placing the tripod on a few books to get a better perspective of the students' written work. A second full sized tripod was placed about five feet away to capture the researcher (i.e., the interviewer) and the student discussion and interaction. We ensured that the phones were fully charged and in airplane mode to avoid receiving any distracting phone calls or text messages during the interviews.

Ultimately this setup enabled us to record students talking about their thinking while they completed the mathematical tasks. However, we learned a few things during this first phase of interviews. First, we learned that while iPhones are adequate at recording interviews, video files can be large (which can quickly fill up a phone's available storage) and iPhones can lose a charge quickly when recording interviews. Second, we found that the placement of the first camera that focused on student work did not always clearly capture their work. For instance, whether a student was right or left handed as well as their penmanship influenced the legibility of their work; a document camera might have worked better (though it

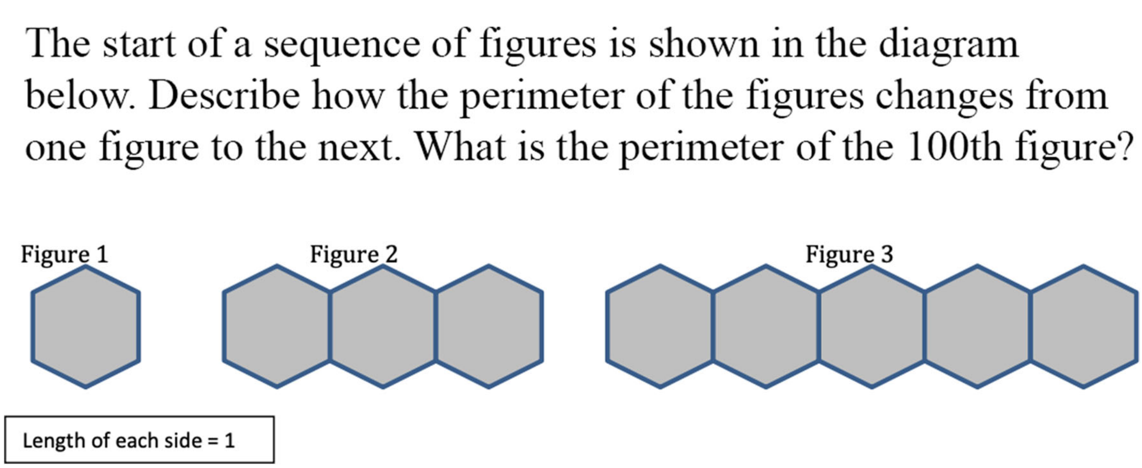

Fig. 1 The Hexagon Task

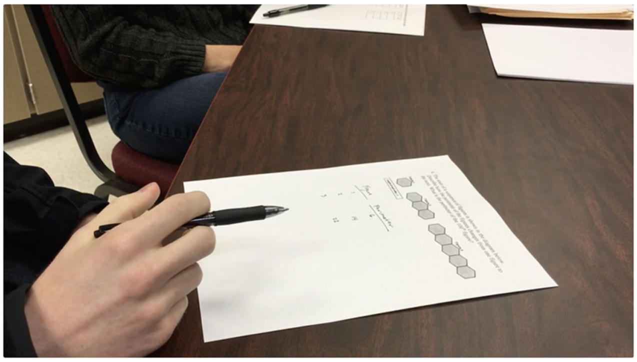

Fig. 2 Perspective of student's work from the first iPhone

arguably could have been more intrusive requiring students to work under the camera). Third, it can be exhausting to conduct back-to-back interviews all day with students as well as disruptive pulling students out of different classes throughout the school day.

Second Phase of Interviews with Secondary Students Solving Mathematical Tasks

Even though we conducted 17 interviews of high school students, we found that the videos did not provide enough diverse examples of student mathematical thinking. In particular, after analyzing the interviews, we found that the range of mathematical ideas was too narrow. Given this, we scheduled a second phase of interviews at a local middle school. We decided to do this for a number of reasons. First, we wanted to interview middle school students to be able to capture differences in mathematical thinking between middle school and high school students; second, we were hoping to get a wider range of student thinking; third, we wanted to try some alternative tasks to more explicitly address ideas related to mathematical modeling; fourth, we wanted to try a new recording setup. Overall, we ended up conducting 23 additional interviews.

We leveraged previous relationships with local teachers to identify not only which schools to focus on but also which students to interview, as well as to help us setup and schedule the interviews. Given what we learned during our first phase of interviews, we first decided to split the interviews among two groups of researchers (i.e., two researchers in one room and two researchers in another room) to address both the interview fatigue as well as to limit disrupting the school schedule as much as possible. We then used a small tripod to record students' work like before but we also used a swivl with an iPad to record the student and researcher interaction. A swivl™ is a commercial video capturing tool designed to collect video and audio data from classrooms (see https://www.swivl.com/). We ensured this time that our phones (and iPads used with the swivl's) had enough space for each recording file and that they were fully charged. We did, though, notice in one room an occasional noise from the air conditioner; we later realized that the background noise was worse than we thought. In hindsight, we should have stressed the need to be in a quiet room and once we noticed the bad background noise, we should have found a quieter room to complete the interviews. We were happy to find that interviewing students from different schools and specifically different grades helped us get a wider range of student thinking than we had from the first phase of interviews.

Third Phase of Interviews with Secondary Students Solving Mathematical Tasks

While we thought we were done interviewing students after the second phase, the national advisory board (NAB) of the VCAST project pointed out two weaknesses with our recorded interviews. First, they found it hard to see the students' work; they highly encouraged us to purchase a Wacom Cintiq tablet to conduct more interviews to replace the videos for one of the four modules. Second, they pointed out that if we hoped for our instructional intervention to be as effective as it could be nationwide, we needed the students in the intervention to reflect the diverse student body found throughout schools in the United States.

Based on this feedback, we purchased two Cintiq tablets. We tested the tablets out with a few high school students before conducting the third and final phase of interviews. We used our professional network to identify schools with a diverse student body. We ended up selecting two high schools and one junior high school with a diverse student body to conduct our final interviews. Similar to the second phase of interviews, we split up the interviews between two groups of researchers and students and/or limited the number of interviews conducted on a given day. We used the Cintiq with TechSmith Camtasia to record the junior high and high school students' work. This involved connecting the Cintiq to a laptop, mirroring the display so that students could see a mathematical task on the Cintiq, and then used Camtasia to record the mirrored computer screen and in turn the student work as the student completed each problem. We also chose to use an external webcam to record the teacher and student interactions rather than a Swivl. While Swivl's are helpful to record a class, we found them distracting to record one-on-one interviews (e.g., they are designed to move or swivel to track whoever is talking). We also still used a large tripod and iPhone to capture any pointing or gesturing a student might make. This new setup resulted in three video files: 1. A webcam video file; 2. A screen recording file; and 3. An over the shoulder video file (which can be seen in the images in Fig. 3).

Using the Cintq required some additional planning. We began by creating folders on the computer for each student we were going to interview. We then saved a PDF copy of each mathematical task in each student folder. We decided to

Fig. 3 Final Interview Setup

use PaintS (a paint program available on a Macintosh computer) for students to use to complete the mathematical tasks; we wanted a simple tool that would allow students to use the Cintq stylus to show their work as they completed each problem. One researcher was in charge of managing the technology while the other researcher was in charge of interviewing each student. Before the student came in the room, each mathematical task was open in a tab in PaintS and the Camtasia screen recorder and the iPhone were already recording. Once the student entered the room, we described the purpose of the project and introduced the student to the Cintq. The student was asked to get familiar with the stylus before starting to solve the first problem.

Overall, we were really happy with this final set up. The Cintq enabled us to capture step-by-step what the students wrote down and the webcam provided a nice up-and-close recording of the researcher and student interaction. We did though have problems with the microphone on one of the computers during the interviews, which resulted in the audio being too low; luckily we were able to use the audio from the iPhone in the tripod. Whenever we record additional interviews in the future, we will plan to check the recording after the first interview (and possibly even provide time in the schedule to check each recording after each interview), as well as adding an external mic (e.g., a MXL AC404 USB Conference Microphone) for an additional audio source. Despite the benefits of the Cintq, we still found that some of the recordings of the students' work were difficult to follow and understand the student's thinking given how they completed the problems on the tablet and/or talked about their thinking.

We learned new things with each phase of interviews. Based on our experience, we would recommend the following when it comes to recording students solving problems:

- Use a tablet, like a Cintq, to capture students' written work;
- Give students time to get used to the tablet;
- Use an external microphone (in addition to the Webcam) to record the audio;
- Add an extra camera to record student gesturing, if the Webcam does not capture it;
- Use a webcam or video recorder to capture the teacher and student interactions;
- Record in a quiet room (consider visiting the room you will be recording ahead of time); bring a sign for the door to show that a recording is in progress;
- Bring extension cords and chargers/batteries, and if needed memory cards for the cameras used;
- If possible, record three times as many interviews or lessons as you think you might need.

Selecting Student Videos

We ended up with 58 interviews from 5 different schools from which to select the videos for each module in our instructional intervention. This was important to us, because we hypothesized that providing a range of examples of student reasoning would more fully engage the teacher candidates in making sense of the secondary students' mathematical ideas.

To identify which videos to use, three researchers coded the student work for each task with the goal of developing a framework for the students' reasoning and problem solving approaches. This work was initially guided by previous work related to the task, but it was not always possible to completely rely on other previous researcher's work to analyze our collected student work. For example, for one of the modules, we used a variation of a well-known bottle filling task (Carlson et al. 2002); but previous research described analyses of university student work. Our students, who were in either middle or high school, used approaches and reasoning that relied on more intuitive understandings, since few had received formal instruction on such a task, and thus the analysis and coding needed a framework that was applicable to our data. Once the framework of student reasoning was developed for each task, the researchers used that framework to purposefully select two to four students to use for each module (see Cavey et al. 2019, for more information).

Creating an Online Platform to Present the Videos

It is easier now more than ever to share video. For example, YouTube makes it easy to share a link to a video or to embed a video into a learning management system. However, we wanted to create an online instructional intervention that could be shared with teacher educators across various institutions. In the following section, we describe the three iterations of what we refer to now as the VCAST web application.

Iteration 1: Adobe Captivate and Blackboard

The initial prototype was developed in Adobe Captivate, an industry standard e-learning authoring tool that can export e-learning modules in a format that can easily be imported into a standard learning management system (LMS) (see Fig. 4 for a screenshot of what this prototype looked like). The initial plan was to develop the modules in Captivate and then upload the Captivate package to Blackboard Learn so that Blackboard Learn would track users' responses. This was a relatively low cost and fast method to develop and host the online modules. However, while testing the prototype with teacher candidates, we discovered that Captivate and SCORM limited the number of characters for short answer questions. Only the first 255 characters for each open-ended question were recorded in Blackboard. We intentionally wanted to ask the teacher candidates open-ended questions to help them see the diversity and depth of student thinking. Given the character limitation, though, we began looking for another option to develop and deliver the online modules.

Iteration 2: HTML Web Pages and a Google Form

The second prototype was developed using basic HTML web pages and a Google form to collect candidates' responses (see Fig. 5 for a screenshot). While not as aesthetically pleasing as the initial prototype, this approach provided a workable solution that allowed for the development of a working prototype for all four modules that could be tested with teacher candidates in an authentic classroom setting.

Limitations to this approach were identified. First, this iteration was not mobile-friendly; due to the nature of the two column design and the scrolling form. Second, teacher candidates had to scroll on the right side of the screen to find where to enter their response to a prompt on the left side of the screen. Third, we found that teacher candidates could (and did) go back and revise their responses before finally submitting their final answers—which interfered with our larger goal of studying the effectiveness of the modules and hence the intervention. Fourth, we did not have an easy way to hide future modules and thus prevent prospective teachers from working forward; while we could remove the links for future modules, this would not be a long term solution if more than one teacher was using the modules in a given semester.

Iteration 3: Custom Built VCAST Web App

Lessons learned from using the first two prototypes, combined with newly acquired funds for development

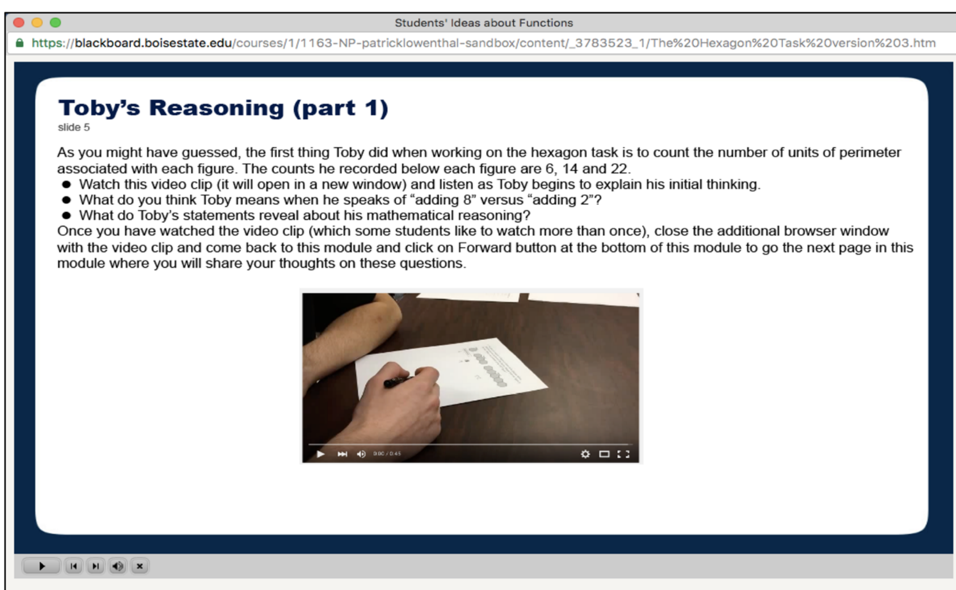

Fig. 4 Prototype Version 1–Adobe Captivate–2016

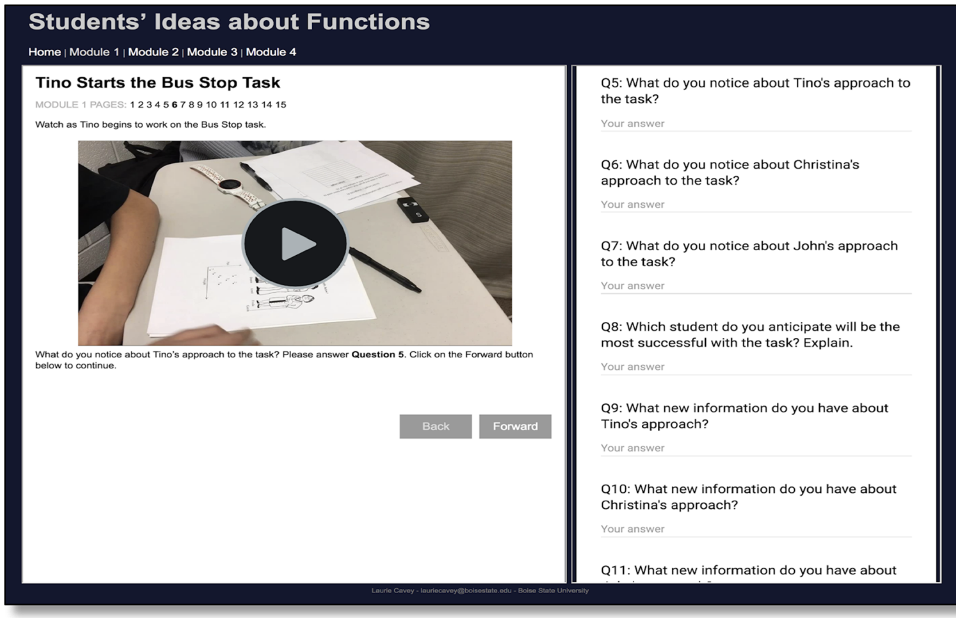

Fig. 5 Prototype Version 2–HTML Pages & Google Form–2017

from NSF, resulted in a new vision for the VCAST platform. After the VCAST team began to work closely with personnel in Boise State University's Office of Information Technology (OIT) to develop the VCAST App, this vision expanded to include features which streamlined module content creation and delivery. We came to the conclusion based on our previous work that the platform for our video-based instructional intervention ideally needed the following features:

- Module content that is easy to create and duplicate;
- Integrated format for module content and questions;
- Controlled user access;
- Students (teacher candidates) can review, but not change previous answers;
- Structured module completion for a prescribed order and timeframe;
- A report of student responses for both the instructor and the student;

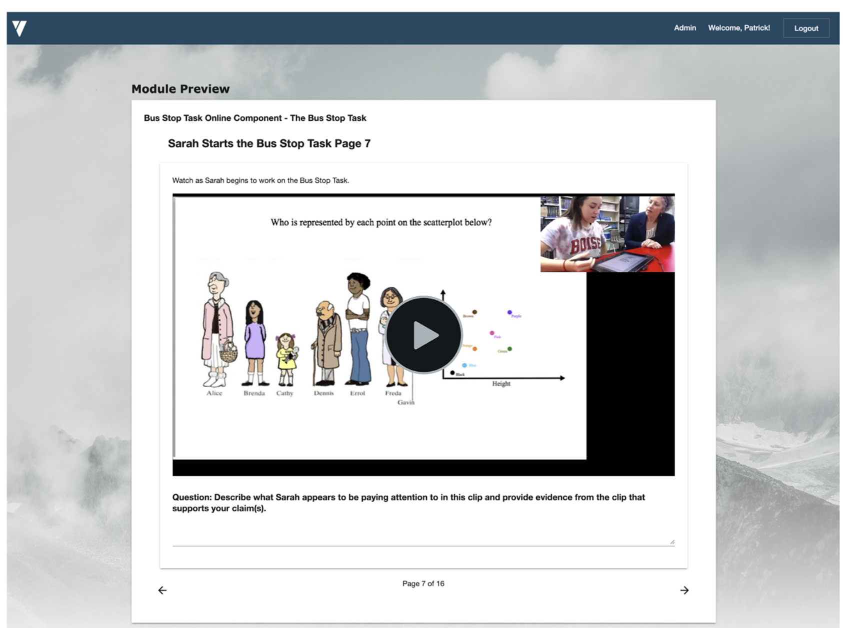

Fig. 6 VCAST Web App

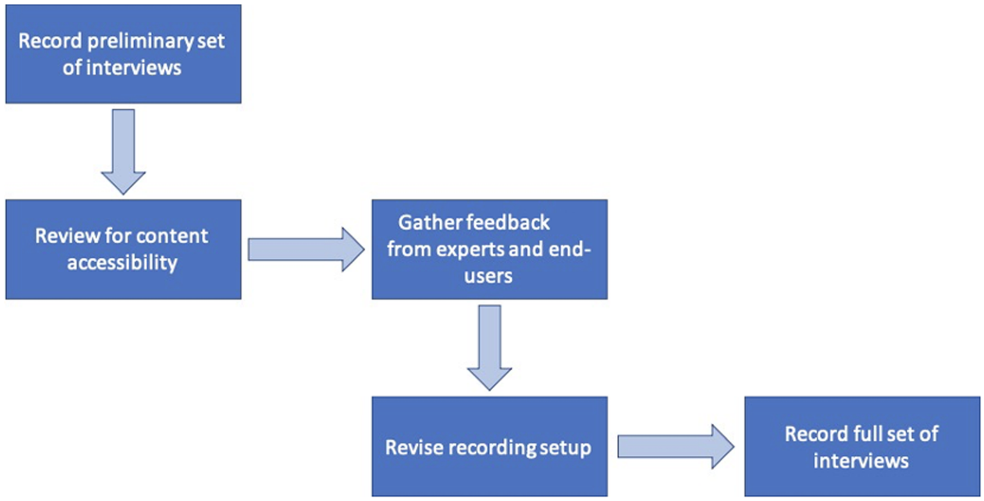

Fig. 7 Process to record Student's solving problems

- Mobile-friendly (i.e., responsive design);
- Simple and easy to access (i.e., not hosted in a LMS);
- A developmental and not a punitive environment (e.g., not an online quiz with a video embedded);
- Students can log out and log back in and continue where they left off.

Our university development team began working on the VCAST Web App during the summer of 2018. We had a working application to test with students during the Fall 2018 semester as part of the MATH 370 Functions & Modeling course at Boise State University. Among other things, the VCAST Web App provided us with a responsive design web application that made it easy for anyone listed as an administrator to create content (e.g., create courses, create modules, create pages), add videos, and add corresponding questions for teacher candidates to answer about the videos. It also allowed us to control what modules were available at a given time as well as to control whether students could go back and change their previous answers. The VCAST Web App itself went through a series of iterations; for instance, initially we could only include one question per page but we found over time that this became cumbersome when we wanted to ask teacher candidates more than one question on any given page. We expect future changes will be made to improve the app over time, including the reporting feature of the Web App (Fig. 6).

Conclusion and Implications for Practice

Video is a powerful form of media. Video can show things in ways that previously were not possible. But simply adding a video to a teacher education course or professional development program does not guarantee that teacher candidates or teachers are going to watch it or that they are going to learn from it (Blomberg et al. 2014; Seago et al. 2018). The lessons learned that we share in this paper contribute to the larger dialogue about video-based interventions, specifically with respect to the recording of video content and presentation of videos through an online application. While others have contributed in terms of instructional content design, this paper adds to the dialogue by lessons learned about the process of capturing the intended video content and the challenges in creating a useful online interface. It took us several iterations to improve the online video-based instructional modules. However, with each iteration our process was refined and improved in a way that will enable us to develop and implement our next project with greater ease. For instance, Fig. 7 illustrates the process we would use to record videos of students solving problems for our next project. Our lessons learned could easily be applied to other content areas (e.g., science teacher education) or ways to investigate how professionals (e.g., instructional designers or graphic designers) think about design and solving ill-structured problems.

As it becomes easier and easier to create, edit, and share video, educators, instructional designers and curriculum developers, and researchers will continue to experiment with ways to intentionally use video to improve teaching and learning (whether face-to-face or at a distance). One of these ways is through the creation of video-based instructional interventions. Through our work on the VCAST project, we learned some valuable lessons about creating videos for video-based instructional interventions. We hope the practical experiences reported in this paper will aid others involved with creating any type of instructional intervention focused on videos of people thinking through problems.

Compliance with Ethical Standards

Conflict of Interest No conflict of interest.

Research Involving Human Participants and/or Animals Not applicable.

Informed Consent Not applicable.

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