Using Videos versus Traditional Written Texts in the Classroom to Enhance Student Learning

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By

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Abstract

The focus of this research is the use of direct instruction outside of classroom time through the use of short instructional videos. Past research has focused on the use of video technology in the classroom and the effects of video technology in the classroom. However, past research on video technology has not examined whether or not text should be integrated with the lesson while the students watch the videos. Data was collected through a preliminary survey, pre-assessment, post assessment, and a post-survey. This study examined participants’ performance on a post assessment after learning a mathematical explanation through one of the following three methods of instructions: Text-only, Video-only, Video+Text. Results indicate that certain factors such as prior experience with videos affected the students rating on the Likert-scale questions. However, despite additional factors, the percent of correct responders on the post assessment was significantly higher for those who were given the Video+Text method of instruction compared to the other method of instructions.
Literature Review

Research on Video Technology for Instruction in the Classroom

Use of Video Technology for Instruction in the Classroom. Several studies have examined the use of videos as a method of classroom instruction (Zahn et al., 2012; Raths, 2014; Jackman & Roberts, 2014; Schwan & Riempp, 2004; Cruse, 2010). Researchers have examined the use of either a few videos along with the traditional lecture method of instruction or the use of only videos for instruction. Studies show videos can be used to provide the students with additional information that allows them to learn more and reinforce the learning (Zahn et al., 2012; Raths, 2014; Schwan & Riempp, 2004). Instructional videos can also be used to help students who are struggling in the classroom (Zahn et al., 2012; Raths, 2014; Cruse, 2010). Short instructional videos can provide the students with further explanations of the information taught in class (Raths, 2014; Jackman & Roberts, 2014). However, little research has been conducted to examine whether or not text should be integrated with the lesson while the students watch the videos.

The traditional instructional method, lecturing, delivers important content to students without much differentiation of the instruction. The use of video technology for instruction in the classroom allows educators to differentiate their instruction and accommodate learners. Teachers who incorporate video technology in the classroom are “freed from delivering whole-class instruction during that hour or so, [and] the teacher can deliver targeted instruction to students one-on-one or in small groups, help those who struggle, and challenge those who have mastered the content” (Bergmann & Sams, 2013). Furthermore, educators can use the video technology as a tool for reviewing concepts and procedures. Video technology can be used as a tool to pose
questions to students and challenge the students to develop answers based off of the video (Bergmann & Sams, 2013).

The flipped classroom is an example of a teacher using instructional videos extensively as a part of the instruction. In a flipped classroom the students learn the material by watching instructional videos outside of class and spend class time applying the information they have learned from the video during class time. Aaron Sams and Jonathan Bergmann are credited with being the first educators to use the term “the flipped classroom” beginning in 2007 (Raths, 2014). The flipped classroom allows teachers to have more extensive face-to-face interactions with the students (Raths, 2014). Aaron Sams and Jonathan Bergmann found that the use of instruction videos is “valuable in shifting the lower levels of Bloom's taxonomy out of the class, enabling . . . [them] to spend more class time at the upper end of the taxonomy, with tasks that ask students to apply, analyze, evaluate, and create” (Bergmann & Sams, 2013).

**Research on the Instructional Video Technology.** Researchers have become more interested in studying the use of videos as an instructional method because videos are more prevalent in classrooms today. Researchers from the Applied Cognitive Psychology and Media Psychology Department at the University of Tuebingen, Martin Merkt, Sonja Weigand, Anke Heier, and Stephan Schwan (2011), explained that "with the growing affordability and resulting availability of video production tools, this trend is unlikely to change in the years to come" (Merkt et al., 2011, p. 687). W. Marc Jackman and Patricia Roberts (2014), from the University of Trinidad and Tobago, conducted a survey of 70 prospective teachers enrolled in the Bachelor of Education program of the institution and the results showed that 90% of teachers say that there was some improvement in class by using educational YouTube videos related to course material (Jackman & Roberts, 2014). In Jackman and Roberts’ analysis two themes emerged on the use
of YouTube videos in the classroom: the videos allowed for “clarification of concepts” and helped auditory and visual learners (Jackman & Roberts, 2014, p. 286). Furthermore, the authors concluded that the videos created “interest and enjoyment” and increased interaction and discussion among class members (Jackman & Roberts, 2014, p. 286).

Researchers have studied the effects of the different types of videos in the classroom including the use of interactive videos, non-interactive videos and teaching without any videos (Cagiltay, et al, 2006; Schwan & Riempp, 2004). One study conducted by Schwan and Riempp (2004) had participants tie four nautical knots of different complexity by watching either non-interactive or interactive videos. The study consisted of thirty-six participants at the University of Offenburg and four video clips were used. Schwan and Riempp created a log of how long each participant took to learn the skill and how many practice trials were used to perfect the skill. The study found that the non-interactive users had to practice tying the knots at least twice as long as the interactive video users. Results from the study also showed that the participants who used the interactive videos developed a better understanding of the process of tying the knots than the users of the non-interactive videos. Overall, the results show the benefits of using interactive videos in the classroom (Schwan & Riempp, 2004). The study conducted by Schwan and Riempp suggested that the videos should “have a non-linear structure, combined with the use of a great number of different symbol systems and interactivity to give users the opportunity to decide on the ‘what’ and the ‘how’ of the information presentation” (Schwan & Riempp, 2004).

Several studies thus far have explained how to incorporate the videos into the classroom (Cagiltay, et al., 2006; Mayer, 2005), how videos can be effective in the classroom (Cruse, 2010; Mayer, 2005), and techniques to use when recording, displaying and teaching with the videos (Cagiltay, et al., 2006; Aiex, 2002). Multiple studies were conducted by the Applied Cognitive
Psychology and Media Psychology Department at the University of Tuebingen by Martin Merkt, Sonja Weigand, Anke Heier, and Stephan Schwan that compared the usage patterns and effectiveness of interactive video and textbooks in German secondary schools. The researchers conducted two complementary studies, one in the laboratory and one in the field, in order to compare the usage patterns and the effectiveness of interactive videos and illustrated textbooks when German secondary school students learned complex content. In the first study, the data collected looked into the processing activities of 12th and 13th grade students learning with video and an illustrated text (Merkt et al., 2011, p. 690). In the second study, the students were asked to prepare a homework assignment with either a common video, an enhanced video or an illustrated textbook in order to evaluate the findings. Results from the two studies showed that videos were comparable or even superior to traditional textbooks (Merkt et al., 2011). These results were explained by the interactivity presented to the students when learning from the videos. For example, the videos offered features such as pause and play that supported the extraction of details and allowed students the ability to take notes. Merkt et al. found that the knowledge acquisition was lower for video than for text when the videos cannot be controlled in other studies. Merkt et al. found that the main concern when allowing students to use videos is that the viewers have control of the video’s flow of information in order to retain the material.

When Merkt et al. studied the effectiveness of interactive videos compared to illustrated textbooks in the two studies, they found that "for children (that assumedly lack reading proficiency), when [given] . . . low complex material (for example, children's news), retention and understanding were equal or even in favor of videos" (Merkt et al., 2011, p. 688). Merkt et al. reported that when adolescent or adult viewers were given complex matters the videos were inferior to print when it came to recalling the facts and when the presentation time was held
constant over the different conditions (Merkt et al., 2011). Merkt et al. also concluded that there was a comprehension advantage of spoken text for short and semantically poor content even though print appeared to be the better medium for complex and semantically rich content. The researchers find that these differences may be due to the amount of control the students have over the videos compared to always having the text available to re-read.

In 2012, Carmen Zahn, Karsten Krauskopf, Friedrich W. Hesse, and Roy Pea from the School of Applied Psychology at the University of Applied Sciences and Arts in Northwestern Switzerland conducted a study among 16-year olds working on a history topic to specifically examine the impact of the video tools and the guidance given to the students. The study compared two contrasting types of guidance for student teams’ collaboration processes (social-interaction related vs. cognitive-task related guidance). Zahn et al. also compared two types of video tools. The guidance and tools were aimed at supporting students’ active, meaningful learning, and critical analysis of a historical newsreel. The study examined the impact of the complexity of design (cognitive task) and the complexity of collaboration in design (social interaction). Zahn et al. emphasized the need for guidance from the teacher when integrating video technology into the classroom, a main factor when determining the effectiveness of the videos in the classroom. Zahn et al. proposed that teachers should vary the learning tasks and activities when using the videos. By doing so, the students would be more motivated and it would add diversity to the learning experience for the students. The study also concluded that teachers should use videos to portray information that allows students to gain insight on events or experiences that cannot be explained through text.

**Criticisms of Using Instructional Video Technology.** As the flipped classroom and its use of instructional video technology is becoming more popular in schools, many researchers are
examining the effectiveness of this instructional method (Raths, 2014; Bergmann & Sams, 2013). Even though researchers have seen students perform at higher levels after learning the material by watching videos, some oppose using videos alone in the classroom (Merkt et al., 2011). For instance, Professor Dede from Harvard University mentions that there is a need for both face-to-face interaction and videos in the classroom. Professor Dede says that the secret to using video technology is to "re-purpose" these technologies and incorporate educational value in them. Through the use of media, a teacher is able to incorporate more situated learning, which is "deriving education value from putting kids in real-world environments" (Pruitt, 2005). However, David Raths finds that teachers should transform traditional classrooms into flipped classrooms where the teachers use videos as the method of instruction so that students have a deeper level of learning in the classroom. Many researchers believe that the flipped classroom allows the students more opportunities to engage in conversations about the concepts and to ask questions for clarification or for the discovery of a main idea (Raths, 2014; Bergmann & Sams, 2013).

Other researchers like E. Bennett and N. Maniar (2007) from the Department of Creative Technologies, University of Portsmouth, UK believe that “. . . students [should] develop the transferable skill of being able to learn for themselves. They should not see a lecture . . . as the only source of knowledge about the subject area. Instead, a lecture should teach the students the key ideas, and students should then be expected to consult other sources to clarify things they did not understand" (p. 3). E. Bennett and N. Maniar also argue that the format of the videoed lectures is uninteresting. E. Bennett and N. Maniar also point out that students have limited time for each course and that it may take longer to watch the video lectures than to study
independently. They believe that the use of videos can make the material seem boring and repetitive (Bennett & Maniar).

Research on the Design of Video to Maximize User Learning

When creating a video for the study, the researcher researched the effects of video design, in order to maximize each students learning. According to a cognitive theory of multimedia learning, placing text near the picture it describes increases the chances that the learner will be able to make connections between the text and the picture (Mayer, 2001, p.145). Richard E. Mayer from the University of California explained the dual-channel assumption, which is that “humans possess separate information processing channels for visually represented material and auditorily represented material” (2001, p. 46). When words in videos are presented as narration, the auditory/verbal channel can be used for processing the verbal spoken words and the visual/pictorial channel can be used for processing pictures and animations (Mayer, 2001). The visual channel is overloaded when pictures and printed words both enter the information processing in the brain through the eyes. Mayer explains that when the visual channel is overloaded, the students learn and understand less. Mayer believes that “presenting an explanation with words and pictures results in better learning than does presenting words alone” (2001, p. 78). This research shows that pictures and printed words should be accompanied with narration in order for students to process the information and learn from what is in the video.

The cognitive theory of multimedia learning also suggests that adding extraneous material can interfere with the process of knowledge construction. Such extraneous materials include unnecessary words, pictures, sounds, and music. Students tend to learn more when less visuals and audio are presented in the videos. Bergmann and Sams (2014), pioneers of the flipped classroom and cofounders of the Flipped Learning Network, state that "... [the] rule of
thumb is one to one-and-a-half minutes per grade level. . . that means for a 4th grader, your video should be no longer than four to six minutes; and for a 10th grader, that means 10-to-15-minute videos” (p. 19). Bergmann and Sams also found that to maximize learning teachers should have one video per discrete objective.

Therefore, the created video for this research study had very little animation, no additional pictures, and no sound effects. Also, the text boxes faded into the video and only appeared after the educator had finished speaking. The other animations that were included emphasized the information being explained by the educator. For example, the educator on the video emphasized that .99 and .999 have finitely many 9’s by placing an arrow next to each of the numbers and a text box with the amount of 9’s that each number has typed next to the values (see Figure 1).
This allowed the attention of the participants to be focused on the content and the voice of the educator.

Research on the Design of Written Text to Maximize User Learning

Research has shown that mathematics texts contain more concepts per sentence than textbooks for other subject areas (O’Keeffe & O’Donoghue, 2011). The organization and structure of the text is also different from other texts that students learn to read from. For example, the main ideas or concepts are presented at the end of problems. Mathematical texts are written in a way that the reader must read from left-to-right. Most mathematics textbooks include step-by-step example problems with the steps on the left hand side and the explanation or rationale for the steps on the right hand side.
Mathematic texts are written compactly where each sentence contains information without much redundancy. Mathematic texts include definitions, historical facts and practice problems. Mathematic texts contain words, numbers, and non-numeric symbols. Students must understand the vocabulary, symbols and terminology used in the text in order to understand the mathematics.

Therefore, the text used was written to fit one page in order to avoid any redundancy. The text included bold headings that emphasized the concepts and all of the examples (Lovric et al., 2010). The examples and algebraic steps were listed so that the participants were able to read the text from left-to-right. The explanations for each of the algebraic steps were written in blue, which is similar to the explanations in mathematics textbooks (Berisha et al., 2013). The main ideas were presented at the end of each of the example problems. Also, the main idea of the entire mathematical explanation was printed on the last line of the text (Pang). For example, the main idea of the entire text is that \( x = 0.999 \ldots = 1 \), and this statement is the last line of the text.

**Purpose of Study**

Questions have arisen in the classroom about the use of videos for instruction. Researchers have looked at the use of videos for instructions, but no study has looked at the use of both instructional videos and texts as part of the instruction. Due to an increase in the use of instructional videos (particularly the flipped classroom) in schools today, the researcher is interested in determining if the inclusion of a text along with the videos during instruction will enhance the learning (Raths, 2014, p. 15). To add to the research, the researcher will examine the effects that the video technology has on the learning process by comparing the results of three different groups of participants. The participants in the study will either be provided the information through text-only, video-only, or video+text. The results of the study can be used to
broaden society’s understanding of the use of videos with or without printed text in the classroom.

**Method**

**Participants**

This study consists of both male and female undergraduate students from a small, private, liberal arts university in the Midwest. Forty-five students were randomly assigned to receive written text, video, or video+text as their method of instruction. The number of participants in each condition as a function of grade level is presented in Table 1.
Table 1

*Number of Participants in Each Condition as a Function of Class Level.*

<table>
<thead>
<tr>
<th>Method of Instruction</th>
<th>Class level</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Freshman</td>
<td>Sophomore</td>
</tr>
<tr>
<td>Text</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Video</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Video+Text</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

**Materials**

For this study, the subjects were given four items to complete: a preliminary survey, a pre-assessment, a post assessment, and a post-survey. The subjects began by completing the preliminary survey and the pre-assessment (see Appendix A and Appendix B).

Subjects were also provided with a method of instruction that explained the mathematical explanation of why \( .9999\ldots = 1 \). The participants were randomly given a video of a mathematical explanation, a video of the explanation along with text, or a written version of the explanation.

The video of the mathematical explanation was seven minutes and twenty-five seconds long. The first three minutes introduced the viewers to the idea of representing large and small decimal expansions as fractions. The educator talking in the video then asked the viewers to consider the following questions: “is .99 equal to 1? “and “is .999 equal to 1?” (see Figure 2 and Figure 3).
The educator talking in the video also answered both of the questions that the viewers were asked to consider in order to show that .99 and .999 can be rounded to 1 but are not equal to 1 (see Figure 4).
After the introduction, the educator talking in the video proceeded to consider the number 0.999... and explained that any value can be set equal to x. Once the educator had an equation, she progressed to explaining different algebraic steps that lead to $x = 0.999... = 1$ (see Figure 5 and Figure 6).
The text version of the mathematical explanation was one page long and contained the same mathematical concepts as those presented in the video. The text was also formatted similarly to a traditional written math textbook. For instance, mathematics textbooks used blue
text to explain the mathematical reasoning for each of the algebraic steps (see Figure 7 and Appendix C).

**Figure 7.** Screen Shot of the Written Text Method of Instruction

Once the participants learned the material through the given method of instruction, they were asked to complete a post assessment (see Appendix D). After the assessment, the participants answered three 5-point Likert scale questions on the post-survey. The 5-point Likert scale questions allowed the participants to explain how they felt about the method of instruction (see Appendix E).

**Procedure**

The following procedure was approved by the University’s Institutional Review Board. Before beginning the study, participants were asked to sign a consent form, which informed them
of what is being requested of them. The consent form also explained that the students’
participation was voluntary and that they were free to withdraw their consent at any time, for any
reason. Each participant was allowed to take notes while watching the video or reading the text.
Following the random assignment of the methods of instruction, the participants were given an
assessment to test their understanding of the mathematical explanation shared in each of the
methods.

Three students participated in the study at a time. Subjects were asked to complete a
preliminary survey about their Sex, Age, Class (Year), Major, and Cumulative GPA. On the
preliminary survey, students were asked how many math classes they have taken and if they have
been required to watch instructional videos for homework. If a subject had been required to
watch instructional videos for homework, then he or she was asked to circle how often he or she
was required to watch videos as a part of instruction. Subjects were then asked to provide
information on how often they watched videos to seek additional information related to courses,
and if they take notes while watching the videos. The subjects provided all of this information by
circling different choices that were given. The subjects also had to complete a pre-assessment,
which was only one multiple-choice question. The pre-assessment was on another sheet of paper
and it assessed prior knowledge of the mathematical explanation. The multiple-choice question
asked the subjects if the number 0.99 is equal to 1. Obtaining this information at the beginning of
the study allowed for control over any preexisting individual differences in their understanding
of the mathematical concept.

After the pre-assessment, the subjects were randomly assigned a method of instruction.
All of the subjects were told that they are able to take notes while learning the mathematical
explanation. Then, the subjects were asked to follow along with the instructions provided for the
method of instruction that was assigned to them. After the instruction, each subject was asked to complete three multiple-choice questions on a post assessment that demonstrated their understanding of the mathematical explanation. The three multiple-choice questions asked the students to determine if two statements are equal. The responses for the multiple-choice questions were either yes or no. For example, subjects were asked if 0.99 is equal to 1 and if 3.9999 is equal to 4. The last multiple-choice question asked subjects if 7.9999999… is equal to 8. The first two multiple-choice questions helped identify subjects who were applying their knowledge of rounding rather than the information from the instruction. When the questions were asked in this manner, the subjects’ use of their prior knowledge of rounding was accounted for in the results.

After completing the assessment, each participant was asked to indicate on a 5-point Likert scale how much they liked the method of instruction that was randomly assigned. The participants also indicated the effectiveness of the method of instruction and how prepared they felt for the assessment. The subjects answered each of the 5-point Likert scales by circling a number from 1 to 5. After completing the post-survey, the subjects were told that the results would remain anonymous.

**Predictions.** Preliminary research suggests that the results may be affected by a variety of factors including the student’s learning style, the videos being used, and the type of instruction given to the students. Results from prior studies have shown that the prior knowledge of students may affect the effectiveness of the videos, which may need to be evaluated before the study (Merkt et al., 2011; Cruse, 2010). During the initial survey, the subjects are asked the number of hours that they spend watching videos in order to learn material for their classes. The participants who are familiar with the video technology and note taking process may be more accustomed to
watching videos in order to learn than other students. Because of this prior use of video technology, the subjects may perform better on the assessments. They may also indicate a higher mark on the 5-point Likert scale when asked how much they liked the method of instruction.

Past research on interactive videos show that the interactive videos in the classroom contribute to an increase in the students’ scores on assessments (Schwan & Riempp, 2004). Since the subjects in the study will have full control of the video, the participants will have the ability to learn the material at their own pace. Even though there are two groups with the videos incorporated into the instruction, the students may not be able to actually process the information from the video without the text. The researcher predicts that the results will show that students will also need to be provided with text that follows along with the video in order for the students to perform better on assessments. Based on past studies on the use of instructional videos in the classroom and personal experience, the researcher predicts that the group of students with the video and the text will perform at a higher level than the other two groups. The researcher believes that the research findings will support the use of videos in the classroom compared to the use of the traditional texts.

**Results**

One of the factors that was considered in the preliminary survey was whether or not students were familiar with watching videos as a part of instruction. A 3 (method of instruction) x 2 (past video requirement) multivariate ANOVA test was conducted on the three Likert scale questions to determine if there are any significant interactions between the method of instruction and previous experience with watching videos for a course. The results showed that regardless of whether or not the student has been required to watch videos for a course, participants assigned to the Video+Text liked this method of instruction (see Figure 8). The results also showed a
significant cross-over interaction between instructional method and prior experience on liking the method of instruction, $F(1, 29) = 4.32, p < .05$. The participants who were required to watch videos for a course in the past liked the method of instruction when they were assigned the video only but did not like the method of instruction when they were assigned text only (see Figure 8). Also, the participants who were not required to watch videos for a course did not like the method of instruction when they were assigned the video only but did like the method of instruction when they were assigned the text.

![Diagram showing the effect of videos required for homework on average “liking” rating.](image)

**Figure 8.** The effect of videos required for homework on average “liking” rating.

With respect to perceived effectiveness of the various methods of instruction, the analysis showed that regardless of whether or not the student has been required to watch videos for a course the Video+Text group of participants found the method of instruction to be effective (see
Figure 9). Similar to the analysis of “liking”, there was a significant two-way interaction between method of instruction (video vs. text) and prior video experience, $F(1, 29) = 4.55, p < .05$. The results showed that there is not a difference between video and text on effectiveness within the group that has not been required to watch videos for a course. However, those who have been required to watch videos for a course found the text only method to be less effective than the video method.

![Figure 9](image.png)

**Figure 9.** The effect of videos required for homework on average “effectiveness” rating.

There were no significant effects regarding how prepared the different methods of instructions made the participants feel.

The results of the chi-square test show that the proportion of participants answering each pre- and post-assessment question correctly did not differ with respect to whether or not they had been required to watch videos in the past. Furthermore, the proportion of participants who
answered the first two post-test question correctly is not related to video experience or method of instruction.

Question 3 of the post assessment was an application of the main concept that was taught to the participants. Figure 10 displays the proportion of participants answering this question correctly as a function of instruction condition and whether or not they have had previous experience with videos. First, with respect to participants who have not had prior experience with homework videos, method of instruction is not statistically significantly related to performance. However, the proportions are in the predicted direction with all participants in the Video+Text condition correctly answering the question while only 67% and 57% of those in the text only and video only groups, respectively, do so. Second, with respect to participants who have had prior experience with videos, method of instruction is related to performance, $\chi^2(2) = 8.9, p < .05$. When the participants who have been required to watch videos are given the text only method of instruction, only 25% answer the question correctly. However, the proportion of correct responders in the Video and Video+Text groups is higher (88% and 82%, respectively).
Figure 10. The proportion of participants who correctly answered the third question on the post assessment as a function of both method of instruction and past video experience.

On the pre-assessment, the three instruction groups did not differ in the proportion of participants correctly indicating that 0.99 is not equal to 1 (86%, 87%, and 94% of participants in Text, Video, and Video+Text, respectively, answered this question correctly). These proportions did not statistically differ as a function of method of instruction, $\chi^2(2) = .60, p > .05$.

On question 1 of the post assessment, the three instruction groups did not differ in the proportion of participants correctly indicating that 0.99 is not equal to 1 (86%, 87%, and 94% of participants in Text, Video, and Video+Text, respectively, answered this question correctly). These proportions did not differ as a function of method of instruction, $\chi^2(2) = 4.0, p > .05$.

On question 2 of the post assessment, the three instruction groups did not differ in the proportion of participants correctly indicating that 3.9999 is not equal to 4 (93%, 73%, and 69% of participants in Text, Video, and Video+Text, respectively, answered this question correctly). These proportions did not differ as a function of method of instruction, $\chi^2(2) = 2.8, p > .05$.

On question 3 of the post assessment, the three instruction groups differed in the proportion correctly indicating that 7.9999999 . . . is equal to 8 (43%, 73%, and 88% of participants in Text, Video, and Video+Text, respectively) $\chi^2(2) = 7.2, p < .05$. Therefore, the percent of correct responders is contingent on the condition of the method of instruction. To follow-up on this significant effect, the proportion of correct responses in each group was compared to chance. There is a 50% chance that each participant correctly answers each question presented to him or her on the pre-assessment and the post-assessment, therefore, by chance alone, half of the participants could respond correctly. The results of one-sample $t$ tests
showed that the text only and the video only group performed at a rate equal to chance, $p's = .61$ and .07 respectively. However, the Video+Text group performed at a level beyond what is expected due to chance, $t(15) = 4.39, p = .001$. Thus, the participants in this group performed better on the assessments than what was expected due to chance.

The scores for the 5-point Likert scale questions were assessed using a One-way multivariate ANOVA which revealed an effect of method of instruction on the question addressing the effectiveness of the method of instruction after processing the lesson, $F(2, 42) = 3.26, p < .05$ (see Table 2).

<table>
<thead>
<tr>
<th>Method of instruction</th>
<th>Liking</th>
<th>Effectiveness</th>
<th>Preparedness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text</td>
<td>3.64 (1.22)</td>
<td>3.64 (1.08)*</td>
<td>3.93 (1.14)</td>
</tr>
<tr>
<td>Video</td>
<td>3.80 (0.94)</td>
<td>4.20 (0.94)</td>
<td>3.80 (1.08)</td>
</tr>
<tr>
<td>Video+Text</td>
<td>4.37 (0.50)</td>
<td>4.44 (0.51)*</td>
<td>4.00 (0.89)</td>
</tr>
</tbody>
</table>

* $p < .05$
The post hoc tests showed that the Video+Text group gave a statistically significant higher rating than the Text Only group (4.44 vs. 3.64), \( p = .02 \).

**Discussion**

The results of this study aligned with some of the expected outcomes, but not all. Certain factors such as the participants’ learning style, familiarity with the video technology, and whether or not the participant takes notes while watching videos were considered when conducting the study. During the preliminary survey, the subjects were asked the number of hours that they spend watching videos in order to learn material for their classes. With respect to participants who reported past requirements to watch videos for a course, there was a correlation between the frequency with which they watched video and the accuracy of the responses on the post assessment, \( r(27) = -.46, p = .02 \), indicating that greater frequency of watching videos in the past was associated with lower scores on the test. This association may be explained in two ways. First, it is possible that participants who had more experience watching videos paid less attention to the video in the present given their familiarity with the format. Furthermore, perhaps participants who are familiar with the videos are used to commercially-produced engaging videos, and by comparison, the videos in the current study were not as unengaging. Similarly, it is possible that those with relatively little experience were not as familiar with instruction videos and, as a result, paid more attention, thus increasing their performance on the post assessment.

These results support the need for interactive and engaging videos, a finding which aligns with the findings of Schwan and Riempp. Schwan and Riempp conducted a study that compared the use of interactive and non-interactive videos when tying four nautical knots of different complexity (Schwan & Riempp, 2004). Results from the study conducted by Schwan and
Riempp showed that the participants who used the interactive videos developed a better understanding of the process of tying the knots than the users of the non-interactive videos (Schwan & Riempp, 2004). Zahn et al. also emphasized the need for guidance from the teacher when integrating video technology into the classroom, a main factor when determining the effectiveness of the videos in the classroom (Zahn et al., 2012). Zahn et al. proposed that teachers should vary the learning tasks and activities when using the videos. In the current study, the results support the findings of the past studies which indicated that there is a need for interactive videos with varying tasks so that the participants who are not familiar with the videos and the participants who are familiar with the videos are both engaged in the learning.

Another different finding from previous research involved a group of 12th and 13th graders who were able to perform at a higher level after being given a text rather than a video. Multiple studies conducted by the Applied Cognitive Psychology and Media Psychology Department at the University of Tuebingen by Martin Merkt, Sonja Weigand, Anke Heier, and Stephan Schwan compared the usage patterns and effectiveness of interactive video and textbooks in German secondary schools. When Merkt et al. studied the effectiveness of interactive videos compared to illustrated textbooks in the two studies, they found that when participants were given complex matters and asked to recall facts, videos were inferior to print. Merkt et al. believed that these findings were due to the participants having more control over re-reading than pausing and stopping the video. The results from the post assessment used in the current study contradict the results of the study conducted by Merkt et al. The post assessment used in the current study determined if the students were able to apply what they have learned about .999 . . . = 1 to a similar problem, the third question. The results of the current study show that the participants in the Video and Video+Text groups were able to recall the concept learned
in order to correctly answer the third question. However, only 43% of participants in the text-only group recalled the information in order to correctly answer the third question on the post assessment. The current study also found that when participants were given the video along with the text, their ability to determine the correct answer on the third question was significantly affected by this method of instruction compared to the other methods. Based on these results, I can conclude that the integration of text with a video may benefit students’ learning.

During the study each participant was asked to rate the method of instruction given to him or her based on three questions. The 5-point Likert scale questions asked the participants to rate how much they liked the method of instruction, the effectiveness of the method of instruction, and how prepared they felt for the assessments. Based on the students’ responses to the Likert scale questions, the results showed that regardless of whether or not the student has been required to watch videos for a course, participants assigned to the Video+Text liked this method of instruction. Participants may have liked this method of instruction because the instruction accommodates auditory, visual, and kinesthetic learners. The kinesthetic learners may have enjoyed having the text in their hands and the auditory and visual learners may have enjoyed having the visuals and sound from the video. The participants who were required to watch videos for a course in the past liked the method of instruction when they were assigned the video only but did not like the method of instruction when they were assigned text only. The participants who were required to watch videos for a course may have found the videos to be effective in the past which could have affected whether or not they liked having the text only. Also, the participants who were not required to watch videos for a course did not like the method of instruction when they were assigned the video only but did like the method of instruction when they were assigned the text. Since the participants are not familiar with the videos then
these results could imply that they do not like something that is unfamiliar to them.

The results of the study challenge the concept of the flipped classroom. The flipped classroom focuses on transforming traditional text and lectures into short educational videos. David Raths finds that teachers should spend more time using videos as the method of instruction so that students have a deeper level of learning in the classroom. However, the results show that the students who were given both the video and the text performed at a higher level on the third question of the post assessment than those who were given video-only and text-only methods of instruction. Therefore, educators implementing the flipped classroom as their method of instruction should include a text to coincide or act as an extension to the videos. Some of the criticisms of using video technology in the classroom suggest that there is a need for both face-to-face interaction and videos in the classroom. For example, Professor Dede says that in order to effectively integrate the video technology educators must "re-purpose" these technologies and incorporate educational value in them. This educational value can be incorporated into the videos by including real-life applications of the concepts and procedures (Pruitt, 2005). Other researchers like E. Bennett and N. Maniar (2007) from the Department of Creative Technologies, University of Portsmouth, UK believe that students should develop transferable skills that include the ability to learn for themselves. The videos should motivate the students to engage in the learning and in discovering the concepts. E. Bennett and N. Maniar state that the video technology used in the classroom should not be an educator lecturing. Videos used as the method of instruction in the classroom, should not be an educator lecturing, but a tool to enhance the students’ learning.

Limitations and Future Research
The current study has several limitations to consider when interpreting the results. One of the limitations includes the small number of male participants compared to the number of female participants. By only having nine males participate, the tests that compared sex and the results of the assessments were not significant. In the future, this study could include more participants which will allow for the assessment of differences between males and females. Future research could look into the effects that the three methods of instruction have on a large number of participants. The results could show more differentiation among groups which could support the need for the integration of text with videos.

Another limitation in this study was that the assessment of the learning was based on one question (question 3 on the post assessment). Participants may have guessed rather than actually understanding why the correct answer was yes. Future research could include assessments with multiple questions to get more of an understanding of the participants’ understanding of the concepts.

Future research could 1) look at learning multiple concepts over an extended period of time (such as a semester or a unit), 2) use a control group to compare the methods of instruction to the traditional lecturing method, 3) formally measure participants’ learning style prior to participating. The first option would allow for the inclusion of more real-life applications which adds value to the concepts and procedures being addressed. The second option would allow researchers to determine the effects of the different methods of instructions compared to the traditional lecture method of instruction. These results may encourage educators to include more methods of instruction into the classroom in order for maximize student learning. The third option involves delving more into the students’ learning style which would allow for future research to predict the participants’ performance on the assessment prior to the instruction.
Future researchers could predict and compare the results of the students based on whether or not they are visual, auditory, or kinesthetic learners. These results may allow researchers to determine if the methods of instruction can effectively accommodate all types of learners.
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September 12, 2015.


Nautical Knots. 113-25.

Appendix A

Preliminary Survey

Age: ____________

Sex:       M   F

Year in College:
First Year   Second Year   Third Year   Fourth Year   Other

Cumulative GPA: ____________

Major(s):
________________________________________________________________________

Number of Math Classes Taken at Ohio Dominican University:
0   1   2   3   4   5+

Have you ever been required to watch instructional videos for homework?
Yes       No

If so, how often are you required to watch videos as a part of your homework?
Daily       Weekly       Monthly       Once a Semester

How often do you watch videos to seek additional information related to a course?
Daily       Weekly       Monthly       Once a Semester       Never

If you watch videos for classes, do you take notes while watching?
Yes       No
Appendix B

Pre-Assessment

Pre-Assessment

Directions: Circle yes or no for each of the expressions.

Is $0.99$ equal to $1$? Yes No
Appendix C

Text-only Method of Instruction

Explanation:
If two numbers look different does it mean that those numbers are different?

Consider 0.5

Is 0.5 equal to \( \frac{1}{2} \) ?

Solution
Yes, 0.5 looks different than \( \frac{1}{2} \) but the two numbers are equal.

**EXAMPLE 1**

Consider .99

\[
.99 = \frac{99}{100}
\]

**Is .99 equal to 1?**

\[
1 = \frac{100}{100} \quad \text{and} \quad \frac{99}{100} \neq \frac{100}{100}
\]

Therefore .99 is **not** equal to 1.

.99 has 2 nines and .999 has 3 nines so they have finitely many nines. These numbers .99 and .999 can be rounded to 1 but are NOT equal to 1.

**EXAMPLE 2**

Consider .999

\[
.999 = \frac{999}{1000}
\]

**Is .999 equal to 1?**

\[
1 = \frac{1000}{1000} \quad \text{and} \quad \frac{999}{1000} \neq \frac{1000}{1000}
\]

Therefore .999 is **not** equal to 1.

What if there are infinitely many nines?
Consider 0.999...

Let \( x = 0.999... \)

\[
(10)x=(10) \cdot 0.999... \\
10x = 9.999...
\]

Multiply both sides of the equation by 10 Simplify the equation

We can subtract equal amounts from both sides of the equation. We will subtract \( x \) from the left side and \( x = 0.999... \) from the right side.

\[
10x - 1x = 9.999... - 0.999...
\]

Subtract 1x from 10x

On the right hand side of the equation the .999...’s cancel since there are infinitely many 9’s in both 0.999... and 9.99...

\[
9x = 9
\]

Simplify the equation

\[
\frac{9x}{9} = \frac{9}{9}
\]

Divide both sides of the equation by 9 in order to solve for \( x \)

Therefore, \( x = 1 \)

Since we let \( x = 0.999... \) in the initial statement and we concluded that \( x = 1 \) then \( x = 0.999... = 1 \). Thus, 0.999... = 1.
Appendix D

Post Assessment

Post-Assessment

Directions: Circle yes or no for each of the expressions.

Is $0.99$ equal to $1$?  
Yes   No

Is $3.9999$ equal to $4$?  
Yes   No

Is $7.9999999\ldots$ equal to $8$?  
Yes   No
Appendix E

Post-Survey

What is the extent to which you like the method of instruction that was randomly assigned to you? (1 = not at all, 5 = very much)

1  2  3  4  5

What is the extent to which you found the method of instruction to be effective when learning the mathematical explanation? (1 = not effective, 5 = very effective)

1  2  3  4  5

Based on the instruction given, how prepared did you feel for the assessment? (1 = not prepared, 5 = very prepared)

1  2  3  4  5