Comparing the Effectiveness of Individual Tutoring and Online Videos

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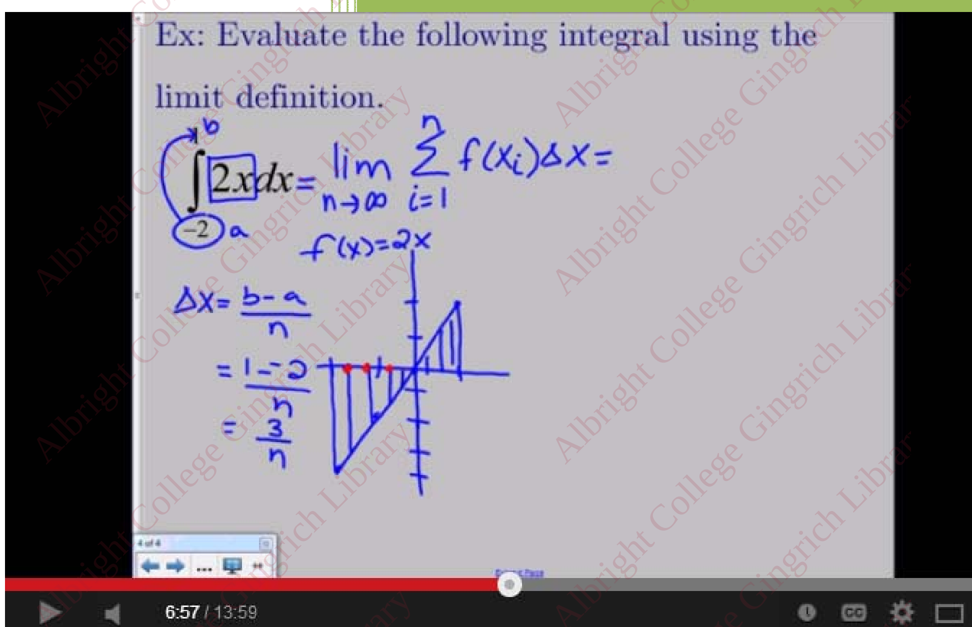

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Benjamin Franklin once said, "tell me and I forget, teach me and I remember, involve me and I learn" ("Benjamin Franklin"). Learning is the ultimate goal of education, and learning how to help students learn should be a top priority for all educators. In today's multimedia world, technology is infiltrating students' lives, both in and outside of the classroom. Teachers are now trained on different ways to incorporate technology in the classroom, and students are connected to each other and the world in ways that have never been seen before. Since students now have instant access to information via the Internet and are already using this resource for entertainment, it is time to bring homework help and tutoring into the 21st century.

Why I Became Interested In This Project

Online tutorial videos can be a powerful learning tool. They can be used for any topic and can be used to demonstrate simple to complex concepts. Personally, I have used online videos to both review simple concepts, such as solving systems of three variable linear equations and more complex topics, such as finding a basis for a vector space. These videos have helped me to understand better my own classes, as well as given me extra descriptions and examples to use when explaining concepts to other students. As a tutor, I have always recommended videos on YouTube and from Khan Academy to the students with whom I work; these videos are an extra resource that my students can use at their own convenience to see an alternate explanation of a topic that may make more sense to them than their professor's or my own. The students I helped could view these videos whenever they pleased and could use them to study and to answer questions before asking for extra help. Different internet sources contain dozens of videos made by experts, professors, or teachers in that field and can be a great way to learn more independently.

After taking a course on instructional technology, I became interested in the process behind making these videos and if I could make them for the students I tutored. After this class, I was especially interested in learning about the different features of the SMARTboard and if these could be used to create videos in the same style as those produced by Khan Academy, where the narrator is not on-screen and in which all a viewer can see is someone writing on a screen while a narration is played simultaneously. I had met a math teacher from Florida via a social networking site who recorded himself solving different problems for his own students and others around the country. This teacher was always on screen and just used a regular video camera set up in his classroom to record his process. I was interested in learning about how to use different screen capturing technologies to eliminate the instructor from the video screen and to remove any other distractions that the recording environment might provide.

Through all of this experience I became curious about how effective online videos are in aiding learning. I had always recommended videos to students but was now interested in researching and determining for myself if they have any real benefit for math education. My specific interest was in comparing the effectiveness of online videos with one-on-one tutoring to see if one had an advantage over the other. If videos were just as effective as live tutors for limited periods of time, parents and universities alike could save money and time in providing extra assistance for students. As a future teacher, I was also interested in examining if taking extra time at the end of each day to record mini-lessons of what was taught would positively benefit my students' understanding of problem solving and the concepts behind it.

Preliminary Research

Existing research is undecided on the effectiveness of online videos, having results to both support and oppose the use of them, and no research was found that compared videos to other teaching methods. Online videos and video learning can be categorized as a piece of multimedia learning; multimedia learning refers to learning from pictures and any set-up in which information is presented in two or more formats at the same time, such as words and pictures (Dey 379). As technology in schools grows, more and more multimedia learning is brought into the classroom, and videos are one of the most frequently used pieces of multimedia (Merkt 687). Videos are already being used inside of the classroom as a learning tool, and they now need to be looked at as a tool for outside of the classroom.

A primary theory concerned with learning is the cognitive load theory, which deals with the limitations of working memory and views these limitations as the major barrier to learning (Dey 379). The more strain that is put onto working memory, the less information is absorbed, so reducing cognitive load on students can help to improve their working memory function. Working off of the cognitive load theory, another cognitive theory was developed that suggested that multimedia could be developed following certain design principles that could reduce cognitive load and optimize working memory. This theory was based on three different assumptions. The first assumption is that humans have partially distinct visual and auditory channels for receiving and processing information and that these distinct channels can allow for multiple inputs that do not conflict with one another. The second assumption is that there is no limit to the amount of information that can be processed in each channel at one time. The final assumption is that humans are active processors and will seek to make sense of multimedia presentations (Dey 379). This research suggests that using videos could be an effective learning tool because information can be presented to both these visual and auditory channels without the information conflicting with each other. Information that is presented visually can then be reinforced by what a student is hearing from the video's narration.

Research has also revealed that videos may be able to reduce cognitive load by giving students control over different video features. Online videos tend to include pause and rewind features which give students more control over the pace and sequence of their learning. Giving viewers the ability to pause and replay sections can decrease cognitive load by giving students opportunities to stop and absorb the information that has already been presented and to see that information again if they missed something the first time (Kay 3). These different theories and assumptions have been tested in several different studies, and these studies have looked at both the effects of videos on scores and student perceptions of the videos on their learning.

One of the positive results that has been seen in studies looking at educational videos is a positive effect on test scores. In one study, 6th and 8th grade middle school students were given a pre-test and then a post-test after viewing a short worked example video podcast, which demonstrated how to work through a sample problem on a simple math concept to compare scores. The results of this study indicate that the worked example videos had a "significant statistical and practical impact on middle school students' short term learning performance" (Kay 12). 79% of the students in this study also reported that they felt that the videos helped them to understand better the concepts (Kay 7). A second study which looked at the effects of videos on undergraduate students' exam scores in a molecular biology class revealed that having access to the online videos had a positive impact on students' academic success and that these students' scores were on average 2% higher, which was statistically significant (Dupuis 71). This research indicated that videos also positively affect scores for undergraduate students, which, when combined with the results of the previous study, could be used to argue that videos can positively affect student scores for learners at any age and over multiple subjects.

Many of the studies that looked at the effects of videos on grades also looked into student perceptions of the videos. One study reported that the majority of participants felt that the online video resources could be used to supplement or enhance the teacher's lectures; these participants also felt that the videos could not replace the lectures and that they were unsure if the videos would have given them the same understanding if the concepts were being introduced for the first time. Overall, the participants from this same study also felt that the video presentations moved at a slower pace than the lecture and that this was a beneficial feature of the videos (Dey 389). The research study conducted on 6th and 8th math students also suggests that students find video podcasts "enjoyable to watch, satisfying, motivating, intellectually stimulating, and useful, helpful, and effective with respect to improving learning" (Kay 3). An overwhelming majority of these students, almost 90%, also agreed that watching the videos was better than using their textbooks; a smaller group of these students liked the videos because there were fewer interruptions to their learning and because they did not have to raise their hand and ask the teacher questions, which they might otherwise be reluctant to do (Kay 8-9). In the undergraduate study using the molecular biology class, the students described their access and use of the videos as "easy and convenient, improve[d] learning, and intellectually stimulating" (Dupuis 64). In each of these studies and their literature reviews, students reported that videos supported a positive impact on their performance. Students already access videos on the Internet for entertainment purposes, and this media form has become a comfortable way for them to receive information. Studies that look at student attitudes towards videos have an overwhelmingly positive response from students.

Another feature of the research that was found on videos looked at the interactive and control features of videos. Research has found that simply having the features to control the flow of information in a video with stop and play buttons benefits learning, even if these features are hardly used. This same research also suggests that giving students the opportunity to control the flow of the video might be the most promising approach to improve videos as a learning tool (Merkt 689). Having access to online videos where a student can pause and rewind is also expected to give slower learners an advantage over traditional lectures since they can slow the pace of the information to match their personal cognitive needs (Dupuis 71). Giving students the chance to control their learning environment and customize how they are receiving information benefits their learning and follows the pedagogical tenet that individualized instruction is the best type of instruction. Present studies also indicate that videos can be just as effective as print materials when viewers have the chance to control the videos and that these interactive features have "leveled out learning related differences between print and videos" (Merkt 702).

Having the option to control the videos is not the only education benefit that has been seen in research. Other key benefits of educational videos include "improved learning and study habits, positive student attitudes toward learning, and increased learning performance" (Kay 2). Evidence has already been presented that using videos can improve students' scores and that being able to control the videos also benefits students, but even just giving students the options of viewing the videos can be beneficial. If students do decide to utilize videos, this decision can be viewed as active participation in their learning rather than passively attending lectures (Dupuis 72). Students who choose to use videos are actively engaging themselves in the learning process by reaching out and finding help. Active participation such as this makes students more invested in their learning which can lead to better outcomes. Online videos are much more convenient for students to access than finding someone to help them because students can watch the videos whenever their schedules allow them the time. This convenience also benefits students who are too self-conscious to reach out for help because they can have a sense of anonymity and can view these videos privately. Videos can also be found at no cost to the student, whereas private tutors can become costly very quickly. This low cost benefit can also be applied to universities (Brecht 230). Videos can be produced at a much lower cost than paying for tutors to be available to help students.

Not all of the research on educational videos has been positive, and there is research that presents information that opposes their use. One study that reported higher scores for viewing videos also indicated that the participants were easily distracted and had a tendency to multi-task while viewing the online videos (Dey 389). Online videos are easy to access and so is a student's Facebook, email, or instant messaging account. This easy access leads to a tendency not to focus on any one thing while working online and instead allows the student to jump back and forth between different applications while the video runs in the background. When students are multitasking while watching a video, they get the benefit of hearing the narration but lose out on the reinforcement of the visuals. Higher level concepts and more complex topics are also more difficult to present in a video fashion. Research comparing print materials to videos found that for adolescent and adult viewers, videos have been found to be inferior to print when it came to recalling facts about a complex matter (Merkt 688). This may be because adolescent and adult viewers are more mature than a younger audience and have more patience and higher reading comprehension levels which would allow them to sit down and dedicate their attention to a print resource. Another downside of the videos was that they have not been researched in a higher education mathematics setting, which is the environment in which this project would be conducted in (Kay 2).

Individualized instruction is thought to be the most effective form of teaching, and tutors who work one-on-one with students are able to provide flexible and customized support for each student. Habley and McClanahan identify tutoring as "one of the five most important factors in increasing student academic success and course retention" (Brecht 230). Tutors are able to provide supplemental academic support and can work to reinforce concepts, to improve study skills, and to increase a student's feeling of confidence in the subject. Studies that have looked at why live tutors are so effective have found that tutors can support and guide students to prevent them from becoming frustrated and confused, while still allowing the students to do as much of the work as they can independently (Merrill 280). Tutors can provide individualized and structured instruction where they re-teach a concept and gradually withdraw their support until a student can proficiently solve the problems on his or her own. A key part of the learning process occurs when students attempt to apply concepts and material on their own, and tutors can provide the necessary guidance that allow them to do this (Merrill 280). One-on-one tutoring sessions are highly interactive, and tutors and students work together to deconstruct problems and piece together concepts. This interactive relationship may also have motivational benefits for students because as students form a relationship with their tutors, they feel like less of a subordinate and more like a peer and in turn try harder to not disappoint their partner (Merrill 299).

Feedback is a crucial part of the learning process. When students receive feedback on computational and conceptual errors, they are able to learn from their mistakes, and this feedback can prevent them from committing the same mistakes again. One of the key benefits of live tutoring is that tutors can give immediate feedback on errors, which is more effective than delayed feedback or no feedback at all (Merrill 289). This is an area in which tutors have an advantage over videos because tutors can follow a student's problem solving process and can intervene immediately when an error is made. A video can point out where common errors might be made in a problem and can explain why these errors are wrong, but the feedback is pre-recorded and cannot be changed to instruct on an individual's mistakes. Tutors also have an advantage for how they can respond to errors. Research has found that tutors tend to draw a student's attention to a mistake and then allow that student a second opportunity to correct it without giving explicit directions (Merrill 281). Allowing students to self-correct errors is an excellent learning opportunity because correcting an error on their own can help them to learn how to look for errors in their own work and correct them without any prompting. Research has also found that tutors are very flexible at how they intervene with mistakes. The research has indicated that tutors will adjust their error intervention depending on the type of error that is made. If an error is mainly a simple computation or syntactic error, tutors were found usually to give immediate and explicit instructions as to how to fix the problem. However, if a student's error represented more of conceptual misunderstanding, tutors tended to focus the student more on why their solution was incorrect (Merrill 282). This flexibility is another way that tutors can individualize instruction and give students the support needed to learn. This flexibility in error intervention can save time and can focus the student's efforts more on understanding the bigger concepts rather than nitpicking trivial errors.

Proposed Hypothesis

The above research shows that both online educational videos and individual tutoring are effective tools at supporting learning. Based on this research, my current hypothesis is that there is no statistical difference between pre- and post-test scores for online videos and one hour of individualized tutoring. I predict that watching online videos is just as effective for students as the combination of both watching online videos and meeting with a private tutor for one hour per week because of the limited amount of time with the tutor.

Research Method

In order to test this hypothesis, I planned and recorded educational videos to accompany the curriculum of an introductory calculus class and designed a case study that was approved by Albright's Institutional Review Board to run in a MAT131 class during the Fall 2013 semester at Albright College.

The educational videos were based on of the 9th edition of the Larson and Edwards Calculus textbook, which is the textbook used in the MAT131 class and covered the first four chapters of the textbook. A comprehensive list of the video topics can be found in the table below.

Video Topics

Chapter 1 – Limits and Their Properties	**Chapter 2 – Differentiation**
• Finding limits graphically and numerically	• The derivative • The tangent line problem

• Properties of limits • Finding limits analytically • $\varepsilon - \delta$ definition of a limit • Continuity • One-sided limits and the intermediate value theorem • Infinite Limits	• Basic differentiation rules • Derivatives as rates of change • Product rule • Quotient rule • Higher-order derivatives and application • The chain rule • Implicit differentiation
Chapter 3 – Applications of Differentiation	**Chapter 4 – Integration**
• Extrema on an interval • Rolle's theorem and the mean value theorem • Increasing and decreasing functions • The first derivative test • Concavity • The second derivative test • Limits at infinity • Curve sketching • Optimization problems • Newton's method • Differentials	• Antiderivatives • Summations • Area • Riemann sums and definite integrals • Area and properties of definite integrals • The first fundamental theorem of calculus • The average value of a function and the second fundamental theorem of calculus • Integration by substitution • Numerical integration

Before recording each video, I first read through the textbook section and my own notes from the semester during which I took MAT131 at Albright. After this, I typed up the information that I wanted to include in the video(s) for the section, such as definitions, theorems, hints and tips, and example problems. If the section was particularly dense or contained more involved problems, I would split the content up into multiple videos to ensure that I could spend enough time explaining and solving each example. After programming out the content and example problems for each video in Microsoft Word, I used SMART Notebook 11 to create the presentation that I would record. Each video presentation had the same theme so that the formatting over the entire series remained consistent; therefore, each presentation was easy to create. I used a light grey background on each slide, navy blue text, and Euclid font. To save time when making the videos, I would have important definitions, theorems, and key information typed out. Once the presentation for each video was made, all that was left to do was to record my explanations of all of the content and how I worked through the example problems.

The process of recording the videos was fairly simple. I was able to use a gaming headset that had an attached microphone and the screen recording feature in the SMART Notebook software to create my series of educational videos. To record each video, I simply had to plug the gaming headset into one of the computer's USB ports and open the presentation in SMART Notebook. Once the presentation was loaded, I would press the screen record button and would set the presentation view to full screen. The screen recording feature used the gaming headset to record my explanations and to capture whatever I wrote on the SMARTboard. Using this technology, I was able to make my own tutorial videos in which I was not seen on-screen.

Once each video had been recorded, I used Windows Movie Maker to clip off the first few and last seconds of each video to eliminate any dead audio time and the frames in which the presentation was not on full-screen. All of the edited videos were saved as Windows Media Files and were uploaded to Google Drive to share easily with my case study participants. At the end of the case study, all of the videos were uploaded to my YouTube channel.

Video production for this project started in June 2013 and was finished in November of the same year. When I first started to record the videos, I made at least two attempts to get a final recording with which I was happy because I would frequently stumble over my words and needed to learn how to modulate the pitch and speed of my voice to improve the audio quality. By the time I finished recording the eight videos for the chapter 1 material, I was much more comfortable recording myself; the rest of the videos were done in only one take, and my voice sounded much more relaxed and natural. By the end of video production, I had made 40 videos covering the first four chapters of the calculus textbook with a total of ten hours and twenty minutes of playback time.

While I programmed the content for each section and created the video presentations, I would also create pre- and post-test measures for each textbook section. The pre-tests would be used in my case study to collect data about students' understanding of each section before receiving any support from tutoring or videos, and the post-tests would be used to collect data about their understanding after receiving the support. Each pre- and post-test contained several problems that were similar to the example problems in the video series. I created a rubric for each pre- and post-test to serve as an answer key and to ensure that each student's pre- and post-tests were scored in the same way. Possible scores on the pre- and post-tests ranged from 5 to 10 points, depending on the number of steps or work required to solve the different problems. The answer for each problem was only worth one point so that students could still earn higher scores for showing they understood the solving process even if they made a computation error along the way.

For my case study, I recruited students from Dr. Catone's section of MAT131 in the Fall 2013 semester. This class had 24 students enrolled at the beginning of the semester. To recruit students I sent the class an email over the summer giving a basic description of what the case study would entail and what their level of participation would be if they decided to sign up. I also made an announcement during class about this opportunity in the first two weeks of the semester and held two information sessions where interested students could come to hear a more detailed description of the study and ask any questions. The four students who signed up to participate in the case study signed a consent form, agreed to not seek outside tutoring services, and were told that they were free to leave the study at any time. Participants' names were withheld from Dr. Catone to prevent any grading bias or special treatment in the class.

Case study participants were randomly assigned to one of two treatment groups, with two students in each group. The first group received the educational videos as well as the option to receive up to one hour per week of individual tutoring with me. The second group received the same videos as the first group but was not given the tutoring option. Students in both groups met directly after their class to take pre- and post-test measures for each section. After participants had taken a pre-test for a section, the tutorial videos for that section were shared with them using their school email addresses and Google Drive. All of the participants took the pre-test for each section around the same time but were able to turn down taking a post-test if they had yet to watch the videos or be tutored and felt unprepared for it.

These four students were also asked to complete feedback questions in a Google Doc after taking the pre- and post-tests for each section. The Google Doc was used for the feedback questions to minimize the time requirement on each of the students. All four participants needed consistent prompting to continue to update their feedback documents, and most of the responses were written for the whole chapter around the time of an in-class test. Each section had the same pre- and post-test questions, which are listed below.

Feedback Questions

Pre-Test

1. How did you feel about the content on this pre-test? (Did you know it all? Had no idea?

Post-Test

2. Did you watch the videos for this content?
3. How many times did you watch the videos?

4. How did you feel about the content on the post-test compared to how you felt on the pre-test?
5. If you feel like you improved, what helped you to improve? (Tutoring, the videos, the homework, going to your professor's office hours, got help from a friend, etc.)
6. Would the videos have been helpful if you hadn't already learned about this content in class?

Analysis of Collected Data

Data collection for this study ran from September 9th to November 6th, giving roughly eight weeks of data with which to work. At the end of the case study, each participant was given a code, and each of the pre- and post-tests was labeled using this coding system to keep participants anonymous; students who were coded with a B received both the videos and the tutoring option and students who were coded with a V received only the videos.

Each participant's scores on the pre- and post-tests were entered into an Excel spreadsheet. Scores were recorded as the number of earned points out of the total number of points, and these scores were converted to percentages. Due to participants dropping the class throughout the semester, each participant has a different number of completed pre- and post-tests. Only pairs of pre- and post-tests were considered If a pre-test had been completed and its corresponding post-test had not been, the pre-test data was thrown out. All four participants' scores are presented as percentages below.

	B1		B2		V3		V4	
	Pre-Test	**Post-test**	**Pre-Test**	**Post-Test**	**Pre-Test**	**Post-Test**	**Pre-Test**	**Post-Test**
ε-δ	25.00%	50.00%	0.00%	50.00%	0.00%	56.25%	0.00%	0.00%
1.4	33.33%	80.00%	0.00%	30.00%	58.33%	65.00%	0.00%	30.00%
1.5	100.00%	70.00%	0.00%	30.00%	30.00%	20.00%	0.00%	40.00%
3.5	0.00%	66.67%	0.00%	100.00%	33.33%	100.00%	0.00%	0.00%
2.1	20.00%	40.00%	0.00%	10.00%	0.00%	50.00%	0.00%	10.00%
2.2	20.00%	75.00%	0.00%	0.00%	0.00%	80.00%	15.00%	10.00%
2.3	12.50%	31.25%			0.00%	0.00%	0.00%	0.00%
2.4	75.00%	91.67%			0.00%	83.33%	0.00%	66.67%
2.5	0.00%	0.00%			0.00%	0.00%	0.00%	0.00%
2.6	14.29%	66.67%			0.00%	16.67%		
3.1	30.00%	30.00%			0.00%	10.00%		
3.2	0.00%	12.50%			0.00%	25.00%		
3.3	43.75%	31.25%			0.00%	68.75%		
3.4	30.00%	20.00%			25.00%	60.00%		
3.6	20.00%	0.00%			20.00%	25.00%		
3.7					0.00%	12.50%		

3.8					0.00%	70.00%		
3.9					0.00%	20.00%		

The first step taken to analyze the data was to first run a two tailed t-test on each participant's pre- and post-test scores to determine if there was a statistically significant difference between his or her pre-test and post-test average scores. This t-test would show if there was a statistically significant amount of improvement between the average pre-test score and the average post-test score for each student.

To run a two tailed t-test for the difference of the means certain descriptive statistics need to be calculated. To find the pre-test and post-test mean score, I added all of the percentage scores for each pre- and post-test for each student and then divided that sum by the total number of pre- or post-tests, n. These mean scores were recorded as decimal values. Next, I calculated the variance by subtracting the mean from each score and squaring the result. These squared differences were then added up and were divided by n; the standard deviation was found by taking the square root of the variance. Next I calculated all of the components to find the t-test statistic for each participant. I found the difference between the two means by subtracting the pre-test mean from the post-test mean and then divided both the pre- and post-test variances by n, added these quotients and took the square root of the final sum. To find the t-test statistic for each participant, I divided the difference of the means by the square root of the sum of the variances divided by n. The following table shows the formulas used to compute each of the described statistics.

Statistic Formulas	
Sample Size	n
Mean	$\bar{x} = \frac{\sum scores}{n}$
Variance	$\sigma = \frac{\sum(x_i - \bar{x})^2}{n}$
Standard Deviation	$s = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n}}$
Difference of Means	$\overline{x_2} - \overline{x_1}$
Sum of Variances Divided by n	$\frac{\sigma_1}{n_1} + \frac{\sigma_2}{n_2}$

Square root of Variances Divided by n	$\sqrt{\frac{\sigma_1}{n_1}+\frac{\sigma_2}{n_2}}$
t-Test Statistic	$\frac{\overline{x_2}-\overline{x_1}}{\sqrt{\frac{\sigma_1}{n_1}+\frac{\sigma_2}{n_2}}}$

In order to determine if these t-scores represented a statistically significant difference between the means, a critical value needed to be found for each student. These critical values were found from a table of values and represent the t-test statistics that would leave 2.5%, half of the alpha level, of the area under the t distribution curve above that value; the other half of the .05 (5%) alpha level would be left below the negative of the same critical value. The critical values for each participant were different because the critical values are dependent on the degrees of freedom for each student, which was one less than the value of n. If the t-test statistic for a participant was larger than the found critical value, then the null hypothesis, H_o, which was that the pre-test and post-test means were equal could be rejected in favor of the alternative hypothesis, H_A, which was that the two means were not equal. If the t-test statistic was less than the critical value, then the test failed to reject the null hypothesis, which meant that the difference between the two means was not large enough to be considered statistically significant and that it cannot be concluded that there is any difference between the two.

The results of this analysis for each individual are re-produced below.

Two-Tailed t-Test: Difference of Means for Individual Participants								
	B1		**B2**		**V3**		**V4**	
	Pre-Test	**Post-Test**	**Pre-Test**	**Post-Test**	**Pre-Test**	**Post-Test**	**Pre-Test**	**Post-Test**
n	15	15	6	6	18	18	9	9
Mean	0.282579365	0.443333333	0	0.366666667	0.092592593	0.423611111	0.016666667	0.174074074
Standard Deviation	0.266556318	0.285708184	0	0.324893145	0.164918819	0.304993169	0.047140452	0.221542169
Variance	0.071052271	0.081629167	0	0.105555556	0.027198217	0.093020833	0.002222222	0.049080933
Difference of Means	0.160753968		0.366666667		0.331018519		0.157407407	
Sum of Variances/n	0.010178762		0.017592593		0.006678836		0.005700351	
Sq. Rt of the Sum of Var./n	0.100889853		0.132637071		0.081724146		0.075500666	
t-Test Statistic	1.593361101		2.764435791		4.05043714		2.084847929	
Deg. of Freedom	14		5		17		8	
Alpha Level	.05							

H_o	$\bar{x}_{pre} = \bar{x}_{post}$			
H_A	$\bar{x}_{pre} \neq \bar{x}_{post}$			
Critical Value	2.1448	2.5706	2.1098	2.306
Conclusion	Fail to reject H_o	Reject H_o	Reject H_o	Fail to reject H_o

The above results revealed that half of the participants, one person from each treatment group, had a statistically significant difference in their mean pre- and post-test scores. B1 and V4 did have small gains in their mean scores from their pre- to post-tests, but these results were not statistically significant at the .05 level. Upon seeing this, a one-tailed t-test was run on B2 and V3's scores to determine if their post-test mean was significantly higher than their pre-test average. The results of this test are located below and show that both B2 and V3 had post-test means that were significantly higher at the .05 level.

One-Tailed t-Test: Post-test > Pre-test		
	B2	**V3**
t-test Statistic	2.764435791	4.05043714
Deg. of Freedom	5	17
Alpha Level	.05	
H_o	$\bar{x}_{pre} = \bar{x}_{post}$	
H_A	$\bar{x}_{pre} > \bar{x}_{post}$	
Critical Value	2.0150	1.7396
Conclusion	Reject H_o	Reject H_o

The second step in analyzing the case study data was to look at each treatment group as a whole. Again, a two-tailed t-test was used to compare the mean pre- and post-test scores of the group, which followed the same steps as outlined above. In this analysis, the scores of the two participants in each group were used to find a mean pre- and post-test score for the group as a whole. These means were then compared to one another at the .05 alpha level. The results of this analysis are listed below.

Two-Tailed t-Test: Difference of Means for each Treatment Group				
	B Group		**V Group**	
	Pre-Test	**Post-Test**	**Pre-Test**	**Post-Test**
n	21	21	27	27
Mean	0.201842404	0.421428571	0.067283951	0.340432099
Standard Deviation	0.25893583	0.299440853	0.141964573	0.303663788
Variance	0.067047764	0.089664824	0.02015394	0.092211696
t-Test Statistic	2.541924721		4.234122176	
Deg. of Freedom	20		26	
Alpha	.05			
H_o	$\bar{x}_{pre} = \bar{x}_{post}$			

H_A	$\bar{x}_{pre} \neq \bar{x}_{post}$	
Critical Value	2.0860	2.0555
Conclusion	Fail to reject H_o	Reject H_o

This analysis revealed that the group that received both the videos and individual tutoring did not have statistically different pre- and post-test means, while the group that only received the videos did.

The final statistical analysis run on the collected data was to compare the B treatment group to the V treatment group. The two-tailed t-test for the difference of two sample means was again used to complete this comparison. The mean for each group was the difference between the pre- and post-test means from the previous chart; this showed the average increase in scores. Since each group had a different total of taken pre- and post-tests, to calculate the degrees of freedom I subtracted one from the smaller of the two n-values.

Two-Tailed t-Test: Difference of Means for Comparison of Treatment Groups		
	B Group	**V Group**
n	21	27
Mean	0.219586	0.273148
t-Test Statistic	0.496792686	
Deg. of Freedom	20	
Alpha	.05	
H_o	$\bar{x}_{pre} = \bar{x}_{post}$	
H_A	$\bar{x}_{pre} \neq \bar{x}_{post}$	
Critical Value	2.0860	
Conclusion	Fail to reject H_o	

This analysis showed that there was no statistically significant difference between the average improvements in scores in each treatment group, meaning that the two different tutoring treatments did not produce different average score gains, which was consistent with the proposed hypothesis.

Descriptive Study of Participants

During the case study, each participant was asked to fill out a feedback document using Google Drive and respond to a set of questions for each textbook section. This feedback document, along with observations from tutoring sessions and the written work seen on the pre- and post-tests, provided a more holistic view of each participant than just his or her test scores. A descriptive analysis of each student is presented below.

Student B1 typically used less than his allotted one hour per week of individual tutoring and would sometimes opt not to utilize the tutoring option at all during the week. During these individual tutoring sessions most of B1's issues with the class content came more from algebra errors rather than a misunderstanding of the calculus concepts. B1 had issues copying a problem correctly from line to line and tended not to use parenthesis in his work, which would lead to order of operation errors and prevented him from correctly solving the problems. His issue copying problems correctly from line to line also caused him to find incorrect answers when he had begun with the correct work. B1 could usually start a problem correctly, which illustrated he had some conceptual understanding of how to apply each calculus concept, but his insufficient algebra skills made it impossible for him to arrive at an answer most of the time. Specifically, B1 struggled the most with factoring quadratics, simplifying rational expressions, and completing basic arithmetic operations; this lack of strong base skills made the course material very difficult for him.

These same errors were consistent with the work seen on B1's pre- and post-tests. On most post-tests, B1 demonstrated that he had a better conceptual understanding of the material than he did on the pre-test, but his inability to manipulate correctly the different equations led to mainly incorrect answers. On several occasions B1 arrived at incorrect answers because he had inaccurately substituted values and made arithmetic errors in his computations, but he had completed all of the previous steps in the problem correctly and had applied all of the calculus concepts correctly. Overall, as the course progressed, B1 showed a slight decline in the number of algebraic mistakes which helped his pre- and post-test scores to improve, although his arithmetic errors remained fairly constant throughout his participation in the case study. B1 may have performed better if the course had allowed calculator use since this would have eliminated his arithmetic errors.

On the feedback document, B1 reported that he watched all of the videos that were shared with him. He watched most of the videos just one time, but watched a few of the videos three or four times. B1 also reported that he felt more confident about the material on the post-test than he did on the pre-test, which was slightly surprising since his work only showed slight improvements in his understanding. The feedback document also revealed that B1 felt it was watching the videos and completing his homework that helped him to improve his understanding of the material for most of the textbook sections. He also reported that for a few of these sections that it was the combination of the videos and tutoring that made him feel he improved. B1 also disclosed that he felt the videos would have still been useful for a few of the sections if the material had not already been presented in class. This was a particularly useful answer since B1 missed several classes due to illness throughout the semester.

Student B2 also did not use the tutoring option each week and was the first person to drop the class and leave the case study. During tutoring sessions, B2 would copy problems that we went over together into her notebook for future reference; we would review questions from previously completed pre- and post-tests as well as example problems from her class notes during our sessions. B2 also lacked basic algebra skills that prevented her from performing well in the class. B2 struggled with factoring both simple and more complex quadratic equations and with graphing simple functions by hand. B2 also postponed taking one or two post-tests at the normal time directly after class and instead used the end of her tutoring sessions to complete them after we had gone over the material from those sections.

Again, most of the errors that were observed during tutoring sessions remained consistent in the work seen on B2's pre- and post-tests. Most of B2's pre-tests were left blank, or the problems were partially solved and usually contained algebraic errors, such as incorrect factoring. On the whole, B2 did demonstrate a small increase in conceptual understanding of the material between the pre- and post-tests. B2 did not seem to retain much information from class and would sometimes write that the material had not yet been covered in class even though the professor had confirmed beforehand that it was being taught that day. B2 demonstrated a slightly improved conceptual understanding by indicating she knew how problems should be started and what general form the answers should take at the end, though the intermediate solving steps were sometimes omitted. B2 attempted most of the post-test questions and was often thrown off track because of factoring errors and other basic algebraic mistakes. Her weaker algebra skills prevented her from correctly finishing the problems that she was able to begin.

B2 only completed the first three of the six total sections of her feedback document. She reported that she was the type of learner who needs to look over the material and learn it on her own to understand it; this could explain why she received a 0% on all six pre-tests she took, since they were administered directly after class and there was no time for her to review the material for herself. The feedback document also revealed that B2 watched all of the videos shared with her at least once and occasionally watched them multiple times. B2 also indicated that she was normally still confused on the content after she had taken the post-test, which was consistent with the work shown and that she tended to understand it a bit more afterwards. She shared that her level of understanding on the post-test also depended on her study habits beforehand, which could be interpreted as her acknowledgement that the videos and tutoring alone would not be enough outside work for the class. B2 said that the combination of the tutoring and the videos helped her to improve her level of understanding. She also reported for the three sections she completed that the videos would had still been helpful for her if the material had not already been learned in class.

V3 was the last remaining participant in the case study at the end of data collection. The majority of V3's pre-tests were left blank and were labeled that he had no idea how to solve the problems. When V3 did attempt the pre-test problems, the answers frequently had no accompanying work, meaning that they were guesses, or there would be some relevant starting information written or introductory steps completed followed by a label of "I don't know." V3 always took his time to complete both the pre- and post-test measures and appeared to always complete as much of the work as possible on each one and was very honest about his performance on them.

Overall, there was some conceptual improvement. Only one post-test was left blank, and all of the others had some correct work shown on them. The correct work may have been a sentence stating general concepts to which the question pertained or formulas that should be used to solve the problem that he was unable to manipulate. V3 also would sometimes write information needed to start the problem or would write the starting steps of the problem. When he started a problem this way, he either was unable to take the problem any further, made a mistake that caused him to become stuck, or he showed all of the necessary work but would incorrectly label his answers or have minor errors strewn throughout the problem.

V3 was able to solve some of the post-test questions correctly and always showed more work on the post-test than on the corresponding pre-test. Many of the problems that were marked as incorrect on the post-tests were started correctly and were either not fully completed or had algebraic mistakes in them. Like the previous two participants, V3 also had weaker algebra skills, such as factoring quadratic equations and simplifying complex fractions (fractions inside of fractions). These weaker algebra skills caused him not to be able to finish solving many of the problems; this was an issue of which V3 was aware since many problems had comments that showed he knew what algebraic steps should be taken to complete the problems, but that he was unable to perform these operations.

V3 also did not answer the questions for each section that were posted in his feedback document, but he did answer the majority of them. For all of the sections V3 answered, he indicated that he always “had no idea” for the content on the pre-tests. V3 watched the videos for each section and watched most of them only once. He watched the videos twice for three of the textbook sections. V3 said that he slightly understood the content after the videos or that it was a bit easier after viewing them, but that the material was still tricky. The feedback document also revealed that V3 felt it was the videos that helped him when he had felt he improved. In a meeting with me, V3 admitted that he did not complete his homework, so watching the videos may been his only out-of-class resource to learn the material other than a friend’s help. The fact that V3 did not complete homework assignments may explain some of his low scores since he was not actively interacting with the material very often.

V3 also indicated that the videos would have still been helpful if the content had not been covered in class, especially since, in his words, he felt he did not learn much from the in-class lectures. He also suggested that the videos be made at a slightly faster pace and include more example problems. V3 seemed disappointed with how the case study turned out. He also acknowledged in his feedback document that when he signed up to participate in the case study, he had been hoping to be placed in the group that received both the videos and the individual tutoring. He preferred to focus all of his studying on the day before tests or quizzes and was hoping that being tutored would give him the motivation to spread the studying out. V3 said that he would have preferred to learn the material from a person instead of the videos and that he learned most of what he knew for the class from a math major friend. V3 also said that watching videos on his own time made him not want to watch them at all.

V4 was the student who showed the least amount of growth throughout the case study and left many of the pre-tests blank and would have irrelevant or very little correct work for questions on the post-tests. For example, on both the pre- and the post-test for the first section V4 solved for unrelated pieces of information on the functions, where they were equal to zero, instead of proving their limits using the specified definition. On other sections, V4 would do part of the work and would occasionally arrive at an answer. When he did have an answer, he usually did not label the appropriate information or would not fully answer the question, such as only labeling the types of discontinuities a function had, but not their locations. Often, V4 would recopy the function in the pre-test question in the space below and would rewrite any square roots as fractional exponents, but he would go no further in attempting a solution. On the pre- and post-tests covering the different derivative rules, V4 copied the functions and rewrote all of the radicals as fractional exponents, but he either did not apply a derivative rule or only applied the appropriate rule to a piece of the function and would find an incomplete answer.

Some of the work on a few of the post-tests showed that V4 had a vague understanding of the concepts being tested and showed that he had a small conceptual improvement for some of the textbook sections. On one section, V4 wrote the correct formula at the top of the page for the limit definition of a derivative and was able to correctly substitute into it for one of the two functions, but he was not able to simplify correctly to find an answer. On a different section, V4 demonstrated that he understood the questions on the post-test and the section's vocabulary by plugging in the specified x-values to check for continuity, and he also understood that a function had both a removable and a non-removable discontinuity when he had left these questions blank on the pre-test, but did not finish either of the problems. He also attempted several times to apply derivative rules to functions and knew which of the rules to apply, which showed some understanding of them, but he was unable to use correctly these rules on the functions given or would only apply the rule to a piece of the equation. These small improvements showed that V4 was retaining some of the information from class and the videos and that he was learning a bit for some of the sections, even though he had little to no score increase between his pre- and post-tests.

Unfortunately, V4 did not fill out any of his feedback document. From my observations, I was unable to tell if he watched the videos for each section. When I asked him if he had watched the videos, he would give me a yes or no and would only take the post-test for each section after saying he had in fact seen the videos. V4 came unprepared to take the pre- and post-tests each day by not having a pencil, even though he came directly from class. V4 took his time and would look over each pre- and post-test for several minutes, even if he eventually turned them in blank.

In general, the group improved a minor amount and seemed to appreciate the instructional videos. This minor improvement could be interpreted as a positive result in favor of both tutorial videos and individual tutoring as instructional aides. The group as a whole also seemed to agree that the videos were what helped them to improve their understanding and that the videos would be effective if they had not previously seen the content. This is interesting because it agrees with the previously presented research that videos can be an effective tutoring tool and that they can be a beneficial source for independent learning. One fact that limited the growth of the participants in the case study was that all four participants had weak algebra skills that prevented them from solving many of the problems correctly. The skills with which the group as a whole struggled were: factoring quadratic equations, simplifying complex fractions, and applying basic trigonometric knowledge. This weak algebra base made the content very difficult, and overall the group seemed to struggle more with solving the algebra problems than with applying the initial calculus steps.

Limits of the Case Study

This study had two main limitations, the first of which was the small sample size. Of the twenty four original students enrolled in Dr. Catone's MAT131 class, only four students participated in the case study, which created a very small sample size. This small sample size affects the meaningfulness of the statistics used to analyze the collected data because the sample size is used to calculate the mean, variance, standard deviation, t-test statistic, and the degrees of freedom for each set of statistics. Small sample sizes have lower degrees of freedom to use in statistical analysis. When there is a high number of degrees of freedom, the student's t-distribution becomes closer to the normal curve and higher confidences levels can be used without creating wide confidence intervals around the true mean of the population from which the sample is taken. When there is a low number of degrees of freedom, the student's t-distribution does not resemble the normal curve and high confidence levels create very wide intervals around the true mean.

The small sample size in this study means that the statistics that were gathered were not very meaningful and that the results of the statistical analysis cannot be generalized to the larger student population, which would be college students taking an introductory Calculus class. Small samples do not closely approximate the demographics and variety of characteristics that are displayed in the student population. Because small samples are typically not representative of the overall group, there is a larger inference jump to make when generalizing the statistics. The small sample size also created a small score distribution in the collected data. A larger sample size would have had more variation and a larger range of scores received on the pre- and post-tests because there would be a larger range of student ability represented in the study.

The second main limitation to the study was a volunteer bias. The case study recruited participants on a completely voluntary basis and did not offer any incentive for students to consider signing up. The voluntary nature of student recruitment created a bias for lower performing students to participate.

Lower performing students were more likely to volunteer for this study because they had a higher need for assistance in the class due to lower confidence in their mathematical abilities and weaker base skills. Students who were strong in math and felt more confident in their abilities to learn calculus had no incentive to volunteer their time for the study since they would not need the extra help in order to perform well. Lower performing students may also have weaker study skills which would make the instructional videos more enticing because the videos would give them a resource from which to study and a study schedule to follow. Stronger students are more likely to have better developed study skills and not need the videos or a more concrete study schedule to continue to work on the material outside of class. All of the students who participated had weaker base skills in math, which contributed to lower scores and limited growth in the class. The four study participants could be classified as lower performing math students, and this created a smaller score distribution and a more homogenous sample which did not represent the larger population.

Dropout Rates for MAT131 at Albright College

Three of the four case study participants dropped MAT131 during the course of the study, and the fourth student dropped the class shortly after the end of data collection. Since all four participants eventually dropped the class, I became intrigued about the number of students who typically drop MAT131 each semester and if losing all four of the participants followed any sort of trend or could be expected. Albright College's registrar, Mr. David Ballaban, was kind enough to supply the number of withdrawals from MAT131 for the past eleven semesters, which is presented in the chart below.

Semester	Number of Students Enrolled	Number of Withdrawals	Percentage of Enrolled Students who Withdrew
Fall 2008	94	24	25.53%
Spring 2009	18	5	27.78%
Fall 2009	80	14	17.5%
Spring 2010	11	2	18.18%
Fall 2010	74	18	24.32%
Spring 2011	30	4	13.33%

Fall 2011	82	19	23.17%
Spring 2012	27	3	11.11%
Fall 2012	60	10	16.67%
Spring 2013	24	6	25%
Fall 2013	85	11	12.94%

Compared to past fall semesters, the 2013 fall semester had a relatively low drop-out rate. Only eleven students withdrew from MAT131 during that semester, four of whom were participants in the case study, meaning 36.36% of the students who withdrew were participants. Because of the low drop-out rate for that semester, it is not entirely expected that all of the case study participants would have withdrawn from the class since they were all receiving extra help outside of class through the videos and individualized tutoring and since the course withdrawals would have been spread across three different sections of MAT131. The volunteer bias could explain why having all of the case study participants drop is not entirely unexpected. Lower performing students were more likely to volunteer, and these students had a higher chance of struggling in the class, which would give them more motivation to drop the class instead of risking their GPAs.

What I Would Do Differently

After reflecting on conducting this case study, I realized there were several pieces that I would do differently if I were to run the study again at Albright College. The first condition I would alter would be to expand the student population from which participants could be recruited. I would do this by opening the case study to multiple sections of MAT131 instead of using just one section of the course. Using multiple sections would give a much larger population of students from which to recruit for the case study. This, in turn, would hopefully lead to having a larger sample size to use in data collection. The only concern using multiple classes would create is that these different sections may be taught by different professors who would have different teaching styles and slightly different expectations for their students; this might induce a teacher bias in the participants' pre- and post-test results.

The second adjustment I would make is to set up a regular meeting time with each student in the B group for his or her weekly individual tutoring session. During the case study, the two students in the B group did not use the tutoring option each week and met at varying times during the week. By instituting a regular meeting time there would no longer be scheduling conflicts, since the time would have been set in advance, and it would be easier to have students utilizing this option each week. It would have been preferable for all students in the B group consistently to use the tutoring option each week so that any difference in scores between the B and V group could have been attributed to having or not having the extra in-person help.

A third modification would be to have case study participants fill out their feedback documents for each section immediately after taking the corresponding post-test. None of the students who participated in the Fall 2013 study completely filled in the feedback document, which created gaps in the information collected on his or her perceptions of their own growth, his or her opinions and use of the videos for each section, and their suggestions for future videos. By having students fill out the document in my presence, I can ensure that each participant has a complete feedback document and that there are no gaps in the collected data.

A final difference would be to offer some sort of incentive for students to participate. The volunteer bias in the Fall 2013 study was a major issue and created a sample that included a narrow range of ability levels. This small spectrum of abilities did not accurately represent the range of abilities present in the population from which the sample was pulled, and this bias meant that the results of the study were not able to be generalized to the larger student population. Offering an incentive to participate in the study would hopefully encourage average and higher performing students to volunteer. This would create a more representative sample, and the results could then be generalized to the rest of the students taking MAT131.By making the listed modifications to how the case study is run, the study would hopefully yield more definitive results.

Benefits to Myself as a Future Educator

Even though the results of this study were not very conclusive and were not able to be generalized to the larger population of students who take MAT131, there were many benefits of the case study to me as a future educator. One of the largest benefits was gaining experience and practice doing a variety of tasks that I would have to do constantly as a full-time teacher.

Assessment is an extremely important part of education, and teachers write their own assessment pieces to use in their classrooms all the time. Writing all of the pre- and post-tests for the case study gave me first-hand practice in creating assessments and in discovering what characteristics make a good assessment. I quickly learned to judge the difficulty level of a problem and whether it was too complex to include in an assessment that was only supposed to evaluate if students had learned the basic concepts. Including too difficult of questions would have thrown off a student's score because the algebraic manipulations and the computations required may have been too advanced, and this would prevent a student from demonstrating that he or she understands how to apply the calculus concept to a simpler situation that is more manageable to complete.

I also experienced how difficult grading assessments objectively can be and learned what steps can be taken to alleviate this hazard. I made scoring rubrics for each of the pre- and post-tests to use when I graded each completed assessment. The rubrics helped me to decide what I thought was most important for the students to show and how many points a test should be worth. They also helped me to remain objective when assigning scores. Staying objective was especially important for the case study so that the scores recorded for each participant could be compared to those collected for the rest of the group. I enjoyed using a rubric for grading and think that it made scoring the tests easier and faster to complete. This experience with rubrics has influenced me as a future teacher in that I shall most likely continue to use rubrics when I teach my own classes to avoid subjective grading and to simplify the grading process.

Grading all of the pre- and post-tests for all four participants also taught me how important it is to grade assessments in a timely manner and to enter scores into a grade book quickly. When I let the pre- and post-tests pile up before grading them, it created minor amounts of stress and anxiety about having a larger volume with which to work, and this was with just four students. As a teacher I shall easily see over a hundred students each day and will have to grade many more assessments. The case study was a first-hand lesson that grading assessments quickly and entering scores as soon as possible keeps the work load more manageable and can keep stress levels lower.

The most important practice I got from running this case study was to practice teaching. Recording each video gave me the forum to practice teaching different concepts, to figure out how to word my explanations, to conquer my nerves, and to learn to regulate my voice. When I recorded the first few videos, I had to record them each multiple times to get a version that I was able to use; I frequently stumbled over words, spoke too quickly, and spoke in too high of a pitch. I was nervous even though I was simply "teaching" to the board and was alone in the room. After recording the first chapter's videos, I started to relax and was able to speak clearly, slowly, and control my pitch. My recordings became much more pleasant to which to listen and sounded much more natural. I had practiced teaching enough at this point to have the process feel natural and comfortable and was no longer nervous recording the videos. This practice and relaxation spilled over into my presentation skills in my own classes and made me much more comfortable speaking to a group. As a future teacher, I need to stay calm and composed in front of a group of thirty students and need to be able to teach in a clear and concise manner. Recording the videos gave me the opportunity to learn these skills without the pressure of students staring at me. By the end of the case study I was much more comfortable and confident in my own teaching abilities.

Conducting this case study also gave me the opportunity to expand the ways I can help my students outside of my classroom. Every practice and method used inside of a classroom must be research-based and supported by empirical evidence. Through this project I have read many articles and have collected my own evidence to show that online videos are effective at aiding learning. Having this information will allow me to confidently recommend online videos to my students as extra resources to help them with the material covered in class.

The case study also made me very familiar with the SMARTboard, its software, and screen capturing technology. This familiarity will aide me as a future teacher by making it very easy for me to teach my lessons using a SMARTboard or similar technology. I would also be able to use the skills I gained during this project to record and edit short summary videos of my lessons at the end of each school day. I enjoyed making the videos for the case study, and this would be an easy and quick way to assist my students outside of class. I could distribute them to my students by either posting them to a class website or setting up a YouTube channel for my classes; students could then access the videos and hear the lesson as many times as they needed. Giving my students a way to re-watch lessons would benefit students who had been absent, were having trouble with their homework, or were studying for an exam.

Conclusion

Individual tutors and online instructional videos have individually been established as effective learning aides, as seen in the preliminary research above. The purpose of this project was to compare these two tutoring methods and to determine if there was any difference in their effectiveness. I hypothesized that individual tutoring and online videos would have similar consequences in students' pre- and post-test scores. The final statistical analysis of the data collected from the case study does support this hypothesis since a two-tailed t-test at the .05 alpha level for the difference of the mean score increase of the B group and the V group failed to reject the null hypothesis that the two means were equal. This analysis is not conclusive, however, because of the small sample size used in the study and the volunteer bias for lower performing students to volunteer, so this analysis is not able to be generalized to the general population of students taking MAT131.

The descriptive study of the participants confirmed the volunteer bias in the study and presented some useful information concerning the videos. All four of the participants reported that they watched the videos, felt the videos helped to improve their understanding of the concepts, and, on several occasions, reported that the videos would have still been helpful if the material had not already been presented in class. These opinions support the research that online videos can be effective learning tools. The descriptive study also showed that the overall group did have minor improvements in its conceptual understanding of the calculus concepts, which supports the performance of both the videos and tutoring methods. Further research and data collection is needed in order conclusively to compare the effectiveness of these two tutoring methods.

Works Cited

"Benjamin Franklin (1706 -1790)." *Benjamin Franklin, Founding Father, Inventor, Diplomat, Scientist, Signer of the Declaration of Independence, Philosopher, Publisher*. American History Central, n.d. Web. 15 Dec. 2013.

Brecht, H. "Learning from online video lectures." *Journal of Information Technology Education: Innovations in Practice* 11.1 (2012): 227-250.

Dey, Eric L., Helen E. Burn, and David Gerdes. "Bringing the Classroom to the Web: Effects of Using New Technologies to Capture and Deliver Lectures." *Research in Higher Education* 50.4 (2009): 377-93. Print.

Dupuis, Josée, Josée Coutu, and Odette Laneuville. "Application of linear mixed-effect models for the analysis of exam scores: Online video associated with higher scores for undergraduate students with lower grades." *Computers & Education* (2013).

Kay, Robin, and Jaime Edwards. "Examining the Use of Worked Example Video Podcasts in Middle School Mathematics Classrooms: A Formative Analysis." *Canadian Journal of Learning and Technology* 38.3 (2012): n3.

Merkt, Martin, et al. "Learning with videos vs. learning with print: The role of interactive features." *Learning and Instruction* 21.6 (2011): 687-704.

Merrill, Douglas C., et al. "Effective tutoring techniques: A comparison of human tutors and intelligent tutoring systems." *The Journal of the Learning Sciences*2.3 (1992): 277-305.