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Utilizing Video Multimedia Tools in Biology Labs

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An Interactive Qualifying Project

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Project EL08

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Abstract

Research has shown that the addition of multimedia into education improves learning. Particularly in life-sciences, multimedia has shown to be beneficial because it provides visualization of concepts that are difficult to envision. Tutorial videos were implemented in the WPI introductory biology laboratories with the intention of helping to improve material retention. It was concluded that although the video protocols were appreciated and utilized by students, it cannot be determined whether the presence of the videos effectively increased student comprehension.

Introduction

Many researchers have debated whether education has improved throughout history with the use of multimedia (Pippert, 2009). With the development of technology, teaching tools have transformed from simple text to interactive media, potentially enabling a more thorough approach to learning. Specifically, the addition of multimedia, such as video, may be helpful in reducing the difficulty of converting text into practice because it offers a visual demonstration of instructions.

In the introductory biology labs at Worcester Polytechnic Institute (WPI), a series of videos were tested as a form of multimedia for implementation in future labs. Textual experiment protocols were supplemented with video representation of the procedures, accompanied by a voice narration and subtitles to accommodate the visually or audibly impaired. Furthermore, the addition of humorous elements to this video multimedia was utilized in an effort to enhance student interest in the presented material, with the hope of increasing the overall comprehension and retention of the lab protocols (Ziv, 1988). Specifically, the presence of the school mascot, Gompei the Goat, was used in an attempt to improve the appeal and effectiveness of the videos. In addition, each of the videos had a closing screen displaying the important points of the procedure. The effectiveness in enhancing laboratory learning by the addition of video multimedia, humor, and a summary of key points, was determined through the use of student surveys and grade statistics. The addition of tutorial videos as a supplement to the lab protocols for the Anatomy and Physiology Lab at Worcester Polytechnic Institute, aided by a subtle presence of humor, was expected to increase student understanding of the techniques and procedures, thereby reducing unnecessary wasted time in the lab, and allowing the students to pursue the course with confidence and efficiency. Through the analysis of this hypothesis, it was

observed that the students had positive feelings towards the videos and the percentage of the A's increased by 4.5% from the previous year, although this cannot be definitively attributed to the videos. However, only a small percentage of students found the incorporation of humor into the videos, via Gompei the Goat, helpful for material retention.

Background

Teaching methods have changed drastically throughout history. Until the beginning of the 20th century, the American students were taught solely through lectures and textbooks. At this time the only other method of applied education was school museums. The first of its kind was opened in St. Louis in 1905, and offered students educational stereographs, slides, and films (Reiser 2001). Beginning in 1908, the "visual education movement" in America drove classrooms to adopt visual media devices. During this movement, the first collection of educational films was introduced into the classroom with a motion picture projector. With the emergence of radio broadcasting and recording in the 1920s and 1930s, the new approach to academia was called the "audiovisual instruction movement" which included educational videos with sound (Reiser 2001). In the 1950s instructional television began to play a large role in classroom education through the creation of public broadcasting stations. In the 1970s, computer-assisted instruction was being developed for use in the classroom and education began focusing instead on "educational technology". Silver (1999) describes this technology as innovations undertaken by many schools and universities in a strategic effort to promote improved education, although there is no concrete data to support their effects on learning (Silver 1999).

By the early 1980s, computers were being used for educational purposes in the majority of American schools (Reiser 2001). The further development of computers and the internet in the 1990s has introduced a virtually endless capacity for the acquisition of information and presentation of material, and has proven to be one of the most influential tools for education. Online resources have provided easier access for students to material that had previously been difficult and time-consuming to obtain. Tools, such as slide shows created using Microsoft

PowerPoint, and textbook CD-ROMs, are continually being developed in hopes of creating more effective and interesting ways to convey information and enabling students to better understand classroom material. These new forms of material presentation are known today collectively as multimedia, and have truly shaped the modern education system (Velleman 1996).

Multimedia technology today uses various forms of communication or promotional media such as videos, computers, and still images, and is now widespread throughout the modern world. This insurgence of multimedia into the world of information technology has resulted in a significant decrease of information being presented in plain text, replacing it instead with combinations of computer-produced digital media, such as graphic images, photographs, videos, animations, and audio (Reiser 2001). Since multimedia technology allows information to be demonstrated in so many different ways, it enables teaching styles that can be directed toward a broadened range of learning preferences (Pippert 1999). Multimedia technologies can help educators present their material in both clear and creative ways to students, allowing students to better understand the concepts and materials presented. Numerous studies, such as those performed by Moreno (2008), Pryor and Bitter (2008), Bockholt (2003), McDaniel (2007), and Ziv (1988), affirm that the addition of multimedia to education results in a more thorough comprehension of material when compared to the traditional text and lecture formats. For that reason, incorporating multimedia as a teaching practice has been an important step forward in the world of education.

The use of multimedia for the purpose of enhancing learning is beneficial because it allows for an easier and broader variety of teaching styles with which information can be obtained; it promotes interactive learning and, as a result, encourages greater enthusiasm toward education in both students and teachers (Pryor 2008). In laboratory science, the use of video

technology is particularly useful, as it enables the visualization of procedures, and allows for deeper comprehension than that obtained just through textual presentation. In a study by Roxana Moreno and Ludmila Oregano-Layne (2008), students were introduced to various teaching principles verbally, which were then reinforced by one of four methods: the principle accompanied by a text example; the principle accompanied by a video example; the principle accompanied by a visual example from the teacher; or the principle not accompanied by any example. Each student was then given a conceptual test, an application test, and an opinion-based survey. Students who were provided with video or in-person visualization showed enhanced interest, as well as a stronger grasp of the material (Moreno 2008).Contrarily, students who were not given further explanation, and those who were given explanation via text did not show a difference in enthusiasm or comprehension of the material compared to the control group.

More specifically, multimedia implementation in education is beneficial in life sciences. According to Bockholt (2003):

> Multimedia is becoming an important tool for faculty in the biological sciences due to increasing conceptual and functional complexity that presents educational challenges that cannot be adequately addressed with traditional teaching methods.

In Bockholt's study the necessity for a connection between conceptual topics and their applications in the biological sciences was addressed through the development of an interactive multimedia program, *Cancer Cell Biology*. The scientists involved in this study used multimedia to focus on each of the different learning styles of the students, categorized in the study as "sensing and intuitive", "visual and verbal", "sequential and global", and "active and reflective". This was accomplished by creating a program in which the user was given the role of a doctor responsible for systematically diagnosing a patient with one particular type of cancer. The program addressed a variety of topics that had been taught in class and required the student to

complete a number of computer based tests to assess their understanding of the material. Testing was completed by volunteer members of a college sophomore-level biology class, who were subsequently given a survey to assess their opinion of value of the program. The overall student response from the survey showed a high level of enthusiasm toward the program, as 17 out of 24 of the students described it as "interesting" and many of them reported spending a large amount of time on the module (Bockholt 2003). Evidently, the addition of this multimedia program to the course curriculum was supported by the students, as it provided them with a new and interactive method of engaged learning and was beneficial for people of different learning styles.

Similarly, in a study conducted at Rensselaer Polytechnic Institute, (McDaniel et al, 2007), professors wanted to observe how the addition of an interactive web-based teaching module would affect the learning curve of an introductory biology course. The course, taught by the same professor for 28 years, changed its approach toward teaching from a lecture-based course to project-oriented and interactive. The traditional course consisted of 3 lectures per week during which attendance was not mandatory. Every Monday, students were required to hand in an assignment for credit, and every Friday, students were to pick up the next week's assignment in class; class attendance was near 100% on Mondays and Fridays, while on Wednesdays, it was as low as 65%. Of the assignments, 10 out of 14 would be included in the student's final score, comprising 200 of the total 600 points available in the course; 97% of the assignments at the beginning of the course were turned in, while the percentage dropped to 48% by the end of the semester. The beginning topic of the course focused on evolution, and the course concluded with a focus on ecology.

The web-enhanced version of the course required attendance at all lectures, and instead of having assignments due once a week, students were required to complete one pre-class session

and one post-class session, each about 1 hour long, on the interactive web module. This web module consisted of multiple-choice and short answer questions, as well as a short video pertaining to the material, online experiments and simulations, articles, and text readings. In class, students were split into problem-solving groups to learn vocabulary, concepts, and data analysis, and often used a tool similar to CPS clickers to test their comprehension of the material. A comparison between the test scores of the control and experimental courses showed that the web-enhanced course had an increase in learning of 95% in the evolution topic, and 143% in the ecology topic (McDaniel 2007).

In addition to multimedia, the presence of humor in learning and education is highly beneficial as well. In an experiment by Ziv (1988), the significance of humor on college-level learning was assessed. The use of humor was tested on an introductory college statistics course, taught at two separate times by the same professor. One section contained 82 students, and the other contained 79, none of whom were informed of the experiment. The first section was randomly determined to be taught with concept-relevant humor, and the second without, though both groups were to be taught the same material. At the conclusion of the course, all students were required to take the same standard statistics final exam. In the experimental group, the mean score for males was 83.2%, and the mean score for females was 81.7%. Contrarily, in the control group, the mean score for males was only 71.5%, and the mean score for females was 73.2% (Ziv 1988). All scores had a low standard deviation. This discrepancy in final scores between the experimental and control groups indicates that the presence of humor in education better enabled the students to learn the material.

Although extensive research has not yet been done on the effects of implementation of video-protocols into biology labs, numerous studies have been conducted on the incorporation of

video multimedia into college-level science courses. From these studies, it is evident that the addition of multimedia to education has immense benefits for a student's capacity for comprehension. Furthermore, the incorporation of humor has shown positive effects on student interest and performance in the classroom.

Methodology

The protocols for the laboratory exercises that were used for the filming of the lab videos were taken from a series of Michael Buckholt's procedures found on myWPI (Buckholt, 2008). Videos were made to show students how to make slides to view amoeba, euglena, yeast, squamous epithelial cells, and potato cells to view under a light microscope. Videos were also made to show diffusion of solutes suspended in a liquid, diffusion of solids, and the effect of solute concentration on the rate of osmosis. Additional videos demonstrated the difference in carbon dioxide in room air and exhaled air, the effect of exercise on carbon dioxide production, the measurement of vital capacity using a spirometer, and the methods for performing two types of ELISA(enzyme linked immunoadsorbent assay). The videos were filmed in the Salisbury labs 219 and 223 at Worcester Polytechnic Institute using lab materials provided by Michael Buckholt and JoAnn Whitefleet-Smith. In order to assist in adding humor to the videos, the Student Alumni Society of Worcester Polytechnic Institute was contacted to reserve the costume of the University mascot, Gompei the Goat, for special appearances in the videos.

The Sony Handycam DCR-SR200 video camera was used to film. All video clips were saved to the 160GB My Passport Essential hard drive provided by the Biology & Biotechnology Department at WPI. The software used to edit the movie clips into their finalized videos was Adobe Premiere Pro CS.3 (see Fig. 2) with the exception of the spirometer, yeast, and daphnia videos, which were edited using iMovie (see Fig. 6). Each video was accompanied by captions and overdubbing created by their respective software, as well as a summary screens created using Microsoft PowerPoint. The overdubbing and captions of the videos created using iMovie are shown in Figures 5 and 7. The audio for the videos was recorded at the Recording Studio in Alden Hall of Worcester Polytechnic Institute using Pro Tools Studio 7.0 software, as well as in

the Editing Suite in Fuller Labs at WPI using Adobe Premiere Pro CS.4. The audio for the spirometer and yeast videos was recorded with iMovie. The video and audio (see Figs. 3 and 4) were compressed into two formats to be compatible with Windows programs and Apple programs. The preset information, provided by the Academic Technology Center at WPI, can be found in Figure 1 and Table 1.

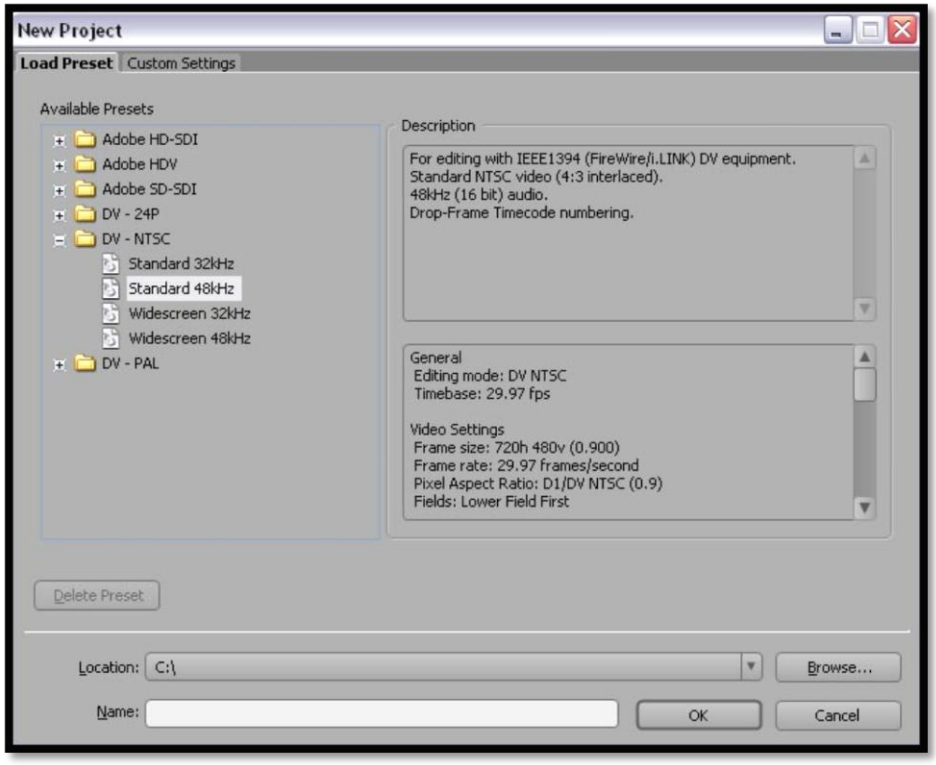


Figure 1: Video Preset Information: Figure 1 is a screen shot of the video presets used for the videos created using Adobe Premiere Pro CS3

WMV	H.264
Codec: Windows Media Video 9, Windows Media Audio 9.2 Size: 640x480, Square Pixels (Progressive) FPS: 29.97 One Pass, Constant Bit-rate Max Bit-rate: 600kbps Keyframe Interval: 20 Audio Format: 32kbps, 44kHz, Stereo (A/V) CBR	Codec: MainConcept H.264 Video, AAC Audio Size: NTSC 640x480, Square Pixels (Progressive) FPS: 29.97 Baseline Profile, Level 3.1, CBR Encoding Bitrate: 1.5 Mbps Audio Format: 160kbps, 48kHz, Stereo (Precedence: Bit-rate)

Table 1: Video Presets: Table 1 lists the video settings for WMV and H.264 formats using Adobe Premiere Pro CS3

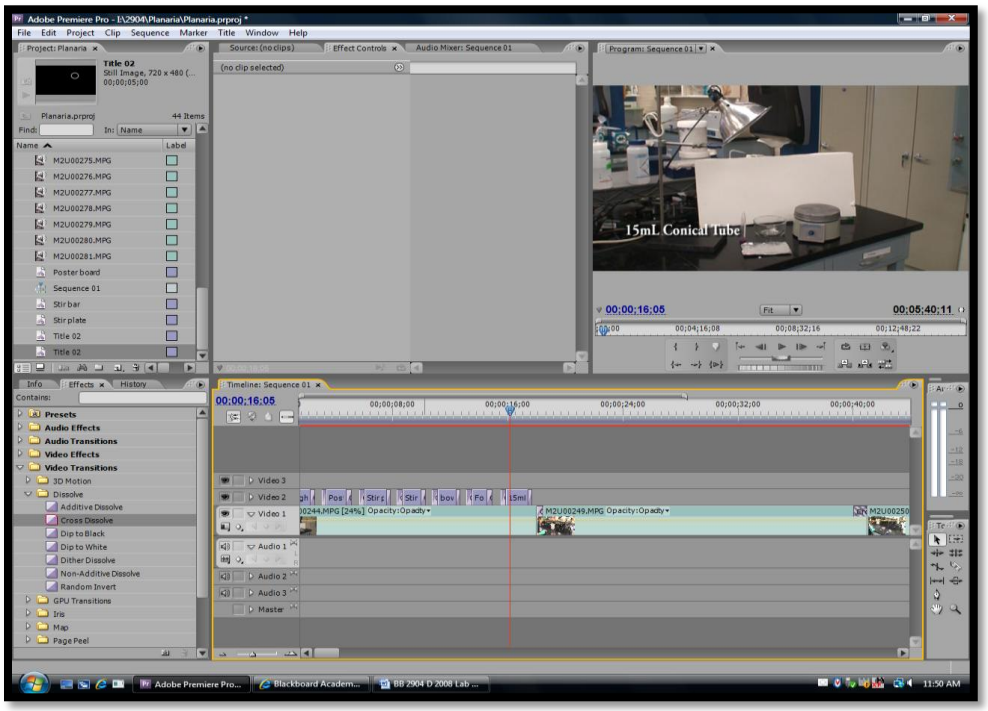


Figure 2: Video Editing: Figure 2 is a screen shot of videos being edited with Adobe Premiere Pro CS3

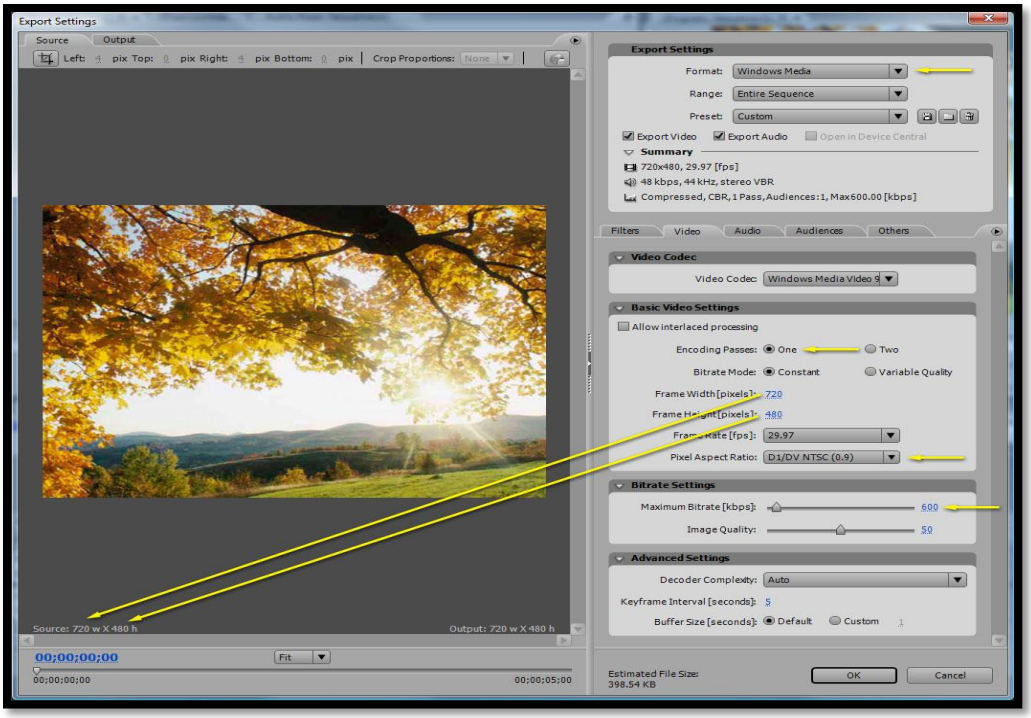


Figure3: Exporting Video: Figure 3 is a screen shot with the settings to export video using Adobe Premiere Pro CS3

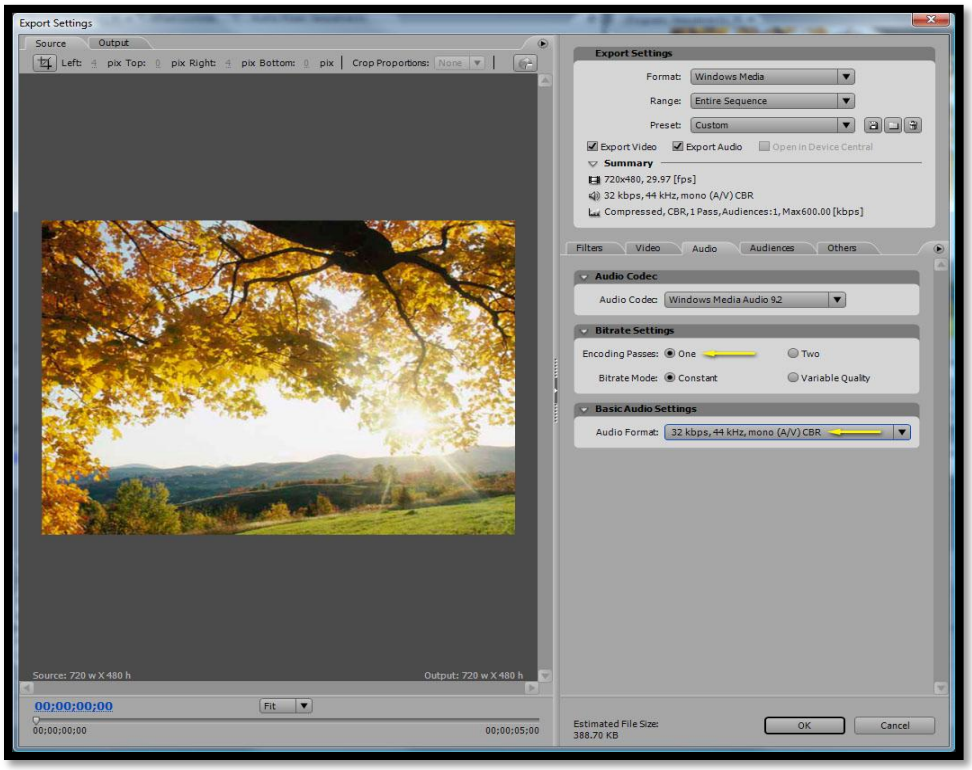


Figure 4: Exporting Video: Figure 4 is a screen shot with the settings to export audio using Adobe Premiere Pro CS3

Figure 5: Overdubbing with iMovie: Figure 5 is a screen shot of the features on iMovie which allow for the creation of overdubbed audio clips.

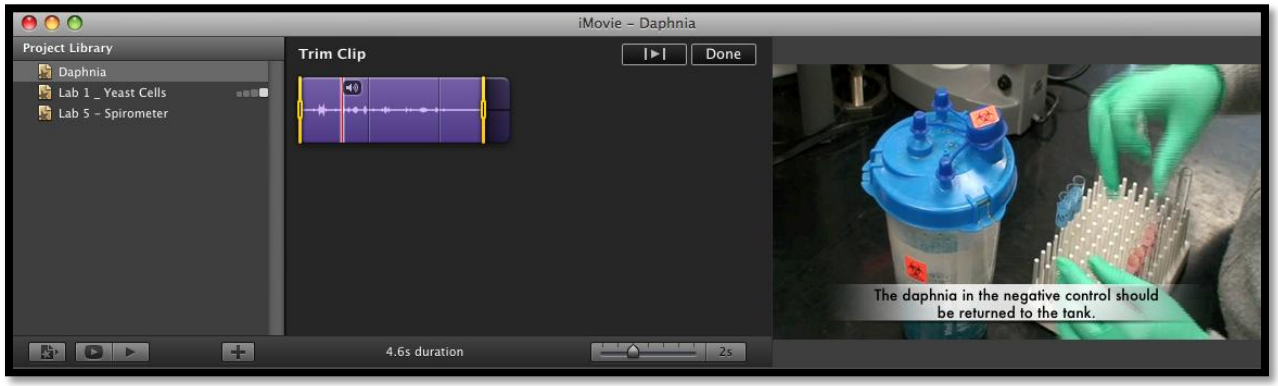
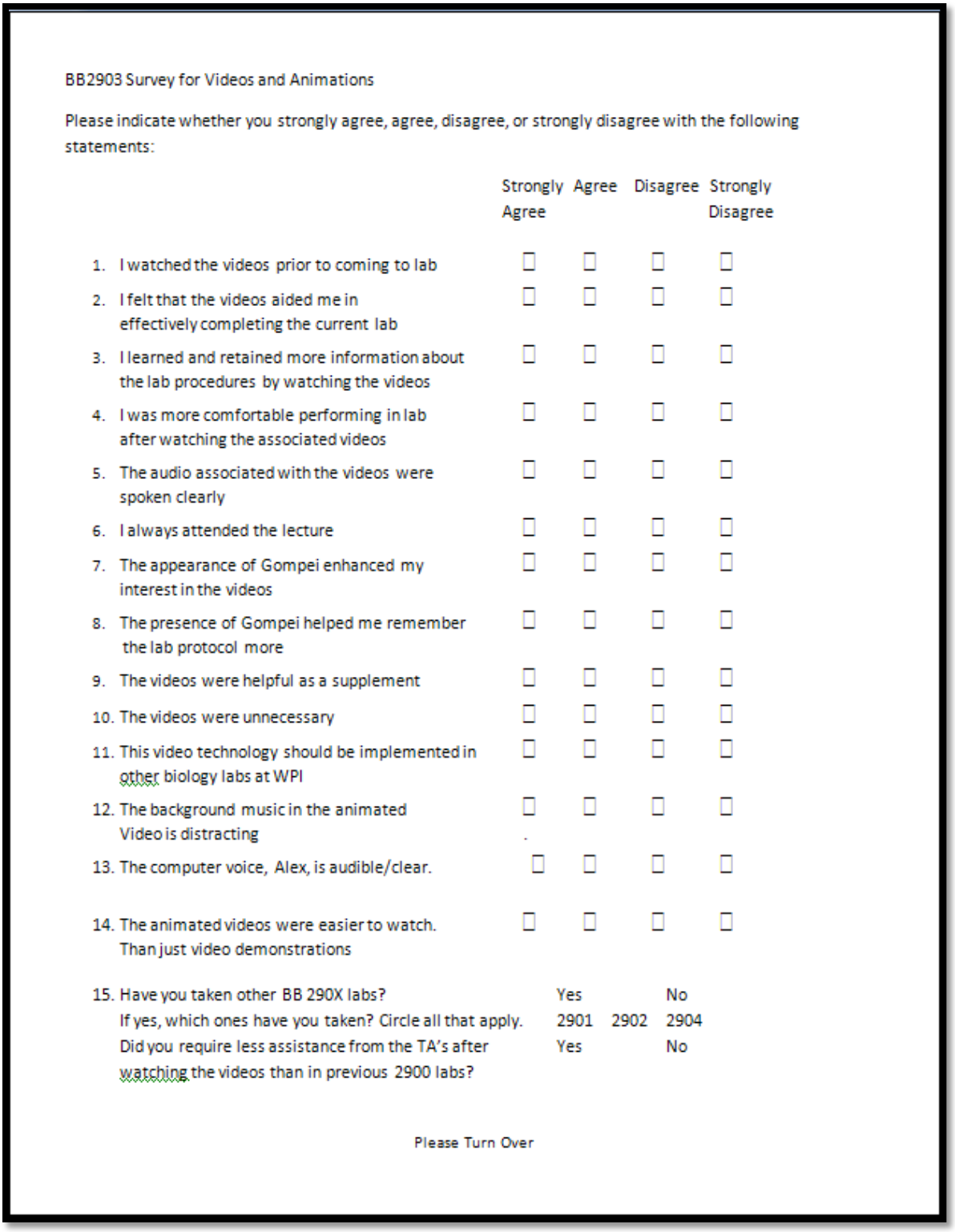


Figure 6: Editing Clips Using iMovie: Figure 6 is a screen shot of the clip trimming features on iMovie. Trimming clips and adding transitions were the primary tools used for film editing.

Figure 7: Creating Subtitles: Figure 7 is a screen shot of the Titles feature on iMovie. This was used to create subtitles to follow the overdubbing in the videos.

The compressed videos were burned onto DVD-R's, uploaded onto the WPI server, and linked to the WPI SharePoint website. The respective protocols were added to the same website and organized by lab to enable students to easily access them.

In order to assess the effectiveness of the videos, a survey was administered to each individual enrolled in the class. This survey consisted of a total of 18 questions as seen in Figures 8 and 9. At the end of the term, the survey was handed to all 90 students at the beginning of lecture. Candy was offered as an incentive for students to participate in the survey. The survey consisted of a variety of questions as can be seen in figure 8 and figure 9.



BB2903 Survey for Videos and Animations

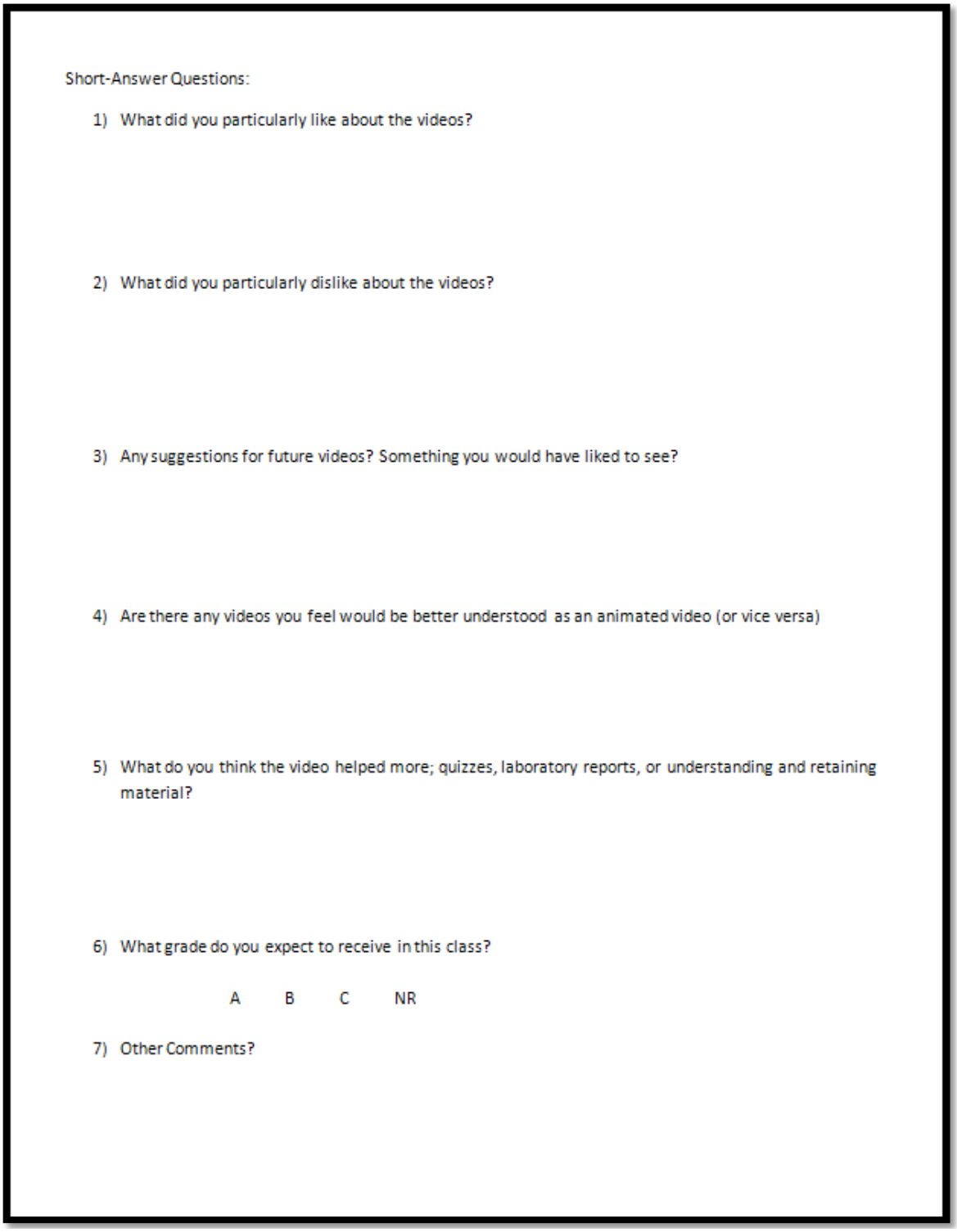
Please indicate whether you strongly agree, agree, disagree, or strongly disagree with the following statements:

	Strongly Agree	Agree	Disagree	Strongly Disagree
1. I watched the videos prior to coming to lab	☐	☐	☐	☐
2. I felt that the videos aided me in effectively completing the current lab	☐	☐	☐	☐
3. I learned and retained more information about the lab procedures by watching the videos	☐	☐	☐	☐
4. I was more comfortable performing in lab after watching the associated videos	☐	☐	☐	☐
5. The audio associated with the videos were spoken clearly	☐	☐	☐	☐
6. I always attended the lecture	☐	☐	☐	☐
7. The appearance of Gompei enhanced my interest in the videos	☐	☐	☐	☐
8. The presence of Gompei helped me remember the lab protocol more	☐	☐	☐	☐
9. The videos were helpful as a supplement	☐	☐	☐	☐
10. The videos were unnecessary	☐	☐	☐	☐
11. This video technology should be implemented in other biology labs at WPI	☐	☐	☐	☐
12. The background music in the animated Video is distracting	☐	☐	☐	☐
13. The computer voice, Alex, is audible/clear.	☐	☐	☐	☐
14. The animated videos were easier to watch. Than just video demonstrations	☐	☐	☐	☐

15. Have you taken other BB 290X labs? Yes No
If yes, which ones have you taken? Circle all that apply. 2901 2902 2904
Did you require less assistance from the TA's after watching the videos than in previous 2900 labs? Yes No

Please Turn Over

Figure 8: Page 1 of Survey: Figure 8 illustrates the first page the survey that was handed out to the students. This page consisted of 11 questions in which students can strongly agree, agree, disagree, or strongly disagree with the statements. One question asked students about previous biology labs they have taken.



Short-Answer Questions:

1) What did you particularly like about the videos?

2) What did you particularly dislike about the videos?

3) Any suggestions for future videos? Something you would have liked to see?

4) Are there any videos you feel would be better understood as an animated video (or vice versa)

5) What do you think the video helped more; quizzes, laboratory reports, or understanding and retaining material?

6) What grade do you expect to receive in this class?

A B C NR

7) Other Comments?

Figure 9: Page 2 of Survey: Figure 9 illustrates the second page the survey that was handed out to the students. This page consisted of 6 short answer questions including the students likes and dislikes about the video, suggestions for future videos, and their expected grade in the class.

Results

The survey was presented to students in BB2903 C09 –Anatomy & Physiology during the final lecture on March 2nd, 2009**.** This survey was used to evaluate the effects of the videos on student comprehension of the lab material. 87 of the 90 students, present at the final exam, responded to the surveys. Using Microsoft Excel 2007, bar graphs were generated to represent the survey results for presentation and analysis purposes. In this section, related questions were grouped together for analytical purposes. In addition, the general course survey responses and grade distribution were analyzed.

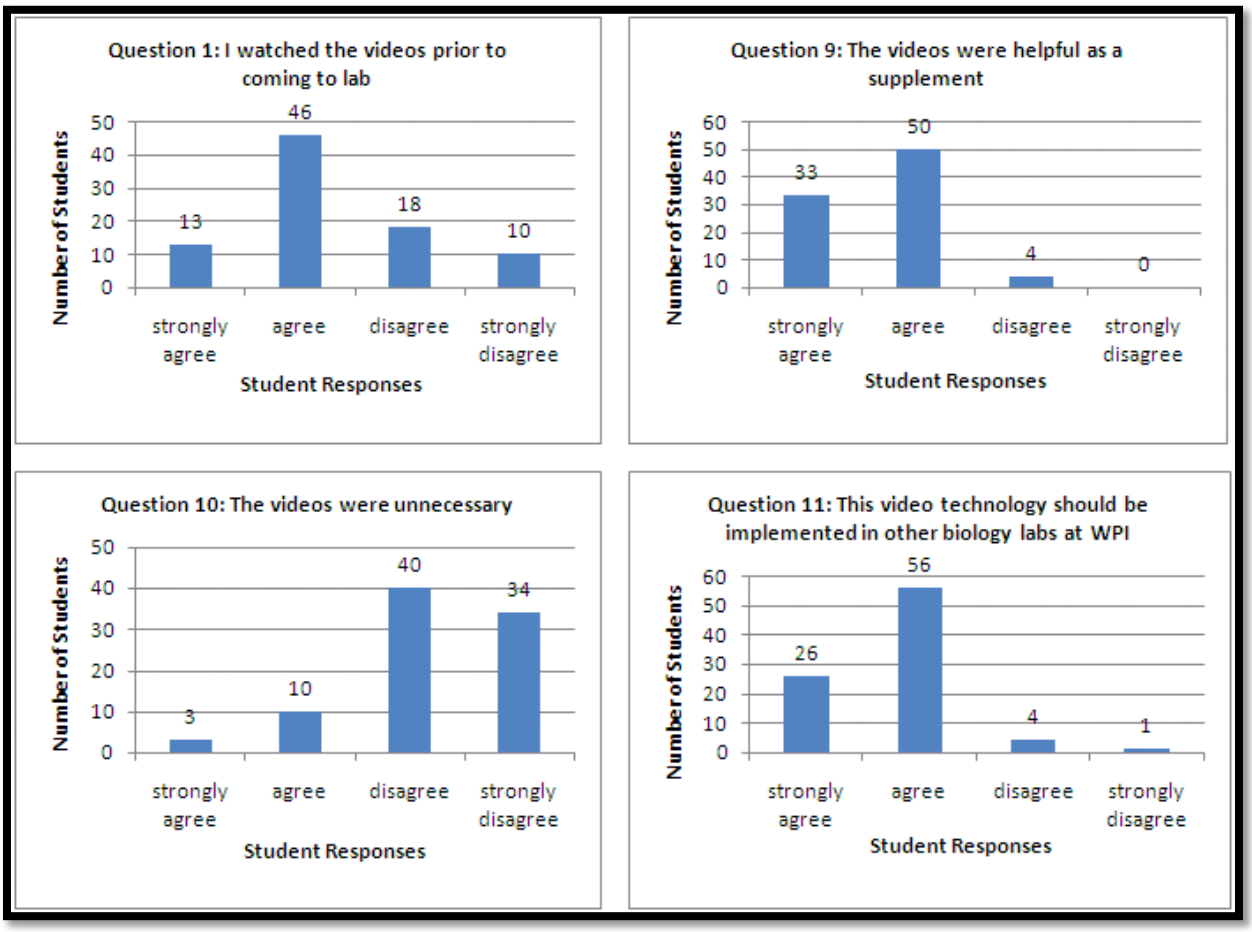


Figure 10: Graphical representation of the responses for questions 1, 9, 10, and 11

Questions 1, 9, 10, and 11 were concerned with the student's general feelings toward the videos. Question 1 asks if students watched the videos prior to coming to labs. Of the 87 responses received, most of the students took the time to watch the videos before coming to lab. 13 students (15%) strongly agreed and 45 students (51%) agreed that they watched the videos before each lab. On contrast, 20% of students disagreed and 11% did not watch the videos before coming to lab. Question 1 shows that the majority of students report having taken the time to watch the videos and learn the procedure before coming to class.

Question 9 asks if the videos were helpful as a supplement and question 10 asks if they were unnecessary. They overall trend suggests that the students feel the videos were helpful as a supplement. 33 of students strongly agreed (38%) and 50 of students (57%) agreed to the videos being helpful as a supplement. Only 4 students disagreed. None of the students strongly disagreed. Question 10 asks the students if they thought the videos were unnecessary. In correlation with the responses from question 9, 85% of the students disagreed or strongly disagreed to the videos being unnecessary. However, 15% felt the videos were unnecessary.

Question 11 asked students if they benefited from the video tutorials and would want the video technology to be implemented in other biology labs at WPI. The survey responses indicated that the students benefited from the lab tutorial videos and wanted the videos to be implemented in other biology labs. 82 students (94%) wanted to see more of these videos and only 5 students did not want videos in future labs.

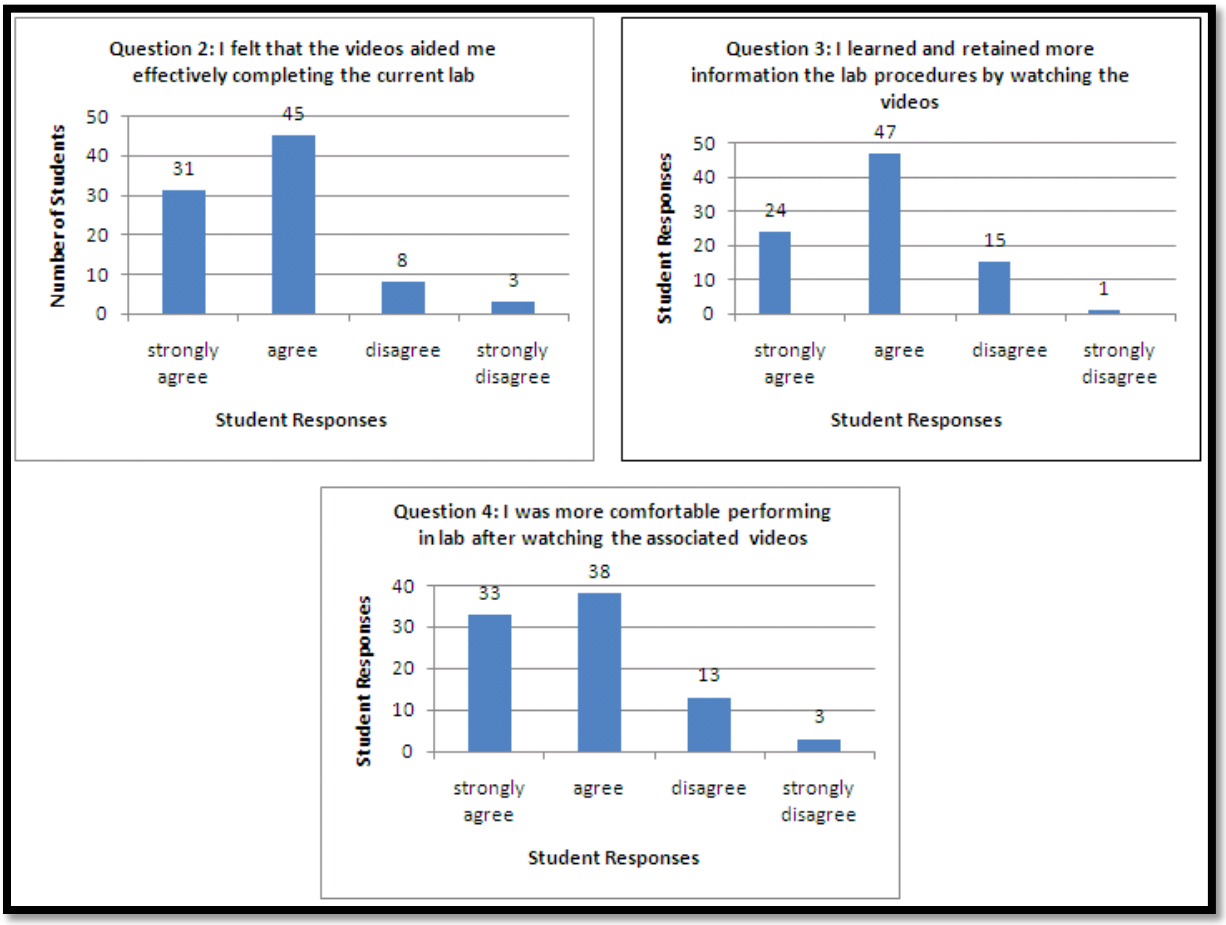


Figure 11: Responses for Questions 2, 3, and 4

The second group of the questions consists of questions 2, 3 and 4. These questions focus on the effectiveness of the videos with the student's lab experiences. Question 2 asks if the students felt that the videos aided them in effectively completing lab procedures. According to the graph, the videos were successful in helping students perform in lab. 31 students (36%) strongly agreed and 45 students (51%) agreed to videos having helped them. On the other hand, 8 students disagreed and 3 students strongly disagreed with the statement.

The next question inquires if the students learned and retained more information about the lab procedures after watching the videos. Out of the 87 responses, 24 (28%) of them strongly

agree to retaining information after watching the videos and 47 (54%) of them agree. Only 15 students (17%) of them disagree and 1 student (1.0%) strongly disagreed.

Question 4 asks students about their ability to perform lab tasks comfortably after watching the associated lab videos. In correlation with the previous questions, the majority of students were more comfortable performing in lab after watching the videos. 33 of the students (38%) strongly agreed and 38 of students (43%) agreed that they were more comfortable after watching the videos. However 13 students (15%) disagreed and 3 students (4.0%) strongly disagreed.

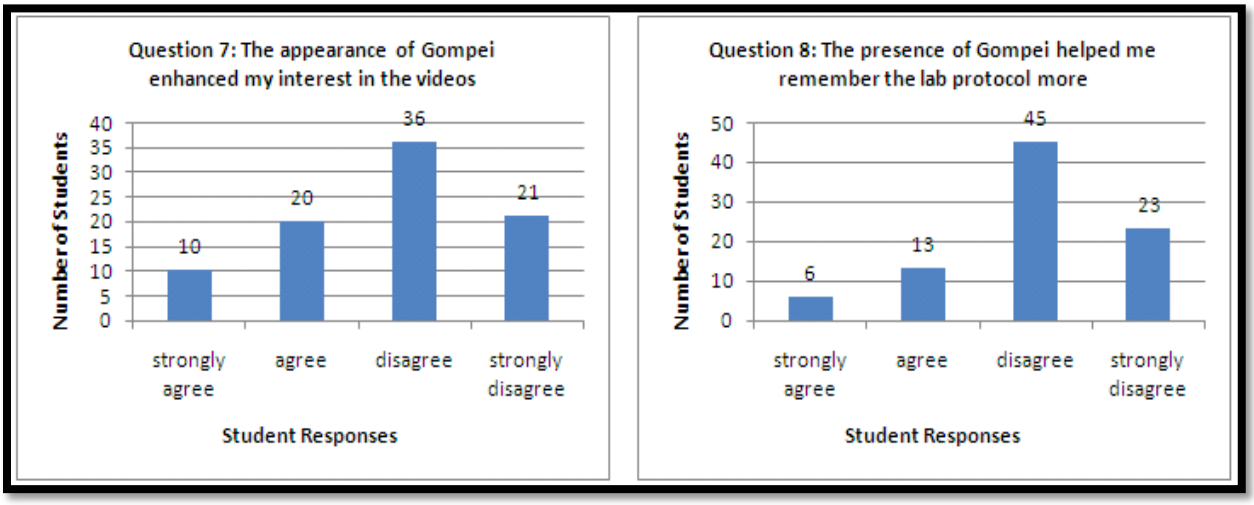


Figure 12: Graphical Responses for Questions 7 and 8

The next group of questions is related to the effectiveness of humor in the videos due to the presence of Gompei. Question 7 asks the students if the appearance of Gompei enhanced their interests in the videos. This question had a wide range of responses. The majority of students (51 out of 87) disagreed or strongly disagreed that Gompei enhanced their interest. However, 30 students (34 %) agreed or strongly agreed to Gompei enhancing their interests in the videos.

Question 8 was intended to find a relation between humor and memory and see if the presence of Gompei helped students remember the lab protocol. Most of the students disagreed with the statement.that the presence of Gompei helped them remember the lab protocol. Only 6 (7.0%) and 13 (15%) of the students strongly agreed and agreed that the presence of Gompei helped them remember the lab protocol more. In contrast, 45 students (52%) disagreed and 23 students (26%) strongly disagreed to remembering the procedure due to Gompei's presence.

Question 15 has various parts and asks students if they have taken other BB290X labs at WPI, which ones they have taken, and if they required less assistance from their TA's after watching the videos than in previous labs. Question 15 A asks students if they had taken other BB290X labs at WPI. For 51 students, BB2903 was not the first biology lab at WPI. For 31 students, this was their first biology lab experience at WPI. For the students who had taken other BB290X labs before, they were asked to list the other BB 290X classes they had taken. 33 students had taken BB2901-Molecular Biology, Microbiology, and Genetics. 27 students had taken BB2902-Enzymes, Proteins, and Purification. 17

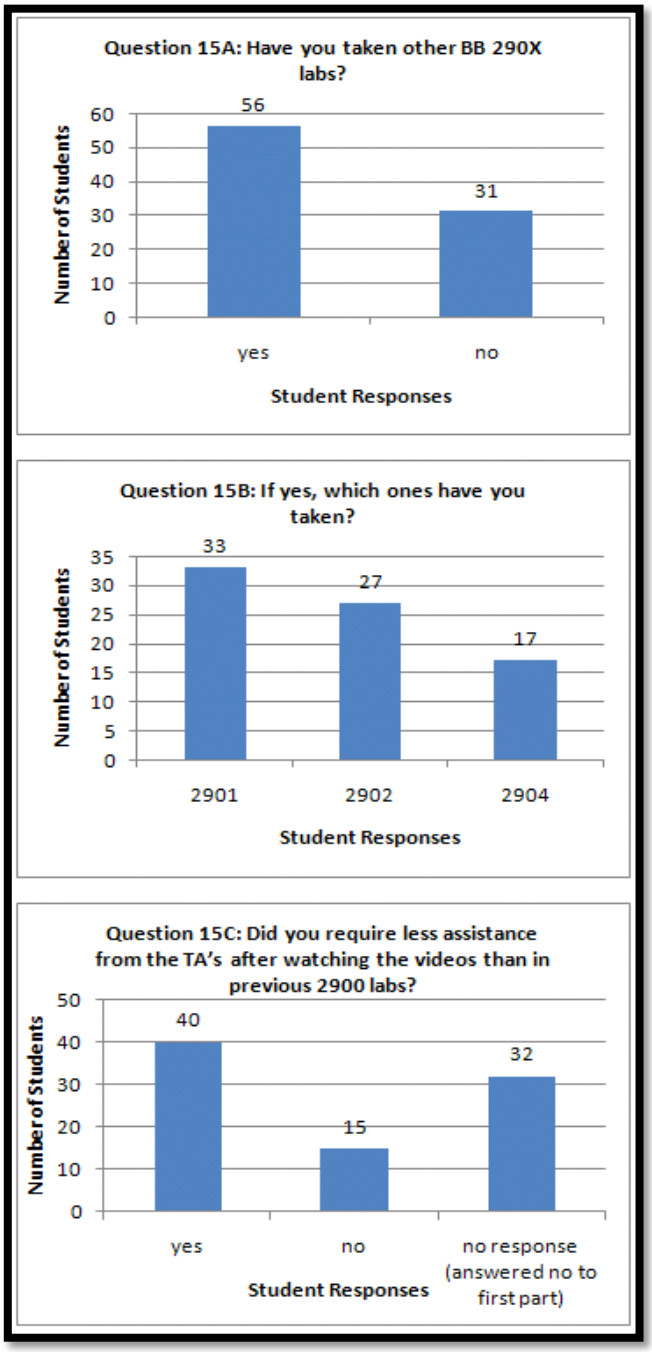
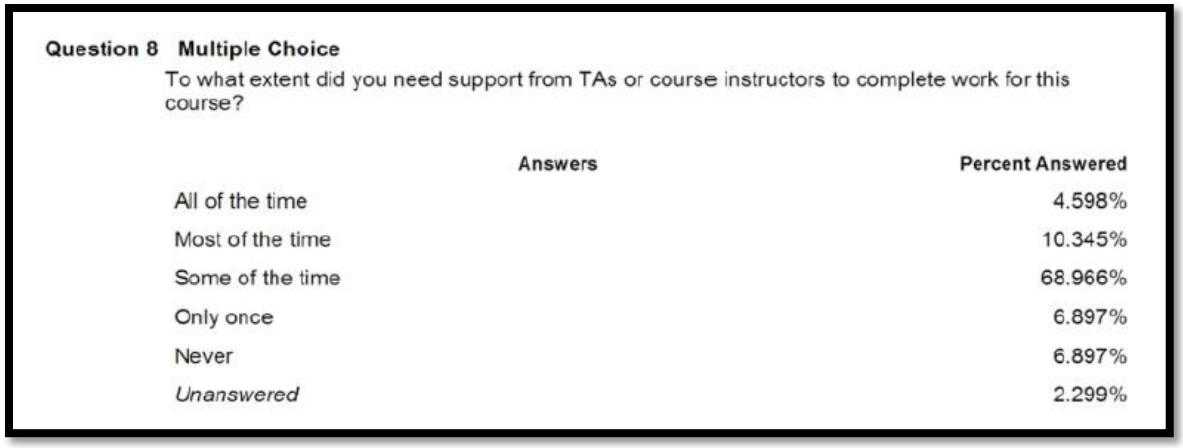


Figure 13: Student Responses for Question 15

students had taken BB 2904- Ecology, Environment, and Animal Behavior. We continued to ask these students if they required less assistance from the teaching assistants after watching the videos than in previous 2900 labs. 40 out of 55 students (73%) felt they needed less help from TA's after watching videos than in previous BB290X labs. 15 (27%) of them felt otherwise.

The following data was taken from the course assessment provided by the professors to the students enrolled in BB2903 C09. The assessment was administered through the myWPI website and received 87 responses. An incentive of ten bonus points to the final grade was offered by the professor for completion of the assessment. Questions relevant to our research are included in the figures below.



Question 8 Multiple Choice

To what extent did you need support from TAs or course instructors to complete work for this course?

Answers	Percent Answered
All of the time	4.598%
Most of the time	10.345%
Some of the time	68.966%
Only once	6.897%
Never	6.897%
Unanswered	2.299%

Figure 14: Student Responses for Question 8 of Assessment Statistics

Question 8 on the Student Assessment Surveys asked students to evaluate the amount of assistance needed from the TA's in order to successfully complete lab procedures. The majority of students (69%) replied that they only needed assistance some of the time, while only 10% of students required assistance most of the time.

Question 11 Multiple Choice

How would you describe the quality of resources other than the TAs or course instructors that were available to you to support your completion of work for the course?

Answers	Percent Answered
High quality	20.69%
Adequate quality	65.517%
Poor quality	9.195%
Not applicable (answered "none" to previous)	3.448%
Unanswered	1.149%

Figure 15: Student Responses for Question 11 of Assessment Statistics

Question 11 on the Student Assessment Surveys asked students to evaluate the quality of materials available to them in order to successfully complete the course. Resources included the lab protocol, links to websites relevant to the lab protocol, and the lab tutorial videos. Students rated these recourses to be of adequate quality (66%) and high quality (21%). A small percentage of students (9.2%) described these resources to be of poor quality.

Question 16 Multiple Choice

Please give your opinion on the value of completing the out-of-class pre-lab to your learning in this course:

Answers	Percent Answered
Not at all valuable	10.345%
Just a little valuable	18.391%
Somewhat valuable	28.736%
Valuable	34.483%
Very valuable	8.046%
Unanswered	0%

Figure 16: Student responses for question 16 of Assessment Survey

Question 16 on the Student Assessment Surveys asked students to state their comprehension of the lab procedure after doing the pre labs. The pre labs required students to watch the videos associated with each lab. Responses for this question varied amongst the students. 8.1% of students rated the pre lab assignments as being very valuable and 35% rated

the pre lab assignments as being valuable. 29, 18, and 10% of students rated the pre lab assignments as being somewhat valuable, just a little valuable, and not at all valuable, respectively.

Question 18 Multiple Choice

Please give your opinion on the value of using videos to your learning in this course:

Answers	Percent Answered
Not at all valuable	5.747%
Just a little valuable	8.046%
Somewhat valuable	19.54%
Valuable	28.736%
Very valuable	37.931%
Unanswered	0%

Figure 17: Student responses for question 18 of Assessment Survey

Question 16 on the Student Assessment Surveys asked students to state opinion on the value of the videos associated with each lab. Responses for this question varied amongst the students. 38% of students rated the videos as being very valuable and 29% rated the videos as being valuable. 20%, 8.1%, and 5.8% of students rated the videos as being somewhat valuable, just a little valuable, and not at all valuable, respectively.

Open-ended questions can both provide incredibly insight and be difficult to interpret. Appendix A shows the responses that were given by the students surveyed in BB2903. Many of the students left portions of the open response, and in some cases the entire open response section, blank. Due to this, it is difficult to extrapolate a response given by one or even a few students into a conclusion for the project. However, for each question in the open-ended portion of the survey, there seem to be some underlying themes common in the responses of the students. In addition there were some singular comments that seem particularly helpful, regardless of the

number of students who responded that way. That seemed especially true in the case of questions where suggestions were requested.

What did you particularly like about the videos?	Responses (#)
Clear and specific procedure / Step by Step	26
Visual Demonstrations were helpful with dissection	15
Thorough and Clear	13
No Response	11
Available Ahead of Time / Prepared for lab	5
Able to follow while doing lab	4

Table 2: Open Ended Question 1

Question 1 of the survey asked, "What did you particularly like about the videos?" The most common response from students who watched the video was that they were very specific and provided a step-by-step reference to accompany the lab protocol.

What did you particularly dislike about the videos?	Responses (#)
No response	23
Length (too long)	19
Nothing	14
Too slow	11
Quality was poor	6
Naming materials took too long	5

Table 3: Open Ended Question 2

Question 2 of the survey asked "What did you particularly dislike about the videos?" There were fewer responses to this question than the previous question. All of the responses are

listed in Appendix A, Table 2. Of the responses, the length of the videos was the most prevalent concern. While many comments spoke primarily of the dissection videos, it was also noted that the introductions of materials for the labs were both too long and unnecessary. The quality of the video did seem to be of some concern as well. Overall there were very few comments that discussed a discontent with the content of the videos, or major issues with playback or formatting. There was also not a single comment that mentioned the videos not being of use, even though some students noted in the other portion of the study that they did not choose to use the video supplements. There were also a sizeable number of students who wrote that they did not dislike anything about the videos.

Do you have any suggestions for future videos?	Responses (#)
No response	36
Nothing	19
Don't list all materials/procedures	4
Separate into sections	3
Keep concise and don't deviate from lab procedure	3
Speed up dissections	3

Table 4: Open Ended Question 3

Question 3 of the survey asked, "Do you have any suggestions for future videos? Is there something you would have liked to see?" Even more students did not respond to this question than was the case for Questions 1 and 2. All of the student's responses are listed in Appendix A, Table 3. Of the students who responded, a majority wrote that nothing should be changed about the videos. For this question, though there were a great many responses that were unique, some of these comments echoed previous statements such as the materials section being long and

unnecessary. Some independent responses that seemed particularly fascinating were the suggestions to standardize the format so that the intro and the conclusion slides look the same from video to video, and to offer several different file formats for download. One student even mentioned in particular putting the videos up as a podcast, which is something in the works for the future. It seems that overall students were satisfied with the videos, but there were some very useful suggestions, and some less realistic ones, such as using smell-o-vision to accompany the video.

Are there any videos you feel would be better understood as an animated video?	Responses (#)
No Answer	40
Prefer actual demonstration	32
Yes (no indication to which)	3

Table 5: Open Ended Question 4

Question 4 of the survey asked, "Are there any videos you feel would be better understood as an animated video? (Or vice versa)" All of the student's responses are listed in Appendix A, Table 4. While a large number of students did not answer this question, a nearly equivalent number of students said that they preferred the actual demonstrations to the animations. This result does not directly reference any hypothesis for this project, but it does suggest that the ways in which the videos were filmed and edited for this project team were successful.

What do you think the video helped more?	Responses (#)
Understanding and retaining material	37
Helped while doing the lab	19
Laboratory reports (procedures)	17
No response	16
All of the above	3
Quizzes	2
Quizzes and Lab Reports	1

Table 6: Open Ended Question 5

Question 5 of the survey asked, "What do you think the video helped more; quizzes, laboratory reports, or understanding and retaining material?" All of the student's responses are listed in Appendix A, Table 5. This question's goal was to address the overall impact of the videos on the students' learning and success in the course. This question has one of the best response rates. A majority of the students who responded noted that the videos helped most in the areas of understanding and retaining the material. An equivalent number of people thought that the videos either helped when actually doing the lab, or helped afterwards with writing the procedural portions of the lab report. Very few people found the videos helpful as a tool for quizzes.

Question 6 Responses	Responses (#)	Percentage
A	42	53%
B	29	36%
C	8	10%
NR	1	1.3%

Table 7: Open Ended Question 6

Question 6 of the survey asked, "What grade do you expect to receive?" All of the student's responses are listed in Appendix A, Table 6. This question had the largest number of responses with only 7 students not responding.

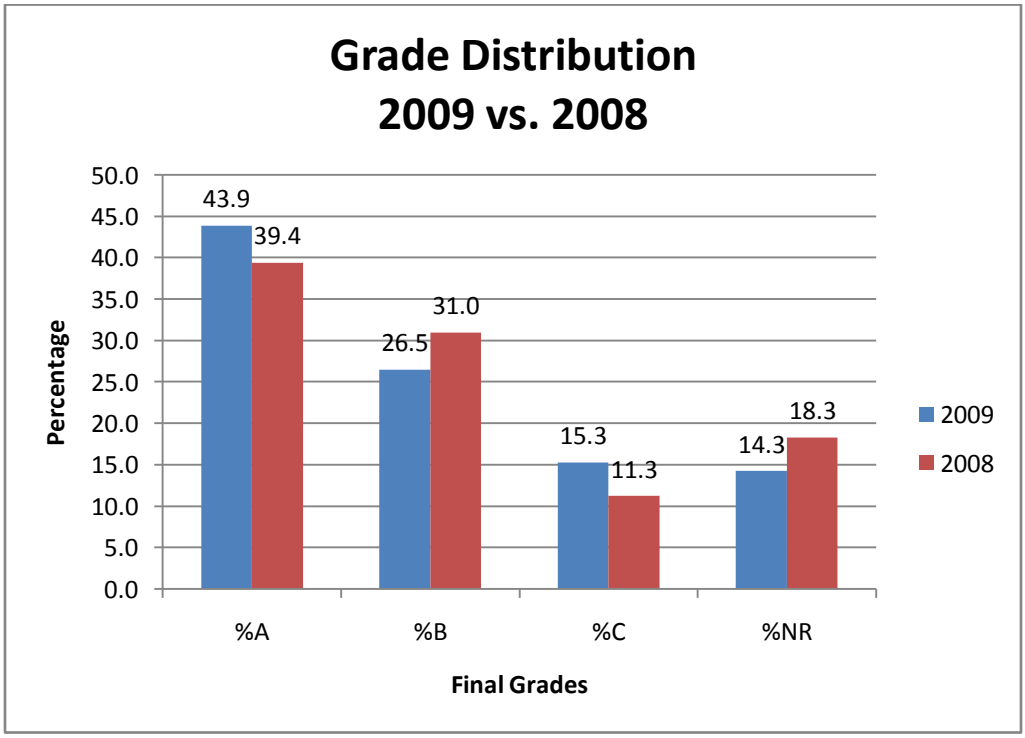


Figure 18: Grade Distribution for BB2903 C08 and C09

This figure compares grades received by students who took the course in 2008 and 2009. In 2009, 4.5% more students received an A in the course. However, there was a 4.5% decrease in the number of B's received in the course and a 4.0% increase in the number of C's. The number of students who failed the class (NR) decreased by 4.0%.

Discussion

Student comprehension of lab material aided by video multimedia was analyzed in this study. A series of tutorial videos were implemented in the BB 2903 Anatomy and Physiology Lab at WPI as a supplement to the lab protocols. In addition to studying the usefulness of the videos, humor was assessed as another method for increasing student retention of material. It was expected was that the videos as a supplement to the protocols would result in an increased understanding of the material performed in lab and humor would help students remember the material. In order to assess the effects of the videos, students were given surveys at the end of the course and questioned about their opinions on the videos, the usefulness of the videos, and their performance in this lab course. The results of the student evaluations indicated a general appreciation for the videos; however, students did not feel that the presence of Gompei enhanced their interest. This may be attributable to the fact that Gompei was only present in three videos and in these videos humor was not substantially incorporated. Due to the absence of adequate humor in the videos, it was not possible to effectively determine the effects of humor on retention of material.

From the evaluations, it is clear that the students were supportive of the inclusions of the videos in this lab course. Figure 10 illustrates that of the students who utilized the videos, there was an overall positive reception. Question 1 shows 51% of the students enrolled in the course took the time to watch the videos prior to coming to lab. In question 9, all but four of the 87 responses indicate that students felt the videos were helpful as a supplement. 85% of the students answering question 10 felt the videos were necessary and 94% of the students wished to see similar videos implemented in other labs at WPI. Figure 16 shows student responses from a course assessment survey given by the professor in which they were asked to evaluate their

comprehension of the lab procedure after doing the pre labs. A part of the pre-lab assignment required them to watch the videos associated with that lab. Although the survey question is not specific to the video portion of the pre lab assignments, 90% of students responded that the pre-labs were valuable. As can be seen in Appendix B, the large number of video hits indicates that students did take the time to watch the videos before lab. However, it cannot be determined if those students who believed the pre-labs to be invaluable actually watched the videos. Figure 17 asks students specifically about their opinions on the videos. Nearly 40% of the students indicated that the videos were very valuable and 95% responded positively to this question. According to Table 2, a large number of comments indicated that the videos were thorough and clear. While it will be noted further in this analysis that students wanted the videos to be shorter, they seem in their responses to this question to respond to a thorough and specific product. Two students remarked that they used the videos as a replacement for reading the protocol. This is always a fear when incorporating multimedia tools such as video into a curriculum. It was a key element of the project that this tool be seen as a supplement to and not a replacement for other components of the course, such as lab protocols and class. In contrast to Table 2, Table 3 asks students about their dislikes of the videos. There was a high prevalence of students not responding to this question or stating that they had no dislikes. Of the few responses, a common dislike of the videos was the length. Remedies to this problem in the future include making the videos shorter and perhaps using more editing tools to shorten repetitive techniques such as pipetting. Despite the few negative comments, the survey results indicate that these video protocols were received with support by the students.

In addition to support of the videos, many students agreed that the videos were useful. The second group of questions, Figure 11, analyzed the students' subjective opinion about the

ability of the videos to confer understanding of the material into the laboratory setting. Question 2 shows that 87% of students felt that the videos aided in the completion of lab assignments, while question 3 shows that 82% of students felt that they retained more information about the lab after watching the videos. Furthermore, 81% of students answering question 4 felt that, after watching the videos, they were more comfortable performing in lab. Students were asked how the videos aided them (Table 6). Responses indicate that the videos were most effective as a learning tool as opposed to just an instructional tool because students frequently responded that the videos helped them understand and retain the material. Very few people found the videos most helpful as a tool for quizzes, since quizzes deal largely with concept and less with procedure. In addition, the responses to the question in table 5 indicate that students preferred video demonstrations as opposed to animations of the procedure. Figure 14 shows that 70% of students only required help some of the time as opposed to all or most of the time. This may be due to the availability of the videos to students during the lab period, and the fact that many students referenced the videos while they were in lab, as was observed by the lab professors and teaching assistants (TA's). Figure 15 illustrates how the students described the quality of the resources other than the TA's and instructors. Other than the videos, students had access to a textual protocol, websites containing related materials, and a reference guide for the fetal pig dissection. Although it cannot be determined specifically to which resources the students were referring, 85% indicated that the resources were of adequate or high quality. This may be attributable to the addition of the videos. These results indicate that the students who utilized the videos generally felt that they gained valuable knowledge from them, and were able to confidently work in the lab.

Some research has indicated that the presence of humor improves student interest and understanding of the material. Figure 12 addresses the presence of Gompei in the videos, in an effort to assess the affect of humor on the learning retention. In question 7, only 34% of students agreed that Gompei enhanced their interest in the videos, and in question 8, only 22% felt that Gompei helped them remember the lab protocol more. These results may indicate that the presence of Gompei, as an icon of humor, did little to add appeal to the videos. However, it is necessary to note that Gompei was only present in three of the twenty five videos provided to the students, and when he was present, it was only for a short period of time. Furthermore, Gompei's contribution to the videos may not have been seen as humorous by the students. Thus, it was determined that the element of humor was not incorporated adequately into the videos, and that it would be necessary to introduce more humor into the videos to come to an appropriate conclusion surrounding its effects. In the open response survey one student suggested that the presence of the instructor in the videos performing something humorous would enhance their interest in the subject (Appendix A, Table 3). Further research on this topic would require a greater analysis of topics that this demographic finds humorous.

In order to evaluate the benefits of having video tutorials for lab procedures, students were asked question regarding their experience in this lab course versus other lab courses. Figure 13 ultimately assessed whether those students who had taken previous 2000-level biology labs felt that they required less assistance from the TAs in this lab, which incorporated video protocols. Of the students who had taken previous labs, 73% of them agreed that they required less help in this lab than in others. However, due to the varied subject matter covered in the three other 2000 level biology labs, it is difficult to attribute this statistic to the presence of the videos. Due to the disparity in the different lab courses, grades from BB2903 in 2008 and 2009 were

compared to determine if the videos had any effect on improving grades. Figure 24 shows the percentage of student who received an A, B, C or No Record (NR). This figure shows promise that the videos were beneficial to students as there is a 4.5% increase in the number of students who received an A, and a 4.0% decrease in the number of students who received an NR. However, there is also a decrease in the number of B's and an increase in the number of C's. This could be due to a number of factors such as students not utilizing the videos as a supplement, variation in the grading by TA's, differences in final grade scaling, and a possible inconsistency in the syllabus of the two years. It is also not feasible to determine the final grades of the student who did and did not watch the videos; thus it is not possible to fully attribute the presence of the videos to the received grades. When comparing the final grades to the grades students expected to receive in the course (Table 7) there is an approximate 10% discrepancy between the actual and expected A's and B's. This may indicate that the presence of videos enhanced student confidence.

This study was on the incorporation of video multimedia into the introductory biology laboratory courses at WPI through the implementation of video protocols. It has given conclusive evidence that the majority of the students enrolled in the course approved of the videos and wished for them to be further incorporated into similar lab courses. However, it is not yet possible to determine the effects of humor on the overall comprehension of the material, as humor was not consistently portrayed in the videos, and many students reported that they did not feel that its presence was beneficial to them. Furthermore, a conclusion cannot be made to determine whether the videos actually had an effect on the students' overall grades, which would be a quantitative determinant of improved student understanding. In order to more effectively assess the effect of humor, a suggestion for future implementation of these videos would be to

include even more humor than was employed in these videos. Also, keeping the humor consistent throughout all videos would make the study reliable. Specifically, in order to properly analyze this, it may be beneficial to develop two identical sets of videos, one set with humor and one without. This would provide for an accurate analysis of the effect of humor on the students opinions, as well as any increased comprehension.

In order to determine the effect of the videos on the overall student grades, it would be necessary to employ a method to keep track of the specific videos that students watched, and compare that to their final grade in the course. However, this is difficult due to confidentiality issues. If a study like this were to be implemented, it would be beneficial to separate the learning groups into three categories: a control group which would be exposed to the traditional course format; a variable group that would be provided with the non-humorous videos; and a variable group that would be provided with the humorous videos. Comparing the distribution of grades between these groups would give the most accurate depiction of which method was most effective. Through the analysis of this study, it is clear that the introduction of video multimedia into the biology laboratory courses at WPI enhanced student interest and comprehension of subject matter, therefore this technology will benefit the education of future generations.

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Appendixes

Appendix A – Responses to Open Ended Questions

Table 1 – Responses to Question 1:

"What did you particularly like about the videos?"

Question 1 Responses	Responses (#)
Clear and specific procedure / Step by Step	26
Visual Demonstrations were helpful with dissection	15
Thorough and Clear	13
No Response	11
Available Ahead of Time / Prepared for lab	5
Able to follow while doing lab	4
Didn't watch any	4
Well Constructed	2
Narration was good	2
Showed what to do and what tools looked like	2
Alternative to reading the lab	2
Well paced	1
Animation	1
Needed TA less	1
Easy to follow	1
Summary at the end was helpful	1
Liked the fact that they just exist	1

Easy to access	1
Good supplement to other materials	1
Nothing	1

Table 2 – Responses to Question 2:

"What did you particularly dislike about the videos?"

Question 2 Responses	Responses (#)
No response	23
Length (too long)	19
Nothing	14
Too slow	11
Quality was poor	6
Naming materials took too long	5
Talked too slow	2
Didn't watch / No opinion	2
Gompei	2
No location of materials	1
Awkward timing	1
Can't skip around easily	1
More detail	1
Some had poor sound quality	1
Trouble loading/playing videos	1
Couldn't follow with dissection book	1

They were in 2D	1

Table 3 – Responses to Question 3:

"Any suggestions for future videos? Something you would have liked to see?"

Question 3 Responses	Responses (#)
No response	36
Nothing	19
Don't list all materials/procedures	4
Separate into sections	3
Keep concise and don't deviate from lab procedure	3
Speed up dissections	3
Better volume control	2
More text to point out key steps	2
Lines for incisions	1
Mike cameo (humorous) with helpful hints	1
Label organs better	1
Podcast	1
Explanation of expected results	1
Close-up shots of more things (i.e. ELISA strips)	1
Spend more time on how to make initial cuts	1
More animations	1
Less monotonous voices	1
Overview at the beginning and recap at the end	1

Better editing	1
Faster	1
More discussion while dissecting	1
Film in smell-o-vision	1
Use a standardized format for the video	1
Have several file formats available to open	1

Table 4 - Responses to Question 4:

"Are there any videos you feel would be better understood as an animated video? (Or vice versa)"

Question 4 Responses	Responses (#)
No Answer	40
Prefer actual demonstration	32
Yes (no indication to which)	3
See what's happening at a molecular level	1
Animated images of wells for ELISA	1
Fetal Pig Dissection	1
Background information on related topics	1
Show what you should see under microscope	1
Animate anything that involves small instruments	1

Table 5 – Responses to Question 5:

"What do you think the video helped more; quizzes, laboratory reports, or understanding and retaining material?"

Question 5 Responses	Responses (#)
Understanding and retaining material	37
Helped while doing the lab	19
Laboratory reports (procedures)	17
No response	16
All of the above	3
Quizzes	2
Quizzes and Lab Reports	1

Table 6 – Responses to Question 6:

"What grade do you expect to receive?"

Question 6 Responses	Responses (#)
A	42
B	29
C	8
No Answer	7
Between A and B	2
NR	1
Don't Know	1

Table 7 – Responses to Question 7:

"Other comments?"

Question 7 Responses	Responses (#)
No Answer	66
No	5
Good Job	1
God help me	1

Appendix B – Video Hits from MyWPI

Table 1 – Hits for the videos filmed and edited for this project.

Video	Hits
Amoeba	457
Dialysis Tubing	298
Diffusion Plates	326
ELISA	223
Euglena	286
Lime water	35
Onion Plasmolysis	191
Phenothalein	36
Potato	277
Safety corner	261
Squamous Cell	267
Spirometer	53
Yeast Budding	250

Table 2 – Hit for the videos filmed and edited for another project group.

Dissection 1	164
Dissection 2	207
Dissection 3	922
Dissection 4	310
Dissection 5	59
Dissection 6	27
Dissection 7	105
Dissection 8	66
Microscope	371
Micropipettors	221
Lab Trash	4
Lab Safety	4

Appendix C - Links to Tutorial Videos

Below are a list of the videos that were provided to the students enrolled in the Anatomy and Physiology Lab.

1) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/amoeba_slides.wmv
2) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/dialysis_tubing.wmv
3) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/diffusion_plates.wmv
4) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/elisa.wmv
5) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/euglena_slide.wmv
6) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/lime water_breath.wmv
7) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/micropipettors.wmv
8) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/onion_plasmolysis.wmv
9) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/phalanges_measurement.wmv
10) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/phenothalein_breath.wmv
11) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/pig_disection.wmv
12) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/potato_staining.wmv
13) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/safety_corner.wmv
14) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/serial_dilutions.wmv
15) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/squamous_cell_stianing.wmv
16) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/using_spirometer.wmv
17) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/yeast_budding.wmv
18) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/general/LabSafety/lab_safety.wmv
19) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/general/Microscopy/using-a-microscope.wmv
20) http://media.wpi.edu/Academics/Depts/Bio/ConnectedLab/BB2903/lab-trash.wmv