Lab Procedure Delivery Method Analysis

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ABSTRACT

Worcester Polytechnic Institute prides itself on the use of laboratories to teach students. The philosophy of WPI, embodied in the school's motto, Lehr und Kunst, theory and practice. Most classes use the same set up, written lab procedure, for their laboratory procedure delivery method; most schools use the same method. This experiment tests three ways of delivering lab procedure: written, video, and streamed. YouTube was used for the video portion and Twitch was used for the streamed portion. The results of the survey showed the video was favored by the students for multiple reasons, including convenience and the ability to re-watch the video. Future directions of this project are testing different video websites and adding other procedure delivery methods.

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INTRODUCTION

Worcester Polytechnic Institute prides itself on the hands on experience that students receive. Labs are one way for the students to receive this experience. Most laboratories use a simple written procedure; the goal of this study is to enhance a student's learning by providing them with the option to use different lab procedures.

Three delivery methods were explored: written, live streamed, and posted video. The live streamed video was shown to students using Twitch. Streaming allows users to watch the video without downloading the video. It starts to play soon after the request is made and the user's computer buffers information in its memory in advance of it being needed (Shephard, 2003). YouTube was used to share a recorded copy of the streamed video to the students.

Research has shown there are different types of learners: auditory, visual, and kinesthetic. Auditory learners would rather listen to things being explained than read about them. Visual learners learn best by looking at graphics, watching a demonstration, or reading. Kinesthetic learners process information best through a "hands-on" experience. Actually doing an activity can be the easiest way for them to learn. The laboratory portion of the course helps the kinesthetic learners. Each student is given a written lab procedure which is helpful for visual learners. The auditory learners would benefit from having a video of their lab procedure, rather than reading the procedure (LearningRx, 2003).

For this reason, many classrooms have been "flipped", which is similar to how this experiment is "flipping" the laboratory. A "flipped" classroom which uses technology outside of the classroom and one-on-one time during the class meeting time creates an environment where students take responsibility for their own learning outside of the classroom (The Daily Riff, 2013). This lab was already partially "flipped" from the beginning. The written laboratory procedure includes short clips of videos showing the lab procedure. This test will be different since it will be one large video showing all of the parts, rather than short bits of some of the lab.

Several studies have evaluated the use of pre-recorded video demonstrations in laboratory courses. Cicciarelli used pre-recorded video demonstrations of laboratory experiments instead of an in-class tutorial to introduce students to various experiments in a chemical engineering lab course. In addition to saving time for both the students and the instructor, this allows students to watch the videos in an "on-demand" setting at their convenience, which is helpful as they prepare lab reports. This approach reduces repetition by the instructor and has been very popular with the students (Cicciarelli, 2013).

Srivastava has also examined students' attitude towards the use of multimedia, videos, in classroom for instruction. The study lays the students' scores between the ranges 10 and 40.

Scores	Interpretation	Attitude
35-40	Strongly Agree	Highly Positive
25-35	Agree	Positive
15-25	Disagree	Negative
10-15	Strongly Disagree	Strongly Negative

Figure 1: Classification of scores and their interpretation.

Students, scores and their attitude towards use of multimedia in classroom- on the basis of student's ratings score for each student was calculated then with the help of figure 2 student's attitude was determined.

Students	Scores	Attitude
17	35-39	Highly Positive
3	28-34	Positive

Figure 2: Shows the student's attitude towards use of multimedia in the classroom.

Out of survey scores for twenty students, 17 were between 35 and 40, and were interpreted as reflecting a highly positive attitude. The remaining three were in the positive range (25-35) . Overall, there were no individual questions that were rated anything less than agree. The average for all twenty questions from all students was midway between 5 "agree' and "strongly agree". Dr. Srivastava's study shows many students like the use of multimedia in the classroom. (Srivastava, 2012)

Another study evaluated the enhancement of student performance in an online introductory astronomy course with video demonstrations. The authors state "We find that students who watched the videos performed better on related exam questions compared to those who did not watch the videos" (Miller & Redman, 2010).

But how is this different from how labs are being put together now at WPI? This class has one lecture a week which covers material necessary for the labs which follow during the week. Most schools have lecture multiple days in a week and a lab once a week or maybe not even at all. The advantage to the way this class is put together is the amount of time spent getting a hands on experience with the material being learned during the lecture before the lab.

This survey differs from many that have been performed in the past. Most have evaluated the use of multimedia in the classroom and others have evaluated the use of others videos in the classroom. This uses both videos that have been created just for the purpose of the class and a live stream that allows students to ask questions and receive quick answers.

METHOD

The class consisted of approximately 71 students in five different sections. Three methods were used to evaluate the best delivery method for lab procedures for Anatomy and Physiology, BB2903.The three methods, written, YouTube, and Twitch, were tested using two different lab sessions: lab 2 (diffusion, osmosis, and dialysis) and lab 6 (ELISA)

Since the students were separated into five sections but there were only three different methods to be tested, students were divided into three semi-even groups.

Twenty-five students were given the written lab procedure. Although all students, regardless of their group assignment were given a written version of the lab procedure, these students were given a newly edited version of the procedures. This version, (see figure 18 in appendix), was more concise and gave step by step directions unlike the original lab which favored paragraph instructions. The idea was to limit the amount of technology used for this method; they were the control group.

The next group, thirty-two students, was provided a live stream video, on Twitch, of the lab procedure, performed by the teaching assistants. Twitch is an online video streaming service. It is a site dedicated to streaming gaming footage, and is therefore geared to work best for gaming. The video was found on WPI_Biology_IQP's channel which was created just for this project. Open Broadcast Software (OBS) was used to set up the stream using the settings given on the OBS website to optimize stream quality. When setting up the sources of video, you right click on the sources box and add the devices you want to show, and where you want them in the scene. You can set up the scene almost any way possible as well as have other scenes you can switch between. For this experiment we only used one scene with the main view, and a secondary view in the corner of the screen to show the teaching assistants (TAs). The stream was able to have both the lab bench and the TAs recorded via a Logitech webcam that was hung from the ventilation hood in the lab and the built in laptop webcam. While the stream was running, OBS was used to record on a separate computer. The computer was running the stream in full screen view. This helps to keep the video for future use. OBS was also able to record the questions that the students asked the teaching assistants. Twitch has a side chat which allowed the students to ask questions and receive instant responses.

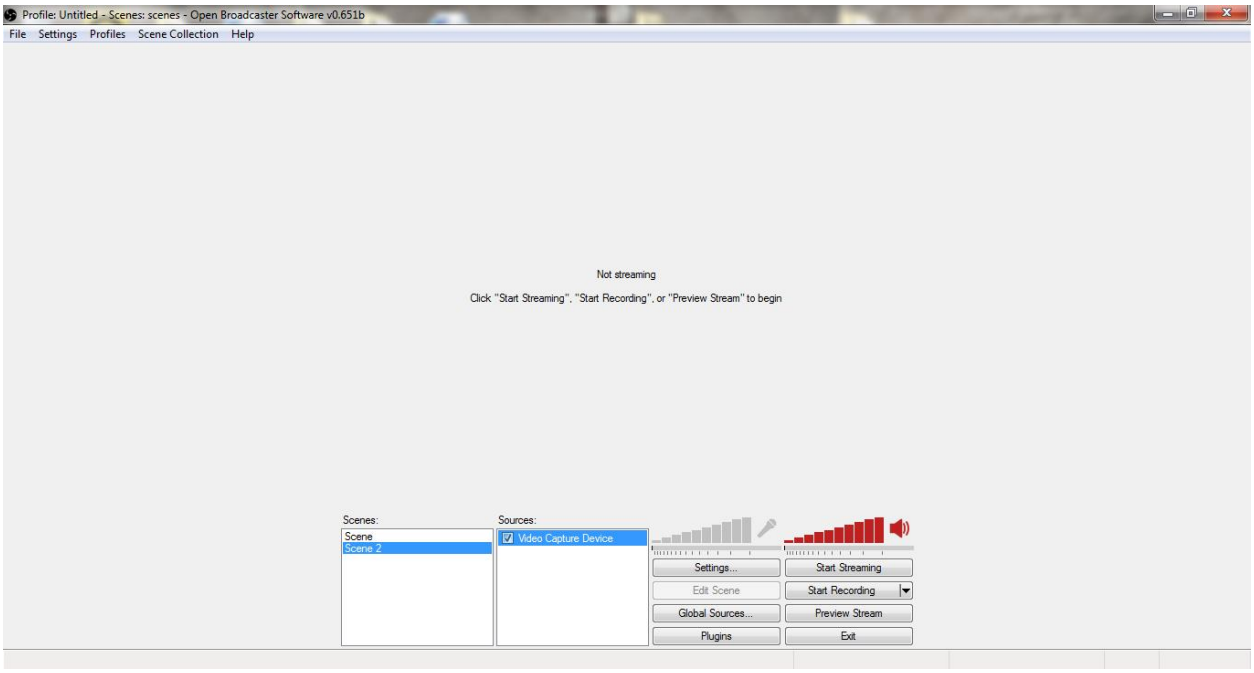


Figure 3: Set up for video recording.

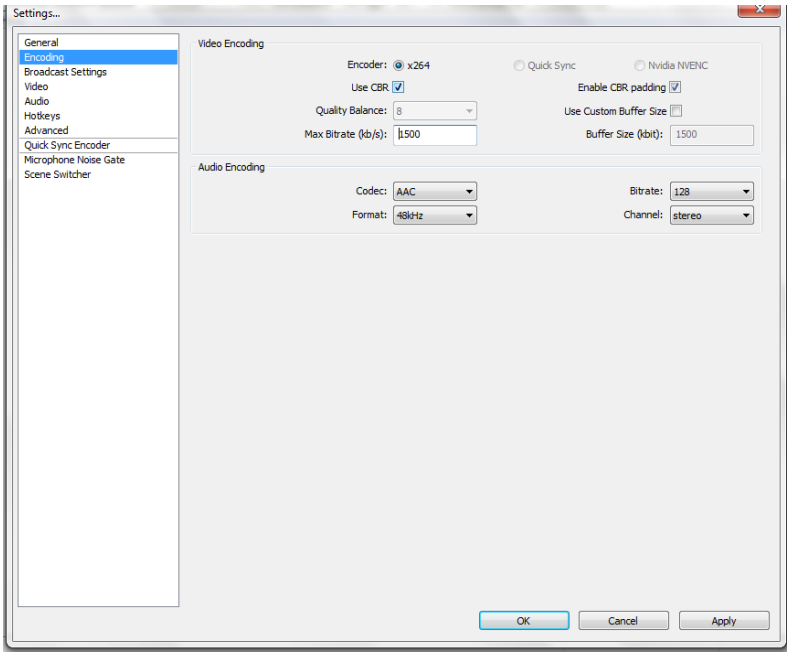


Figure 4: Settings used for Twitch.

Finally, twenty-eight students were provided a video of the lab procedure using YouTube. The video was found on a preexisting channel that had no other contents. The video provided was a recording of the live stream; the students saw exactly what the live stream group saw, along with questions asked by the students. They could also ask their own questions in the comment section of the page, however they could not receive instant answers, they had to wait

till it was convenient for the TAs to go onto the channel and answer their questions. Unfortunately, due to the TAs' schedules, they were never able to answer the posted questions.

After all students completed the lab, a survey was provided to them in order to provide feedback on the three different lab procedure delivery methods, (found in the appendix, figure 21). The survey was delivered through myWPI, WPIs learning management system site, which allows each student access to the survey. It also allowed the students to receive extra credit for answering the survey, without having to give their name so the survey could be anonymous. From the survey results, the experiment was redesigned and tested on lab 6.

In the first trial many student commented that the time for the live stream was not convenient for them. As a result in the second trial, rather than assigning students o predetermined groups, students were allowed to pick which delivery mode they wished to use.

First, the stream was provided to all the students. The link to WPIBiology_IQP and the live stream viewing time was provided to the students three days ahead of time so they could be prepared. The live stream settings were adjusted after receiving comments saying the stream was too choppy to watch, so the max bitrate was changed to 50% of what was recommended. This slightly reduced the quality of the stream, but allowed for a smoother feed.

Those who were unable to tune into the live stream were then provided a link to the YouTube video which was once again a recording of the live stream. There were a few issues with the video recording, where the second laptop for recording the stream was unable to load the stream properly for the first half of the stream, forcing the use of the streaming computer to record as well. Using Movie Studio Platinum 13, the videos were able to be pieced together to make one complete video for the students to watch. It was then the students' choice to watch the video or just use the written lab that was available to everyone. Once the students finished the lab, a survey (found in the appendix, figure 23) was provided to them, through MyWpi, so the success of the three different procedure delivery methods could be analyzed.

RESULTS (LAB 2)

The students were asked an array of questions after they completed lab 2. Each question was used to measure the success of the different lab procedure delivery methods. The first five questions were answered on a Likert ranking scale from strongly disagree to strongly agree. Figure 5 shows the distribution of responses when asked if they felt prepared for the lab. From the graph, you can see most students, from all three sections, felt prepared for the lab. All of the students who used the YouTube procedure either agreed or strongly agreed that they felt prepared for lab. Although there were fewer of them, all of the students who watched the streamed procedure agreed that they felt well prepared. Only students given written procedures provided neutral or negative responses to this question.

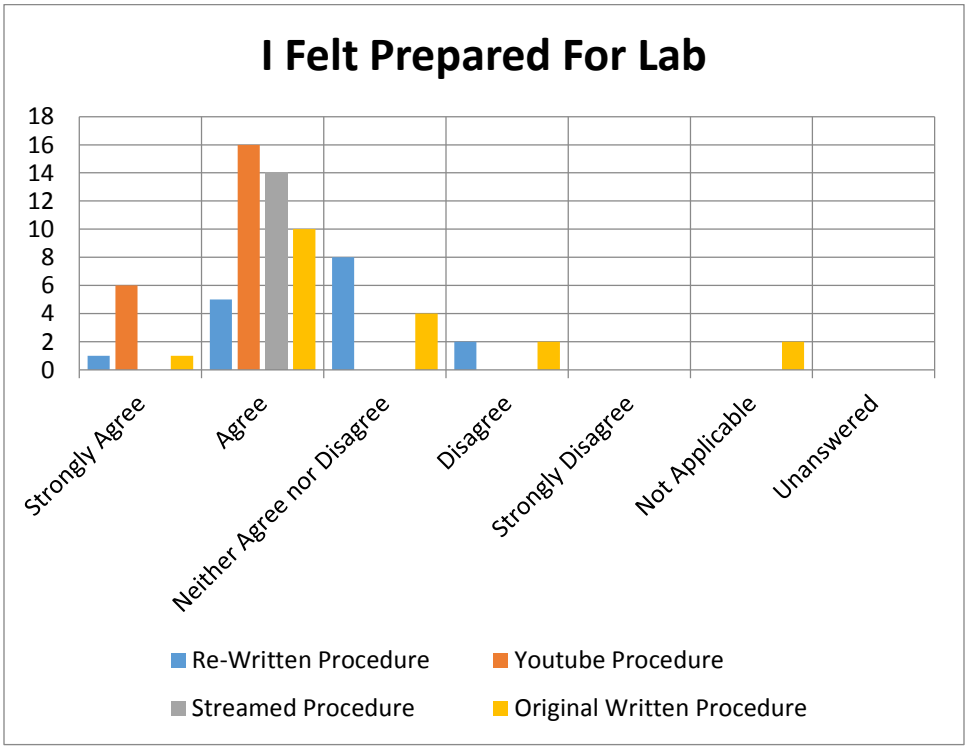


Figure 5: the distribution of how prepared each student felt for the lab.

Many students, 53 out of 71, felt they were able to receive quick answers to the questions (Figure 6). The students who watch the stream were able to receive responses to their questions while watching the video. Those who used the YouTube video could leave comments in the channel where the teaching assistants responded at a later time. This is important to determine since many students have questions about the lab that need to be answered beforehand so they feel prepared. If the students do have a question and they have to wait until lab to get an answer, they are sure to forget the questions. In this regard there is a clear advantage to the streamed session as is evident from the data. As expected students provided only with written procedures gave neutral or negative responses as they had no special access to the TA.

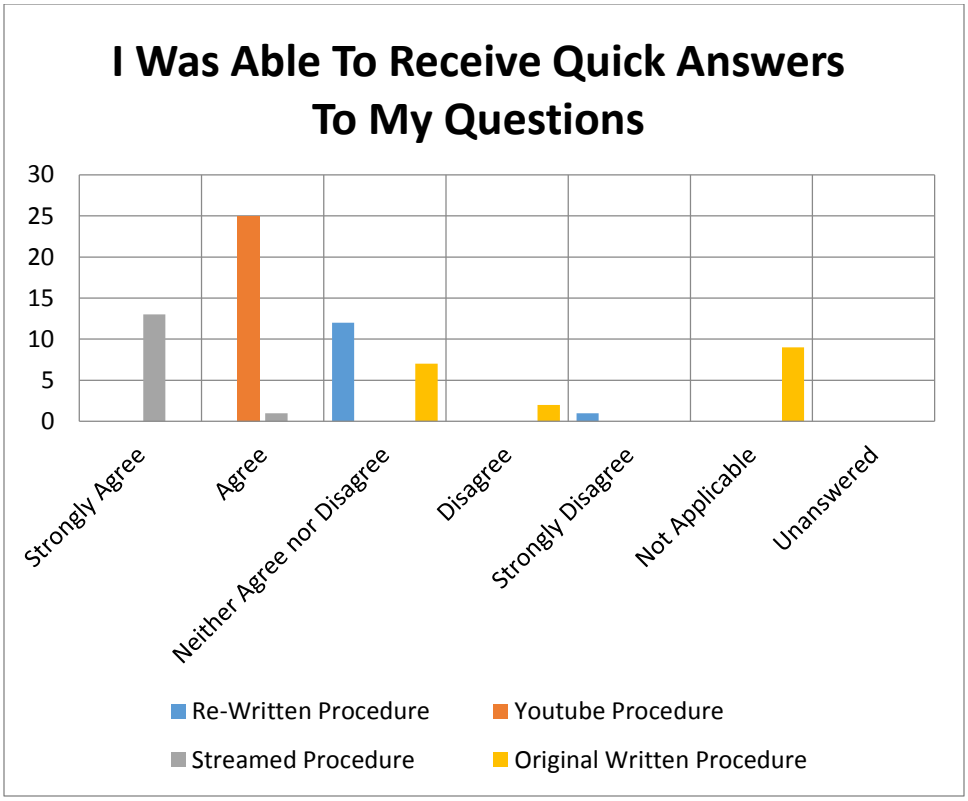


Figure 6: the distribution of how fast the students felt their questions were answered.

The original lab procedure was rewritten which gave the students something to measure the clarity of the lab against (figure 7). Most students thought the original lab procedure was clearly written; therefore the lab was not rewritten for lab 6. Interestingly, the students who watched the live stream provided the only neutral or negative responses to this question, perhaps suggesting that seeing the lab demonstrated "live" gave them a clearer idea of the procedure than the original written version with which they were provided.

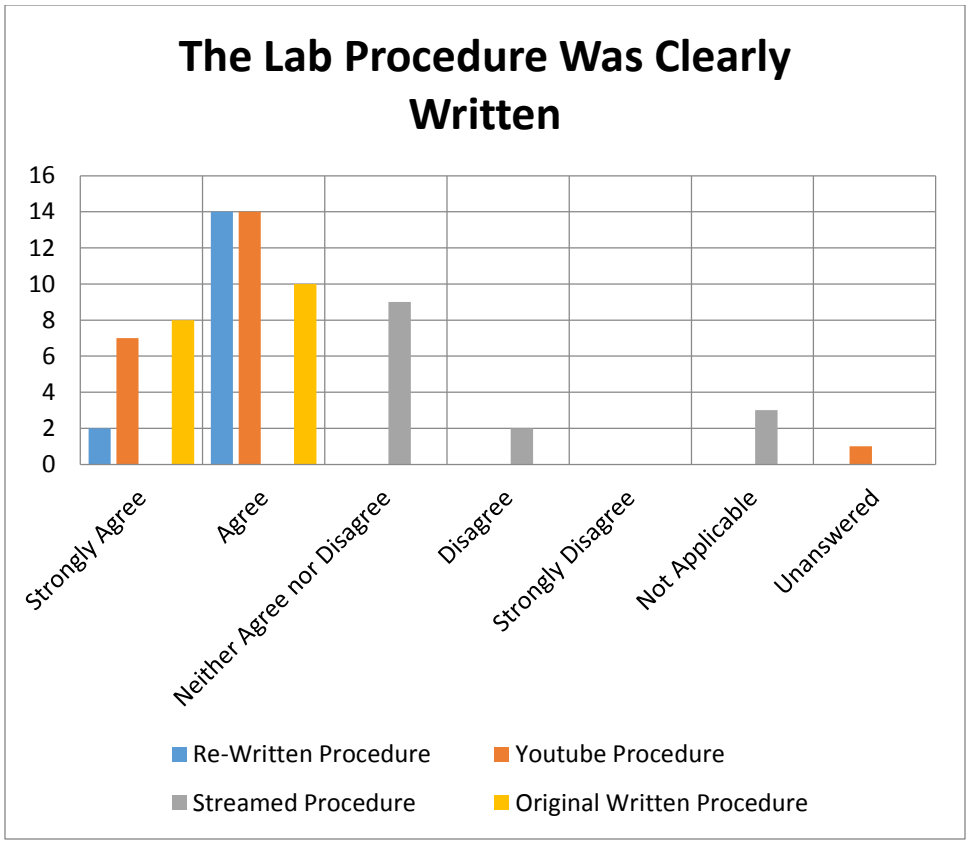


Figure 7: the distribution of how clear the students felt the lab procedure was written.

No matter how well something is prepared, if the student cannot work the technology, it is of no use. The students were asked if they felt comfortable using the technology, over 60% said they either agreed or strongly agreed, as shown in figure 8. Most of the students struggled with the streamed procedure. Many did not realize they needed to create an account to leave comments on Twitch. YouTube did not seem to be a problem for many students since mny have used it before for entertainment and educational purpuses. Those who did have problems, may be the few who do not already own an account, therefore they did not know how to leave comments.

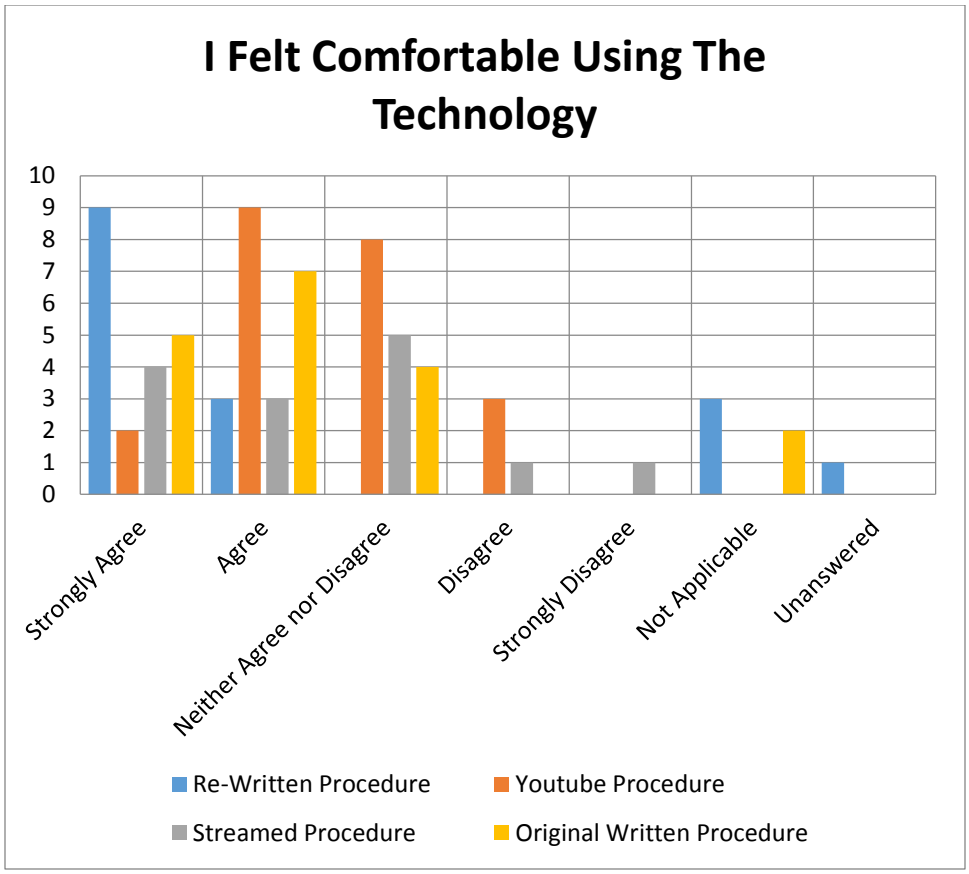


Figure 8: The distribution of how comfortable the students felt using the technology.

To truly see how the students felt about experiment, they were asked if they would want more labs presented in the way in which they received it. Figure 9 shows many of the students would like more YouTube videos such as those provided for these two labs available in the future. Surprisingly, of those who watched the live stream about 40% disagreed or strongly disagreed that they would like more labs presented this way. It is not clear what role the time constraints or the technology might have played in these responses.

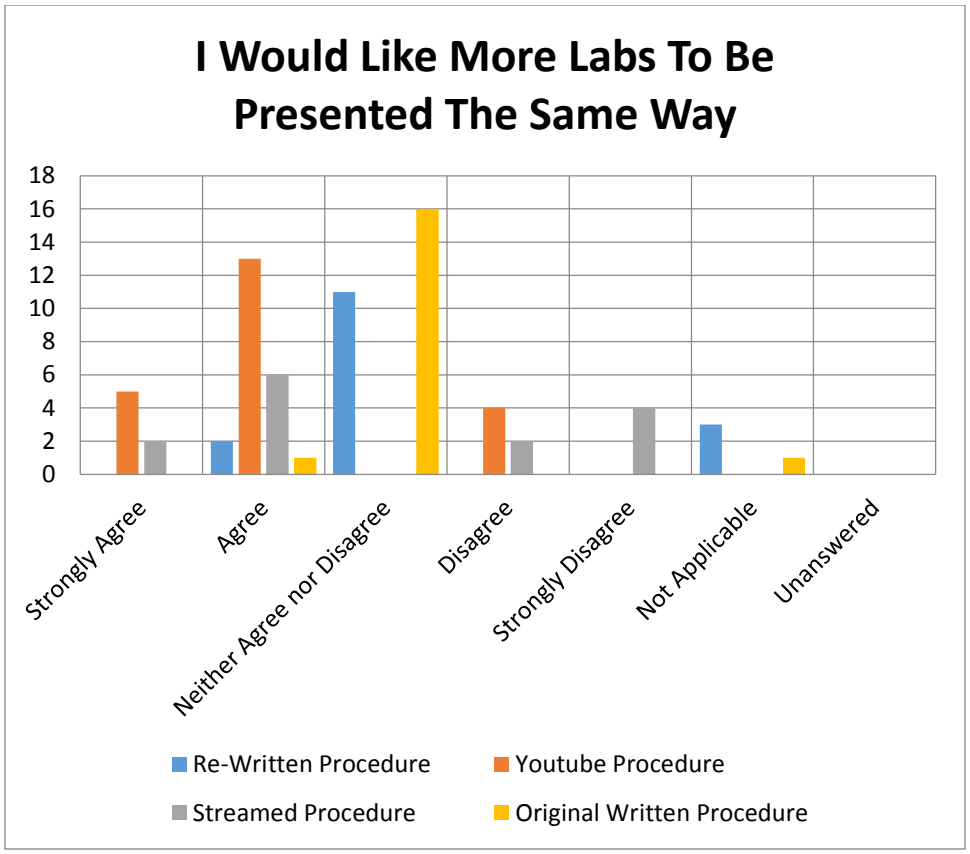


Figure 9: the distribution of students who wishes the lab procedure would be presented in the same way they were provided.

The students were then asked questions to determine which group they were in and whether they had completed this lab before since WPI allows you to retake classes. (Figure 10 and Figure 11)

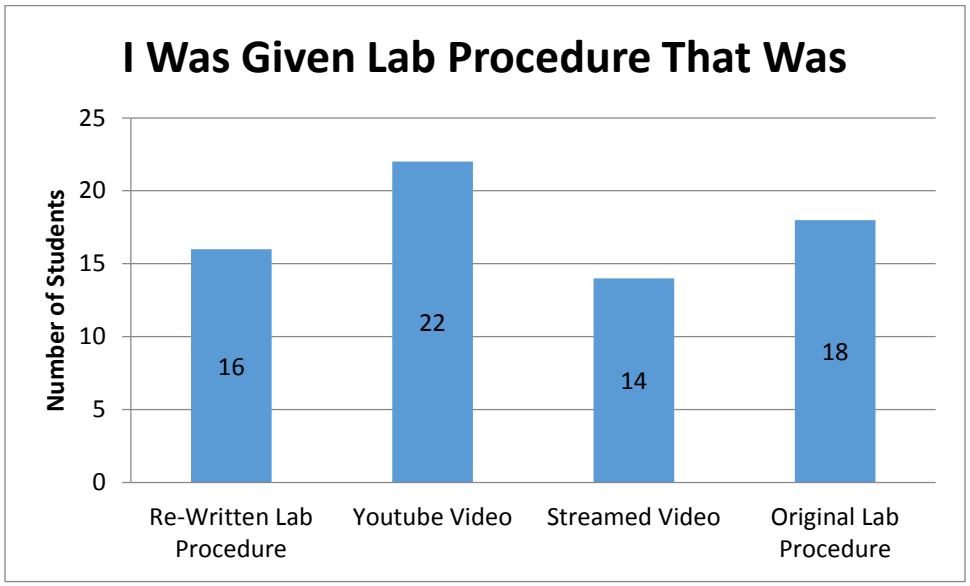


Figure 10: Distribution of students using the different lab procedures provided.

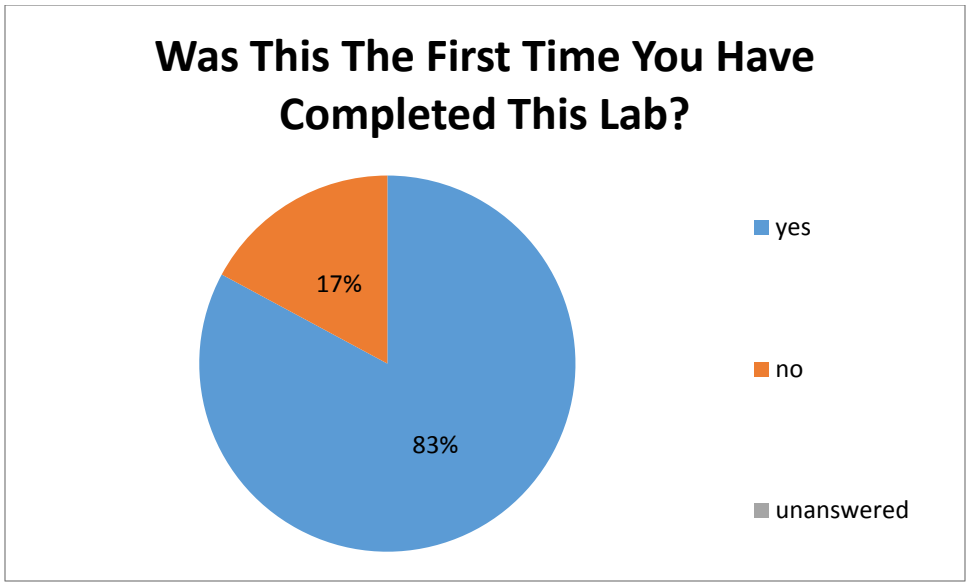


Figure 11: Percent of students who have either completed the lab before and those who have not.

Finally, the students were asked what they would change about the way the lab procedure was delivered (See figure 22 for complete answers). One student responded, "Chronological order with lab safety presented first, followed by notes on which procedures take more time/ can be completed simultaneously. Then, the procedures." This shows that the videos are favored but may need more details.

Additional comments suggested making future lab procedures in YouTube but give instructions on how to create an account for students that do not have one. Another student stated, "Overall, I think the video definitely helped understand the procedure and when I came in the lab, I knew exactly what I was doing better than the first lab." This definitely shows that video of some sort is better than just paper procedures.

After receiving the survey results from lab 2, the procedure was modified for lab 6 as described in Methods.

RESULTS (LAB 6)

Due to the changes that were made, it was hoped that the students would feel better prepared for lab 6 then they did in lab 2. Figure 12 shows 89% of the students felt prepared for the lab.

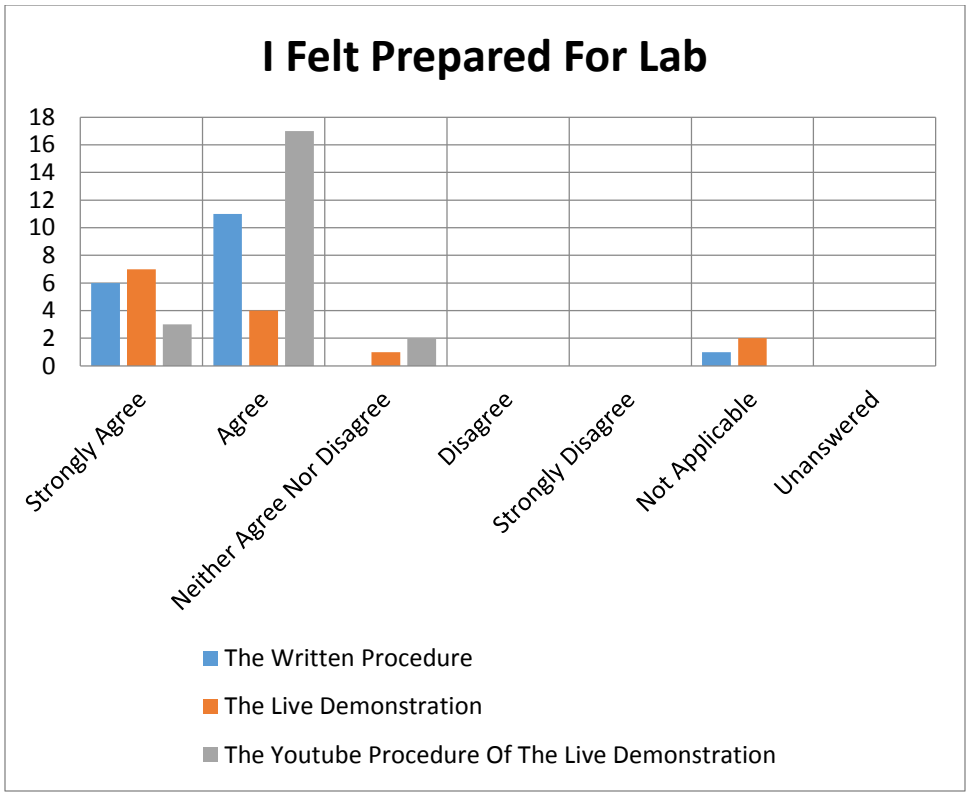


Figure 12: Shows how prepared the students felt for the lab.

Since the students were given a choice of which delivery method they used, the quickness in responses to their questions was evaluated again. Approximately 50% of the students felt their questions were answered in a reasonable amount of time (Figure 13), compared to 71% in figure 6. This drop in percent may be due to more students using the written procedure. Again, none of the students who used the written procedure thought they received answers in a timely manner.

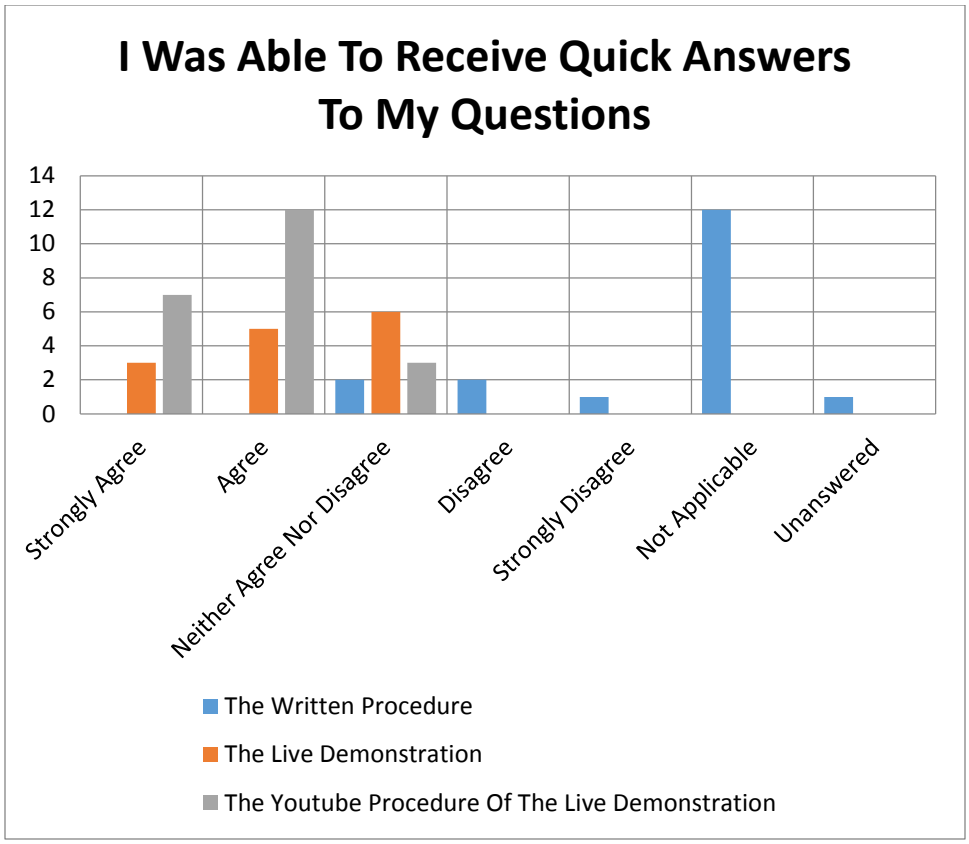


Figure 13: Shows the distribution of how fast the students felt their questions were answered.

From lab 2 to lab 6, changes were made to the process which affected the written procedure. Lab 6 was not rewritten to be step by step but in a paragraph form. Figure 14 shows approximately 80% of the students found the lab procedure was clearly written compared to figure 7 with 75%. This allows one to conclude either written procedure style is clear and usefully for students.

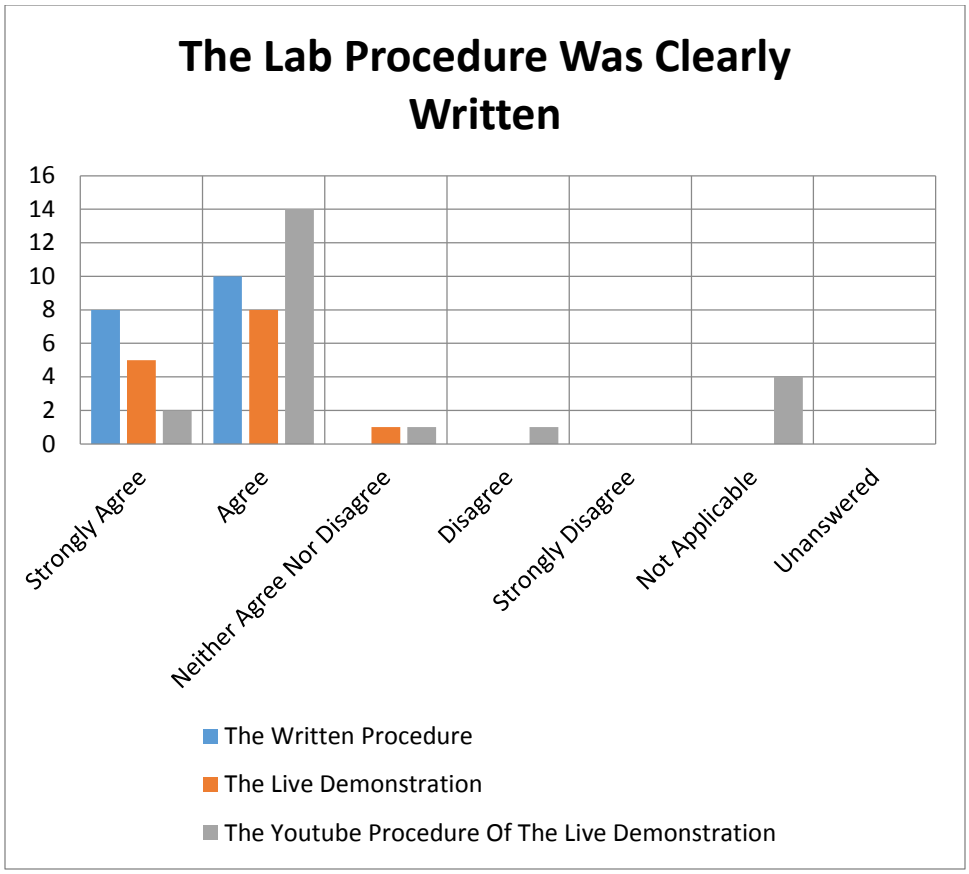


Figure 14: Distribution of the students' feelings on the clarity of the written lab procedure.

No matter how well something is organized, if it cannot be used, it is not usable. To test the ease of use of the technology from lab 2 to lab 6, the students were once again asked how comfortable they felt using the technology. In figure 8 above, approximately 65% of the students felt comfortable using the technology in lab 2. This percentage rose in lab 6 to approximately 80%, shown in figure 15. The most evident difference was in the absence of negative responses by the You Tube or Live Demonstration groups.

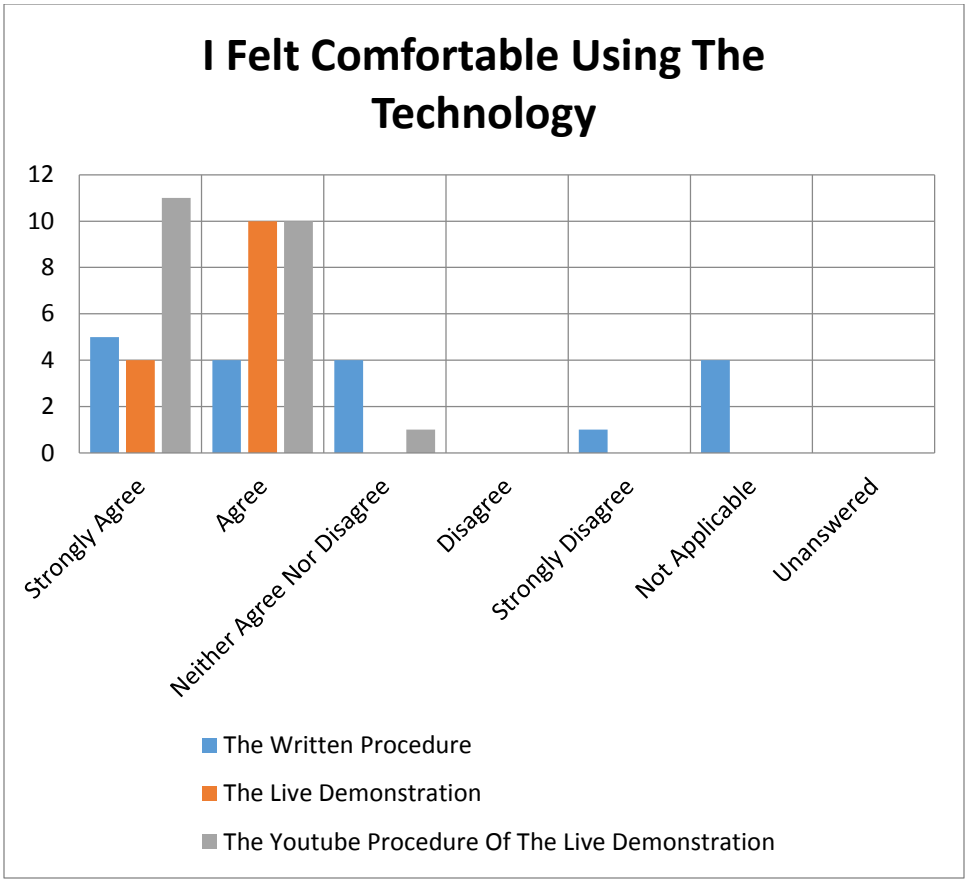


Figure 15: Percentage of students who felt comfortable using the technology.

After running through two experiments that tested different lab procedure delivery methods, the students should have a preference for which method they prefer. Figure 16 shows how many students would like to have more labs presented the same way in which they received in lab 6. Both figure 16 and figure 9 shows 81% of the students who used YouTube as their procedure would like to have it again. 72% of the students would prefer to have the written procedure again and only 43% of the students who used Twitch would like to have it used again.

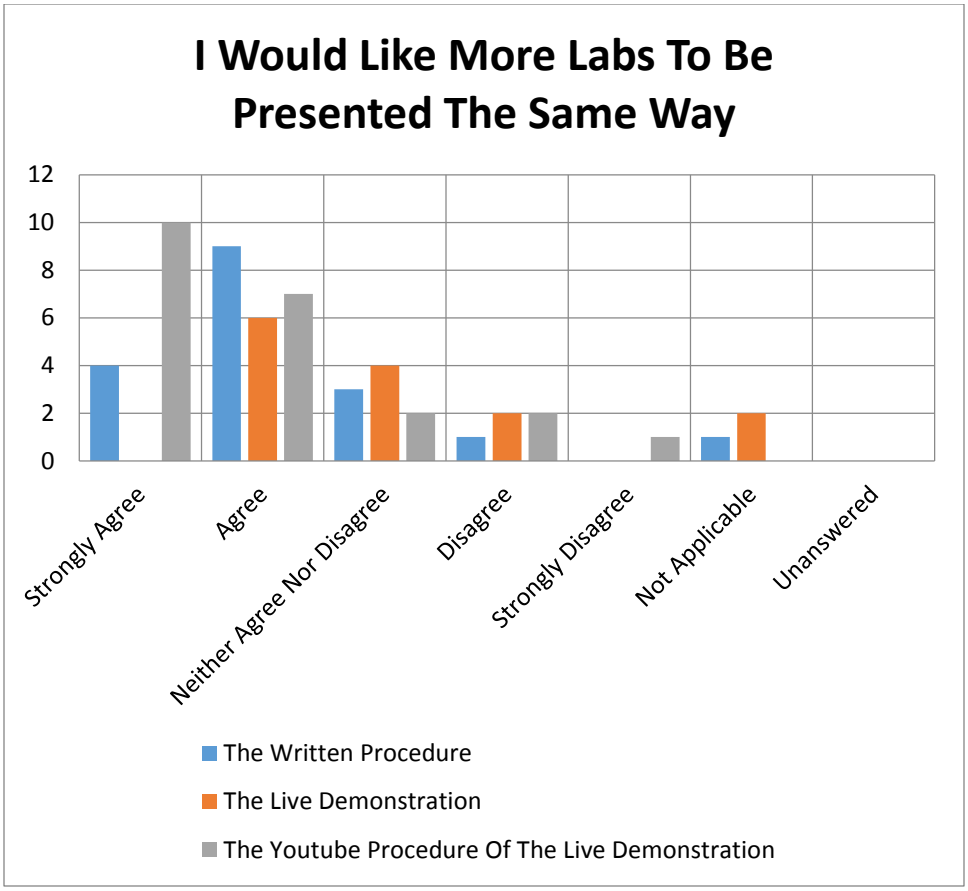


Figure 16: Percentage of students who would like more labs to be presented the same way in which they received it.

The distribution of students using each lab procedure was measured to see which method students chose to use when given a choice. Figure 17 shows approximately half of the students chose to use only written procedure for lab 2. Figure 18 shows 15 of the 54 or 28% of the students chose to use written lab procedure when given a choice. The written lab procedure is definitely the easiest for the students, when it comes to the technology, but is not better in other areas.

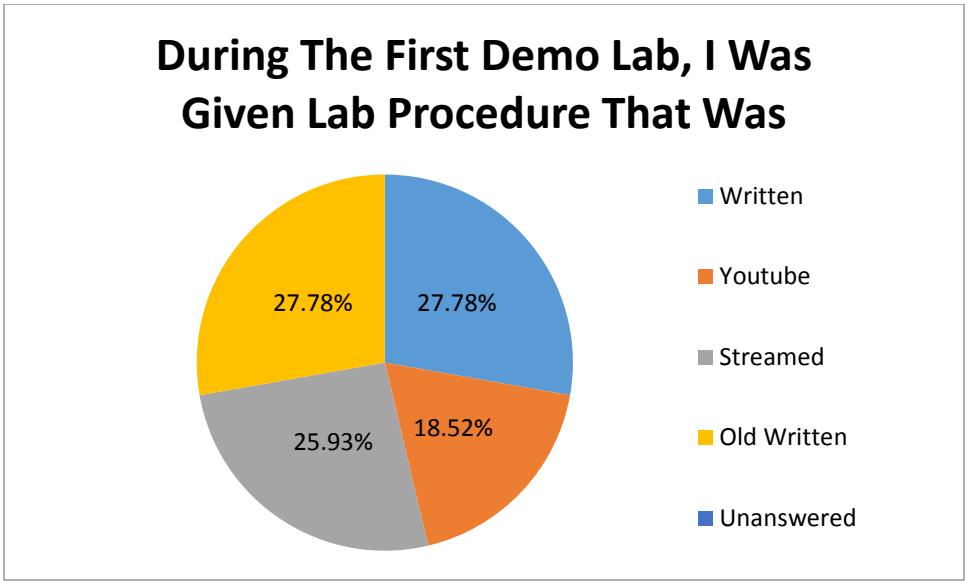


Figure 17: Recap of the percentage of students who received each lab procedure in lab 2.

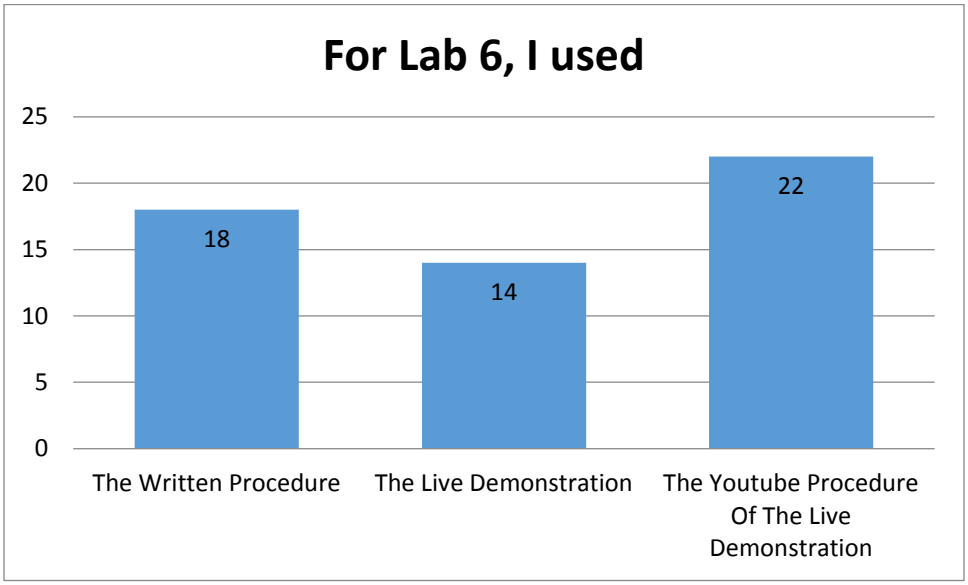


Figure 18: Which lab procedure each student participated in for lab 6.

After completion of the structured questions, students were given an opportunity to leave additional comments. A student commented, "The video demonstration shows a more comprehensive approach. Reading the manual is sort of boring and you have to re-read parts of it, for it to actually make sense. But in the video, you can clearly see what's happening." Their comment reinforces the decision to continue the use of a video of some sort.

Another student thought, "I liked having the live demonstration, it was really beneficial in a sense that I got to see all of the steps required to perform the experiment. It allowed me to complete my labs a lot faster and made it easier to remember and understand because it was as if I did the experiment twice." This student shows how a simple video can make something easier and move faster.

Finally, one student remarked, “I liked the YouTube presentation of the lab procedure. It is much easier to visualize what will occur in lab, when you can see someone use the materials and complete the procedure beforehand. Reading a procedure, for myself, is somewhat pointless, since I am a visual learner, and some terms are unfamiliar to me. It is hard to visualize a procedure when certain substances and tools are unknown to the reader, and therefore are hard to understand.”

DISCUSSION

From knowing the students feel comfortable with both Twitch technology and YouTube technology, both can be viable options. If they did not feel comfortable, then the source would not be helpful. The overall goal was answered by the students in the survey. Like Srivastava's study, many students gave a positive feedback on the overall use of video for lab procedure (Srivastava, 2012). Of the 36 students who used a form of video for lab 6, 23 of them or 64% would like some form of video to be used again. Nearly each student that participated in the YouTube procedure, wanted to use the procedure again. After lab 6, only 3 students did not want to have more labs use videos. Two students did not want written procedure to be used again which shows even though it is common, it is not favored by all. When you group the results from figure 16 into three groups, good, bad, and neutral, you find of the 69.2% of students who had a positive attitude towards the lab procedure they used, 32.7% of them used YouTube (shown in figure 19 below).

Percent of Students	Procedure Used	Attitude Towards Procedure
25%	Written	Positive
11.5%	Live Demonstration	Positive
32.7%	YouTube	Positive
Total = 69.2%		
5.8%	Written	Neutral
7.7%	Live Demonstration	Neutral
3.8%	YouTube	Neutral
Total = 17.3%		
3.8%	Written	Negative
3.8%	Live Demonstration	Negative
5.8%	YouTube	Negative
Total = 13.5%		

Figure 19: Grouping results from figure 14 into their attitude.

When the students were asked why the chose the procedure they did for lab 6 and how they felt about it, many gave positive responses for the YouTube procedure. One student stated, "I liked the way the procedure was delivered by YouTube. The two camera views were useful. The link is accessible at all times. By having a YouTube video and a lab procedure, it solidifies the procedure for all types of learners." Another gave a suggest on what they thought would make the written better but also stated what they liked about the videos. "Pictures of the set up always help. The YouTube videos are also nice because if there's a part I am having trouble understanding, I can rewind and watch again." This student's comment is similar to Cicciarelli's findings. He suggested the videos allowed students an "on-demand" setting (Cicciarelli, 2013). Like this student, "I can pause the YouTube video and review sections I may not have understood. Also, I like having written directions when doing labs," many liked the ability to match the written procedure and the videos together. Finally, a student stated, "Having an actual

demonstration that could be viewed at any time was a great way to prepare. Rather than just being able to read the procedures, I could see how they worked and prepare for how I would organize my time in lab." Having the video run completely together, rather than in multiple small videos, allowed the student to see which parts should be completed in which order to optimize time.

After taking into account all of the results from lab 2 and lab 6, it would be recommended future labs use YouTube to deliver lab procedure. Figures 9 and 16 show which procedure the students would like to receive in the future. Both of these figures favor the use of YouTube. This does not necessarily be YouTube needs to be used but a similar format. The ideal lab delivery method would be a video that is available over an extended period of time and can be watched many times; it allows the student to watch the video when they have time rather than having a set time they must be available to watch the video.

This suggests the background information presented in the introduction is accurate. The auditory learners can benefit from listening to the videos, the visual learns can benefit from reading the written procedures, and the kinesthetic learns will benefit from the laboratory portion of the class. (LearningRx, 2003)

The current labs offer the students videos of almost every part of the lab, which makes it partially a "flipped" classroom. Each lab provided the link which the student must then copy and paste to their internet browser. The video is then downloaded to their computer and played. The advantage to this over YouTube is the ability to show exactly what you need for each part and keep the procedures in the same order as shown in the paper. These videos also have disadvantages. Since the videos are downloaded to video, the student must have the room to download the video and the internet space since WPI limits the amount you can download in a day and in a week. It also requires the student to have the ability to view these types of videos on their computer. If the computer is a custom build, they may not have the required software. The YouTube videos allow a student to view the video without having to download the video or software. The video would also be updated each term which allows the students to be familiar with the person showing the procedure. Since the videos are being taped each term, the video will be up to date on any changed procedure or equipment. Finally, since the teaching assistants are the ones in charge of the video, they can give personal insight on what they have learned about each lab through the terms in which they have helped with the lab. This may consist on what to do first, not just following the procedure, or any tricks to getting something to work. Overall, the YouTube videos are more personable which helps the students feel comfortable watching the video.

Future work is recommended for this project. One option is to find another streaming website that is suited for academic use. Twitch was made for streaming video games; the website only allows the videos to remain on the site for 14 days. Ideally, you would like a website that would allow the videos to stay up for the 7 weeks in which the course lasts. This way the students can watch the videos again before finals in case they need a refresher on what they learned in lab.

Also, creating a YouTube account made specifically for the class or the subject is recommended. This allows the videos to remain in use for many years without worrying about the student who holds the account graduating and ending the account, which will happen now.

Additional work could include further testing between the use of a YouTube video and the videos already provided with the lab. It would be interesting to see the responses between the two different video types. YouTube allows for one straight video on all of the procedure where the videos are broken up to contain easy section. It would also be useful to test what kind of learners each student is, to see if it matches the preferred lab procedure.

Another possibility for future use would be to schedule the Twitch stream as a part of the class. You could have an hour scheduled for a lab procedure stream and the lecture after, in person. Or the lecture could also be a part of the stream.

BIBLIOGRAPHY

Cicciarelli, B. A. (2013, Spr). Use of Pre-Recorded Video Demonstrations in Laboratory Courses. *Chemical Engineering Education*, 133-136.

LearningRx. (2003). Retrieved April 25, 2015, from Types of Learning Styles: http://www.learningrx.com/types-of-learning-styles-faq.htm

Miller, S. T., & Redman, S. L. (2010). Enhancing Student Performance in an Online Introductory Astronomy Course with Video Demonstrations. *Astronomy Edication Review*, 9.

Shephard, K. (2003). Questioning, promoting and evaluating the use of streaming video to support student learning. *British Journal of Educational Technology, 34*(3), 295-308.

Srivastava, S. (2012). A Study of Multimedia & its Impact on Student's Attitude. *Technology Enhanced Education*, 1-5.

The Daily Riff. (2013, July 9). Retrieved April 24, 2015, from The Flipped Class: Myths vs. Reality: http://www.thedailyriff.com/articles/the-flipped-class-conversation-689.php

APPENDIX

Procedures:

Diffusion: visualizing the rate of diffusion and its dependence on MW

Part I: Diffusion of Solutes Suspended in Liquid

Introduction: The solidified agar is known as a colloid; the agar molecules give the matrix structure but the water between the agar molecules still behaves as liquid water. Today we will think of the agar as water that is easy to handle. We will do three different experiments on the same agar plate: the diffusion of silver cation relative to a chloride anion, silver cation relative to a bromide anion, and silver cation relative to a ferricyanide anion.

1. Obtain a plate containing 2% Agar
2. Make 4 holes in the plate
    A. Set the plate on a plastic lid with a dot in the middle and a ring drawn around it
    B. Use an upside down 5ml pipette to cut holes (*Center hole goes at the dot, other 3 should be placed roughly equidistantly around the ring)
    C. Use suction to remove the agar if it does not come off with the pipette
    D. *See Figure 1 for example of hole arrangement
3. Label the plate so you will know which hole has which solution
    A. *You may label directly on the bottom of the plate, include your initials
    B. *Figure 1 shows how the finished plate should look
4. Place a drop or two of 1M silver nitrate in the center hole
    A. *You can fill the hole but do not overflow it
5. Place a drop of two of potassium bromide, potassium ferricyanide, and sodium chloride into their appropriate holes
    A. *You can fill the hole but do not overflow it

Notes: When each of these three diffusing compounds collides with the diffusing silver nitrate, a precipitate is formed (You will see this collision as a distinct, sharp line perpendicular to the line between the two wells). This diffusion takes a while, so continue on with the other experiments in the handout. It may not react by the time lab is done; if this is the case, come back and check it over the next few days. Be sure to draw a representation of your experiment and label the distances to the line of precipitation for your lab report. It may be possible to scan or photocopy you plate for a direct representation. Give it a try. You can also try taking a picture of it. When you are finished with your plate, place it in the labeled bin under the hood. These plate are considered chemical waste because of the heavy metals used and must be disposed of properly. Place them in the designated hazardous waste bin.

Part II: Diffusion of Solids

1. Obtain a plate containing 2% Agar
2. Mark the back of the plate with two dots about 5cm apart
    A. Label one dot potassium permanganate and the other malachite green
3. Remove a few crystals of each of these chemicals from the stock bottles
    A. *Use a cotton applicator or tooth pick
    B. Place the crystals on the dots
4. Place your plate in the designated areas, keeping crystals upright

Notes: The chemicals will begin to diffuse in the agar and create a halo of color. Observe the size of this halo. You will probably need to wait a day or two. Measure the radii or diameters of the halos after 24 or 48 hours and record that. Be sure to make a representative drawing of your results. As with diffusion part I you can also take a picture of your plate. When you are finished with your plate, deposit it in the appropriate waste bin.

Osmosis

Part I: Effect of Solute Concentration on Rate of Osmosis

Introduction: The rate at which osmosis occurs is a function of the **tonicity** of the cytoplasm of the cell and of the extracellular fluid. Artificial membranes can be used to determine the effect of varying the tonicity of fluid inside a differentially permeable membrane on osmosis. In this experiment you will look at the effect of different solute concentrations and their locations on osmosis. You will be using dialysis tubing as an artificial membrane in these determinations. Follow Figures 3 & 4 for the setup of this test. You will be collecting your data and recording it in Table 1. Just like last week you will not only be recording it in your own table but at the same time you will be uploading your data into class data base using google docs. You will then use the section and class data in your lab report to see what statistics tells you about your data and what the effects of analyzing different numbers of data points are on the believability of your data. Be sure to follow the instructions carefully for inputting your data and if you have a question about it please ask your instructor or TAs. We will only be collecting data for the change in weight from bags 2-5.

Figure 3:

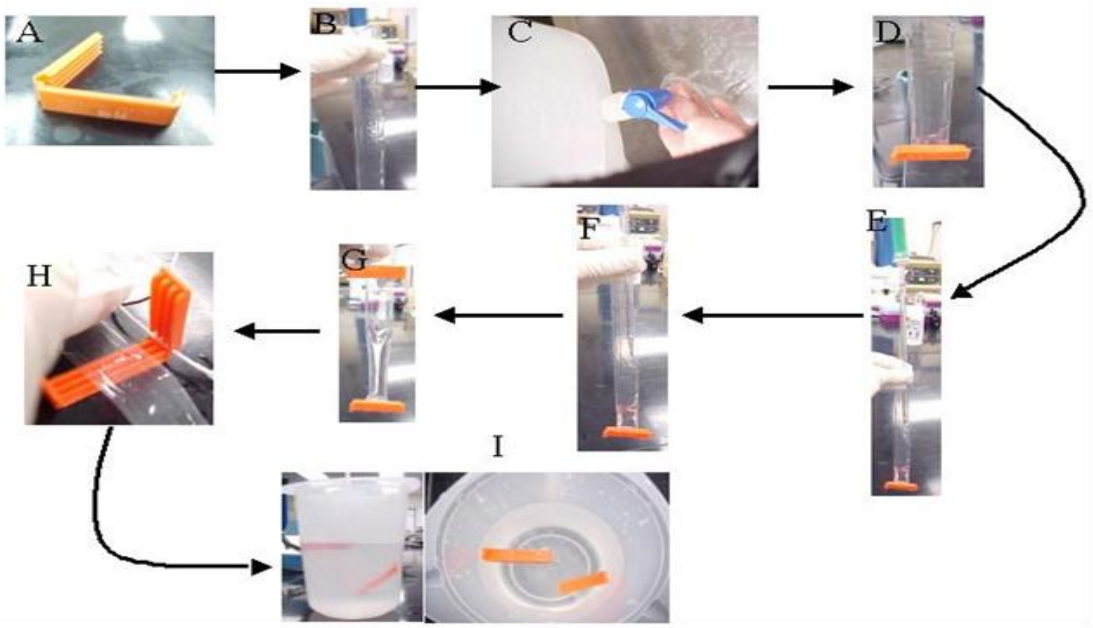


Figure 4:

Bag #	1	2	3	4	5
Bag Content	water	1% sucrose	20% sucrose	40% sucrose	20% Sucrose
Beaker Content	10%sucrose	water	water	water	water

1. Remove a piece of dialysis tubing from the storage beaker
    A. Fig 3, Panel B
    B. *Wear gloves
    C. *Never let the tube dry out
2. Rinse tubing with distilled water
    A. Fig 3, Panel C
3. Clamp one end leaving a little extra extending from the clam
    A. Fig 3, Panel D
4. Use a 5 or 10ml pipet to add 5ml of the appropriate solution to each bag
    A. Fig 3, Panel E & F
    B. The bag should not be more than ½ full
    C. If bag is more than ½ full, ask TA for help
5. Remove the excess air by gently squeezing the tube at the liquid level and sliding your fingers upward all the way to the top of the bag
6. Without letting go, clamp the open top end just under your fingers
    A. Fig 3, Panel G
    B. This should leave room for expansion between the liquid and the clamp but not air
    C. The bag should not be tight at this point, except bag 5
7. Place the completed dialysis tubing setup on a clean paper towel
8. Continue to fill the remainder of the tubes
    A. Label the bags, do not write on the clips
9. Fill the tubes one at a time with the appropriate solution
    A. Fig 4
    B. Bag 1: Tap Water
    C. Bag 2: 1% Sucrose Solution
    D. Bag 3: 20% Sucrose Solution
    E. Bag 4: 40% Sucrose Solution
    F. Bag 5: 20% Sucrose Solution
10. For bag 5, instead of squeezing out the air, place the second clamp right at the liquid level

in the tube

A. The bag should be firm, like stuffed sausage

11. Gently wipe each bag dry
12. Weigh it to the nearest 0.1g
13. Record the weights in Table 1 at time zero
    A. Put all bags into their beakers at the same time
    B. Or keep track of the time each went in

Table 1	Bag #1		Bag #2		Bag #3		Bag #4		Bag #5	
Time (minutes)	Weight (g)	Δ wt From **t=0**	Weight (g)	Δ wt From **t=0**	Weight (g)	Δ wt From **t=0**	Weight (g)	Δ wt From **t=0**	Weight (g)	Δ wt From **t=0**
0		0		0		0		0		0
15										
30										
45										
60										

14. Bags can be placed in individual 1 L beakers of the appropriate solution
    A. Or bags 2-4 can be placed in a single 4L beaker of water
    B. Fig 3, Panel I
15. Place bag 1 in a beaker of 10% Sucrose solution
16. At 15-minute intervals, for 60 minutes, remove all bags from the beakers
    A. Carefully wipe off all water and weigh the bags
    B. First put a large weigh boat on the scale
    C. Then zero the balance
    D. Add the bag and determine weight
    E. Record data in Table 1
    F. Return all to the beaker
17. You need to enter your data into the class data table too
    A. Use google docs
    B. Enter a total of 16 data points
    C. Enter the data as soon as you have completed each trial
    D. See appendix I if you don't know how to use google docs

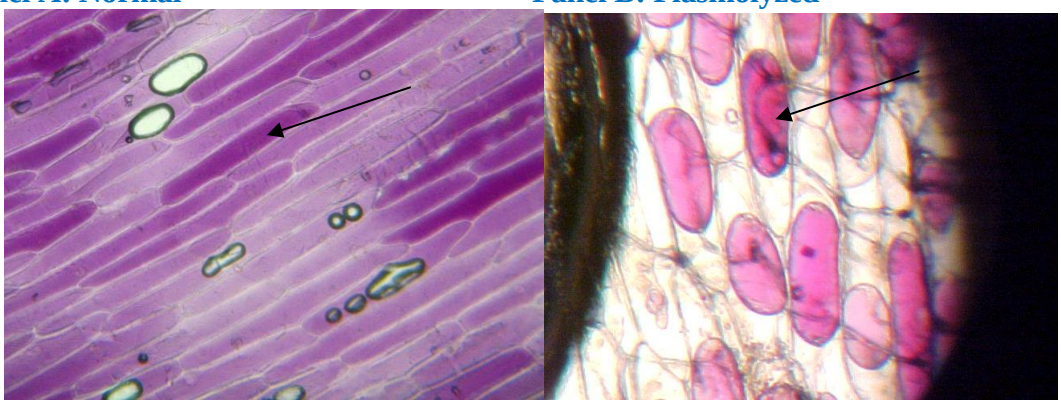
Plasmolysis in Onion Cells

Introduction: Plant cells have tough cellulose walls outside their plasma membrane. As water enters the cell through this porous wall by osmosis, pressure builds up inside the wall until there is no more net entry of water (osmotic pressure outside and inside the cell are in equilibrium). In highly solute-concentrated environments, however, water can also leave the cell through osmosis, resulting in shrinkage of the cell away from the cell wall. This shrinkage is termed **plasmolysis**. In a red onion, most of the cell volume is a large vacuole that contains the red onion's pigment, anthocyanin. As the cell and its associated vacuole shrink during plasmolysis, it is possible to observe this effect as an increase in concentration of red pigment toward the center of the cell.

1. Peel a thin portion off one of the red onion bulb leaves with a razor blade
2. Once you have the cut started and without removing the blade
    A. Hold the onion onto the blade with your finger
    B. Gently tear the tissue the rest of the way off
    C. If you are unsure how to accomplish this, ask the TA
3. Place a section of the peeled onion on a slide
4. Add a drop of water and a coverslip
5. Examine under low, then medium magnification until you find an area where you can clearly see individual pigment cells
    A. You will hopefully see something similar to Figure 5 below
    B. Arrows indicates a pigment vacuoles

Figure 5:

Panel A: Normal **Panel B: Plasmolyzed**



6. Draw a drop of plasmolyzing solution (0.5 M solution of KNO_3 and $CaCl_2$) under the coverslip using the staining technique you developed in the last lab
    A. While observing, check cells under the scope
7. After a brief period of observation, attempt to deplasmolyze the cell by drawing water under the coverslip
8. Record your observations of the plasmolysis and deplasmolysis by drawing the "before and after" cells
    A. Be sure to label your drawing

Process of Dialysis

Dialysis: is the net movement of solute from an area of higher concentration to an area of lower concentration through a semi-permeable membrane

Introduction: In this experiment we will exploit the size and properties of starch and iodine to demonstrate this. The things to keep in mind about the experiment are; starch and iodine react to form a blue-black color, starch is a very large molecule, and iodine is a small molecule. Note you might want to set this experiment up when you set up part B because it will take 90 minutes to run.

1. Fill dialysis bag ½ full with a 1% starch solution in water
    A. Clamp loosely as you did in the Osmosis part
    B. Wash the outside of the bag carefully with water
2. Place the bag in a 1L beaker filled with about 400ml of water
3. Add about 5ml of iodine to the beaker
    A. Record the appearance of the water and of the bag of starch
    B. Pay particular attention to the colors
4. After 30 minutes
    A. Swirl the beaker and agitate the bag
    B. Record appearance
5. Repeat step 4 at 60 minutes

Figure 20: Re-written procedure for lab 2.

	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
I felt prepared for lab				
I was able to receive quick answers to my questions				
The lab procedure was clearly written				
I felt comfortable using the technology				
I would like more labs to be presented the same way				

I was given lab procedure that was: written written and on youtube written and streamed
Was this the first time you have completely this lab Yes No
What would you change about the way the lab procedure is delivered?
Additional Comments:

Figure 21: Survey given after lab 2

Question 1: Opinion
I felt prepared for lab
Percent Answered
Strongly Agree 11.429%
Agree 64.286%
Neither Agree nor Disagree 15.714%
Disagree 5.714%
Strongly Disagree 0%
Not Applicable 2.857%
Unanswered 0%

Question 2: Opinion
I was able to receive quick answers to my questions
Percent Answered
Strongly Agree 18.571%
Agree 37.143%
Neither Agree nor Disagree 27.143%
Disagree 2.857%
Strongly Disagree 1.429%
Not Applicable 12.857%
Unanswered 0%

Question 3: Opinion
The lab procedure was clearly written
Percent Answered
Strongly Agree 24.286%
Agree 54.286%
Neither Agree nor Disagree 12.857%
Disagree 2.857%
Strongly Disagree 0%
Not Applicable 4.286%
Unanswered 1.429%

Question 4: Opinion
I felt comfortable using the technology
Percent Answered
Strongly Agree 28.571%
Agree 31.429%
Neither Agree nor Disagree 24.286%
Disagree 5.714%
Strongly Disagree 1.429%
Not Applicable 7.143%
Unanswered 1.429%

Question 5: Opinion
I would like more labs to be presented the same way
Percent Answered
Strongly Agree 10%
Agree 31.429%
Neither Agree nor Disagree 38.571%
Disagree 8.571%
Strongly Disagree 5.714%
Not Applicable 5.714%
Unanswered 0%

Question 6: Multiple
I was given lab procedure that was
Percent Answered
written 22.857%
written and on youtube 31.429%
written and streamed 20%
I only used the old normal lab procedure 25.714%
Unanswered 0%

Question 7: Multiple
Was this the first time you have completely this lab
Percent Answered
yes 82.857%
no 17.143%
Unanswered 0%

Question 8:
What would you change about the way the lab procedure is delivered?
Unanswered Responses 12
Given Answers
I liked how it was on YouTube as well. Helps the more visual learners.
Nothing, I like the fact that the labs are online as PDFs so we can pull it up on our laptops, review before the lab, and have it out and easy to read during the lab.
I would definitely benefit from more videos or diagrams, I'm a very visual learner.
It would be really cool if the TA's and the instructor were to demonstrate the task at hand, in that case it would be easier to replicate.
None really.
no
I would like to watch short videos that demonstrate the procedures that we are going through the next day.Also, maybe a short summary in the beginning of lab by the TA's would help to understand the procedure better.
I did not get to see the youtube or streamed options but I think that they are potentially interesting, especially youtube, since I would be able to pause and rewind things that I wanted to see more of
Not sure, I would have liked to try the youtube video and the stream.
Nothing comes to mind; I like the way the lab procedure is currently being delivered.
I was in the control group, and also received the new procedure in text, and the only thing that I would change are some of the descriptions of the procedure. If it included more information about the procedure in more depth it would be easier to follow. Besides that, I found that it was very helpful and clear for the most part.
nothing
Nothing
Graphs and pictures could be more helpful in explaining some complex procedures. Seeing the objects the procedure is referring to can eliminate some confusion caused by a long list of items.
n/a

This method seemed fine, being able to pause and go back to review was a large help.
Chronological order with lab safety presented first, followed by notes on which procedures take more time/ can be completed simultaneously. Then, the procedures.
Overall, I think the only difficulty was the HD level of the video was moderate but could improve. When instructing the procedure, the close up view of the procedure could help improve understanding procedure- even the TAs struggled in showing us what they were doing/handling.
It would be clearer if there were video of the procedures.
Nothing really. I love how it is taught and performed.
I feel as though something along with the printed procedure hand out would be most beneficial!
I liked the way it was delivered but more structure in the lab might be helpful
The live stream time did not work in my schedule so I was not able to watch it live. Then, I was unable to watch the recording at a later time because it was unavailable on the channel. Rather than a live stream, I would post the video online then have a set hour or so where the TA would also be online to answer questions.
I thought the procedure was delivered well.
If streaming allow instant question and answer so that it is more interactive. Or have a discussion board about the lab where the TA/Professor can answer and comment on student posts and students can answer each others questions.
I did not enjoy streaming, the timing did not easily fit into my schedule.
Visuals like pictures would have helped. I relied heavily on the videos that were uploaded separately on myWPI.
Lab procedures should ideally have a general "plain English" summary beforehand, so that when the technical stuff is elaborated, you can understand better what's going on.
Don't live stream it because some people are busy and it is almost impossible to pick a good time for every one.
I don't think I would change anything.

I really liked the youtube video it provided a very nice example for people who are visual learners like myself
I would not advise the live stream of the lab procedure because I think that many students may find it difficult to tune in at the right time. Instead, what I would change would be to have a recorded version of the lab so that if students need to refer back to the procedure, they can do so on my.wpi. Youtube is a convenient medium but I like to keep my academic and leisure websites separate as I get distracted by other videos on Youtube.
not all of the lab info was in the protocol. There were tasks in the old prtocol we needed to do that were not in the new one
more pictures
Perhaps be clear on some things that seem a bit ambiguous.
My laboratory section was presented with the written lab procedure and the live streamed video. Unfortunately, I had many problems with the streamed video. The live feed kept on cutting out because I was using WPI wireless instead of being connected by an Ethernet chord. This would be inconvenient for a large portion of the student population if the live stream is not capable of being watched over wireless connection.
Warning for when the stream is going to go live, I realized late that the stream was already happening.
Have a better time to stream the twitch. So viewers can ask questions. However, being able to see the recorded video is still just as sufficient. Just being able to see someone else do it before you have to perform the lab is greatly beneficial.
I like reading through the lab procedure rather than watching videos.
N/A
Nothing- I think the information and directions were presented well and were easy to understand.
I could not hear the instructors part of the stream because they would step away from the microscope. I felt like instruction could have been better organized. Since this was new, the instruction and answering questions of students during the stream looked a bit disorganized.
Nothing - this is a simple, accessible format for most people.
Add a youtube video on how to prepare the chicken breast slide. Videos for all procedures should be included.
The lab procedure was nicely delivered, very thorough.
I am not applicable.
I would include a short synopsis of the lab and objectives at the end of the stream.
Having only the written document, I do not think you understand at the level as opposed to having an additional (relatively short) video describing the techniques and procedures.
Give simple directions and pictures easily explaining the procedure.
I actually have no idea, there was so many different things that I got really confused and just kinda looked at whatever, I don't know if I've even opened all the files.
a demonstration first, and then we go ahead and do the lab
I think that having a demonstration lab is helpful, but students are usually not willing to take extra time from their schedule to watch a procedure agead of time. I think if anything, the time in class could be used to explain the procedure better, and less time spent on the background for the lab. The would then of course require the students to do more background reading on the lab before it happens
I would've broken down the language even more.
Include more pictures of what is being done for references
nothing really, having both pdf and .docx formats are useful so people with different devices can access them.
I like videos, seeing how the procedure is done better than reading steps.
nope

Question 9:
Additional Comments:
Unanswered Responses 26
Given Answers
none
NA
Overall, how the procedure was delivered was good because it was clear and answered questions I as looking for.
Have the harder sections of the lab be streamed, not the entire lab.
Keep on going guys. You got this!!!
Well done.
--
None.
This definitely was a good way for the lab procedure in my opinion. It was relatively clear and VERY effective in laying out what was going to be done in lab. It was very helpful and I would prefer that more of the lab procedures were like this in teaching the lesson and giving useful advice without giving too much away for the lab. It let me experiment more and try to figure out the pieces more which was helpful in making me fully understand the content.
Additionally, it was difficult to understand how to log onto the website to watch the live stream. I am not a technology person and need a step by step manual of how to be granted access to the video.
Videos were very helpful, especially for dissection, to visualize methods used in the lab.
I think this visual way is much better because, as a visual learner I can follow easier.
I feel really bad because I think this was all very confused due to the snow storms. Honestly, I'm a senior taking this to graduate and I don't really put effort into learning the labs so I would just take me out of the data.
no
It's pretty cool that you guys are doing this, it would be nice if every class had standardized lab procedure format and delivery method that was easily accesible to students as it it in BB2903.
If I were to choose between youtube and twitch i would go with youtube because everyone has time to view the video, while some might not be able to watch the livestream
N/A
I have no additional comments.
Overall, I think the video definitely helped understand the procedure and when I came in the lab, I knew exactly what I was doing better than the first lab. I hope there are more future lab procedures in youtube. Making the account to comment on the stream live video was not clarified so well - wish that could have been clarified better before the live stream.
Nothing else.
None
None that I can think of!
nothing
n/a
I love lab!
I wish all labs at WPI allowed you to see what you have to do. It would greatly improve productivity during lab time and help students that are nervous before the lab. Anyways great IQP idea.
Good luck!
So far the lab instructions I have seen in this class have been workable, but watching the recorded videos (when available) usually gives me a better sense of what I would be doing in the lab.
not applicable
nope
I wasn't in the YouTube group, but I think this would be a good way of delivering the lab.
Parts were missing concerning the Lab Safety features.
Any questions about procedures answered during lab by the TA's is helpful and has been helpful.
No.

Figure 22: Complete results from the survey given to students for lab 2.

	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
I felt prepared for lab				

I was able to receive quick answers to my questions				
The lab procedure was clearly written				
I felt comfortable using the technology				
I would like more labs to be presented the same way				

During the first demo lab, I was given lad procedure that was: written YouTube streamed
For lab 6, my lab procedure was: written YouTube streamed
Even when given a choice on which lab procedure to use, I chose the option I chose because:

Was this the first time you have completely this lab: Yes No
What would you change about the way the lab procedure is delivered?
Additional Comments:

Figure 23: Survey given after lab 6.

Question 1: Opinion
I felt prepared for lab
Percent Answered
Strongly Agree 29.63%
Agree 59.259%
Neither Agree nor Disagree 5.556%
Disagree 0%
Strongly Disagree 0%
Not Applicable 5.556%
Unanswered 0%

Question 2: Opinion
I was able to receive quick answers to my questions
Percent Answered
Strongly Agree 18.519%
Agree 31.481%
Neither Agree nor Disagree 20.37%
Disagree 3.704%
Strongly Disagree 1.852%
Not Applicable 22.222%
Unanswered 1.852%

Question 3: Opinion
The lab procedure was clearly written
Percent Answered
Strongly Agree 27.778%
Agree 59.259%
Neither Agree nor Disagree 3.704%
Disagree 1.852%
Strongly Disagree 0%
Not Applicable 7.407%
Unanswered 0%

Question 4: Opinion
I felt comfortable using the technology
Percent Answered
Strongly Agree 37.037%
Agree 44.444%
Neither Agree nor Disagree 9.259%
Disagree 0%
Strongly Disagree 1.852%
Not Applicable 7.407%
Unanswered 0%

Question 5: Opinion
I would like more labs to be presented the same way
Percent Answered
Strongly Agree 25.926%
Agree 40.741%
Neither Agree nor Disagree 16.667%
Disagree 9.259%
Strongly Disagree 1.852%
Not Applicable 5.556%
Unanswered 0%

Question 6: Multiple
During the first demo lab, I was given lab procedure that was
Percent Answered
written 27.778%
written and on youtube 18.519%
written and streamed 25.926%
I only used the old normal lab procedure 27.778%
Unanswered 0%

Question 7: Multiple
For lab 6 I used _____ (pick all that apply)
Percent Answered
the written procedure 83.333%
the live demonstration 25.926%
the YouTube procedure of the live demonstration 40.741%
The video from the link in the procedure and prelab 20.37%

Question 8:
When given a choice on which lab procedure to use, I chose the option I chose because:
Unanswered Responses 2
Given Answers
the video demonstration shows a more comprehensive approach. Reading the manual is sort of boring and you have to re read parts of it, for it to actually make sense. But in the video, you can clearly see whats happening.
I get a better feel for the lab when I can see it visually rather than written out
I liked being able to see what was happening instead of just reading about it
Any video would be helpful as long as it is short enough. One of the videos gave a 5-6 minute overview which I found very helpful. Another one was 25-30 minutes long, and I didn't have that kind of time nor the desire to watch a video that long. Short, concise videos about the techniques required would be very beneficial.
You have the information right in front of you, easy to access.
I chose the live demonstration as the best lab procedure beacuase I'm more of a visual learner
Time limited.
I like reading the procedure rather than seeing it
The written procedure gave me a good overview and then the recorded video let me see how everything would work once I actually got in the lab
I would use he live demo because I can ask questions if I have something to ask.
I liked having the live demonstration, it was really beneficial in a sense that I got to see all of the steps required to perform the experiment. It allowed me to complete my labs a lot faster and made it easier to remember and understand because it was as if I did the experiment twice.
I read the procedure since I need to see in what sequence I need to complete the steps, and to see where I should look in case I forget something during the lab itself.
I also watched parts of the youtube demonstration recording as I wanted to see how a few subtle details are dealt with.
Speedy/efficient; live demonstration captures more than written instructions.
I liked the YouTube presentation of the lab procedure. It is much easier to visualize what will occur in lab, when you can see someone use the materials and complete the procedure beforehand. Reading a procedure, for myself, is somewhat pointless, since I am a visual learner, and some terms are unfamiliar to me. It is hard to visualize a procedure when certain substances and tools are unknown to the reader, and therefore are hard to understand.

It is simple and I am busy during the live stream.
Watching the demonstration with the procedure next to it helped alot.
I like the both the demonstrations and the written procedures because the demonstrations allowed for me to visually see what was occurring and the steps were not difficult to follow. However, I chose the written procedure because I like to be able to see physically what the next steps are.
I can understand it more.
I chose the choice of written and live demonstration because they were both clear in the material and offered a firmer understanding of the material. By accompanying the written with the visual presentation, a clear comprehension was gained for the lab. This made me feel a lot more prepared for the lab setting and what I had to do/what to split up with my lab partner for the next day.
I like to copy down my own procedure in my lab notebook in order to better remember the steps I have to take. Reading and annotating written notes helps my memory.
I had a little extra time.
It was more convenient an visual.
The written lab because it is easier to follow.
Written, because it is the easiest to refer to
Typically, I would choose the written laboratory report. I am not a visual learner for the most part so reading laboratory procedures is more helpful than a video.
I prefer the written procedure, watching the video on how to do the lab is time consuming.
I like the way it is now, I don't like taking the time to watch a video, I like to go at my own pace.
I can pause the youtube video and review sections I may not have understood. Also, I like having written directions when doing labs.
Youtube live demonstration bc its convenient when you want to show it and shows how the lab should be done
it was convenient
I like the written procedure, I was unable to view the videos because I had class
It would have been nice to use the live demonstration, however, had an evening class at the time of both demonstrations. So by default, I used the other tools.
I would choose the live stream because it makes everything easier.
I like to see demonstrated what the lab procedure looks like.
The video took too much time
Most convenient and easy to understand
Live feed because you can have real time answers to your questions
The live demonstration was not at a time I could watch it.
It's easier for me to go back to
The lab itself was very simple and repetitive. I wish that snow-canceled lectures could be done in this fashion to convey missing information and details. I prefer the written procedures because it gives me the opportunity to write on the report and take the notes i need next to the procedure so that I know when a change is made or an observation and where it fits in the flow of the experiment.
I usually chose to read the report first because I felt that it provided very detailed descriptions on what to do and I could easily get from one section to another. I also would then watch the youtube video so I could see how something was done.
I like something that's short but encompasses everything I need to know to do well on the lab.
I hadn't tried the video before and thought it would be useful.
It is the easiest to refer to at any point in time, assuming the content is clearly organized and articulated.
It was easier to access.
I liked to visually see what I was going to do in lab.
Having an actual demonstration that could be viewed at any time was a great way to prepare. Rather than just being able to read the procedures, I could see how they worked and prepare for how I would organize my time in lab.
I had never before learned a lab procedure via live stream so I wanted to compare the effects of each!
I felt it was more convenient to skim through a text than watching a video.
I prefer the written lab for quick experiments that do not require the direct observation of an animal. However, for the dissection of the fetal pig the videos were very helpful.
I enjoyed the youtube option because it provided a visual example of what we should be doing during the lab. It also made it easy to go back and rewatch the video if necessary.
I prefer reading the material as opposed to watching it. It was also slightly out of habit.

Question 9: Multiple
Was this the first time you have completely this lab
Percent Answered
yes 88.889%
no 11.111%
Unanswered 0%

Question 10:
What would you change about the way the lab procedure is delivered?
Unanswered Responses 5
Given Answers
Better connectivity on twitch
Having the lab procedure more streamlined in a flow chart format where it lists things rather than having long descriptions of the steps in the procedure itself
The timing is not convenient at all. I work on Monday nights and missed the live streams. If there were two live streams as in one at night and one during the day, that might be more helpful in allowing all students to be able to catch the timing right.
Sometimes the background info seems relevant, but info we need is not provided.
I think this is a good way to do it. Perhaps have the TA periodically check the YouTube comments for questions so that they can also be answered there.
Just written no video
I wound't change it. I enjoy these lab sessions.
Do more of them this way.
The lab procedures can sometimes be confusing and a little too elaborate, so the short videos are good.
Better spacing and clearer writing style.
Not during my class.
I like the both the demonstrations and the written procedures because the demonstrations allowed for me to visually see what was occurring and the steps were not difficult to follow. However, I also like the written procedures because I can follow step by step and not have to forget what I was suppose to do next. Though, sometimes the wording in the procedure seems a little vague, so that's when the live demo comes in handy because I can watch the next step without having to get confused over the written procedure.
No
Make a short, concise (less than 10 minutes) video for each lab describing / demonstrating the techniques required for the lab.
Stream the procedure at a different time and day or stream at multiple times.
I think a recorded video with visual overlays would be ideal.
I wouldn't change anything cause I fully understood the lab
Better instructions on the written document.
Maybe have a better streaming service so there's less chance of lag. Or just a better way of filming the live stream.
I thought the procedure was delivered well, and I wouldn't change it
There isnt anything i would change
Make the laboratory procedures less dry. The content can be more fascinating.

A live demo presentation would be awesome. Like step by step.
The TA's were shy to tell us about the enzymes because they wanted us to read about them ourselves, but in lecture the professor had no problem discussing them. Perhaps before other demonstrations these details could be discussed so that we can gain more information.
I wouldn't change anything!
Nothing
Nothing. Lab 6 was pretty straightforward so all the tools for the procedure were satisfactory for delivering the procedure.
nothing
No, i liked the videos and written procedure
I would highlight key terms in the lab procedure.
n/a
Youtube is good for reviewing and watching specific parts of a demonstration
Live stream time was weird.
I liked the way the procedure was delivered by YouTube. The two camera views were useful. The link is accessible at all times. By having a YouTube video and a lab procedure, it solidifies the procedure for all types of learners.
I like both the written lab procedure and the Youtube video because they support each other and prepare me more for the lab.
More visual pictures next to written procedure.
Maybe more still, labeled pictures to keep track of things.
I think the youtube links should become standard as a supplement to the usual written procedure.
shorter
Pictures of the set up always help. the youtube videos are also nice because if there's a part I am having trouble understanding, I can rewind and watch again
Nothing.
The lab procedure was delivered well. I would only fix the typos on the handout.
Nothing really
In terms of the written lab, maybe more visual direction instead of just text would be helpful.
-
Nothing, I liked the culmination and ability to decide which worked well. Although based on the wifi, the stream was not as easy to follow, and the material did not flow as well as the standard video.
More specifics in the written procedure

Question 11:
Additional Comments:
Unanswered Responses 21
Given Answers
Everything is good!
none
I chose a random answer for question 9 because it is missing a verb.
NA
None
The program works well, make sure to emphasize that the connection is much better on wired internet rather than wifi.
n/a
Only what I said in Question 8
It's all good
I enjoyed watching the procedure as oppose to reading it.
None.
It's a great idea, a new way of learning. I really like it, it's hands on.
None!
GOOD JOB Demo team!!!!
Much better this time around
.
The live demonstration is the best lab procedure
Monday nights might not be the best time to do live demonstrations as a lot of upperclassmen have grad classes and ID
2050
-
I did not watch the live stream as it was during an inconvenient time.
A live demo would be helpful as just a video instead of streaming it.
It would also just be easier to complete the labs if all the equipment worked
N/A
Good Luck with IQP and final presentations!

Figure 24: Complete results from the survey given to students for lab 6.