

EFFECTS OF WEB 2.0 TECHNOLOGY ON STUDENT LEARNING IN SCIENCE

by

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ABSTRACT

This investigation addresses how the implementation of Web 2.0 technologies for completion of research projects affects learning in middle school science students. Web 2.0 programs were utilized by students to complete both group and individual research projects. The programs were used for collaboration during data collection and interpretation. Plus students used Web 2.0 programs to present their evidence. The programs appear to have a positive effect on student engagement and research skills; however effects on retention of content knowledge are yet to be determined.

INTRODUCTION AND BACKGROUND

Introduction

As technology advances, educational possibilities become limitless. The amount of information available on the Internet has increased the potential for learners to discover answers to many of their questions. Training and experience help make efficient use of that information to facilitate learning. Therefore as educators, we must ask ourselves: What is the best way to increase student learning with the use of modern technology?

Students in Corvallis, Montana have access to multiple computer labs for educational purposes. Several teachers in the primary, middle, and high schools utilize these labs for a variety of beneficial educational activities including research projects. Following their research, students create reports of their findings with spreadsheet and word processor programs. Students learn many valuable skills while completing these assignments including: how to format documents, how to find reliable information on the Internet and also how to present information to their peers. This traditional use of technology is now being replaced with cutting edge teaching practices that allow students to demonstrate their ability to utilize a wide variety of computer skills to increase learning.

Students at Corvallis Middle School produce presentations of their research in many different ways. Recently, students have shifted from relying on Microsoft PowerPoint for presentations to using programs from the Internet. I will be referring to these as Web 2.0 programs which allows the user to participate in information sharing

through a user-designed collaborative learning environment. Web 2.0 users participate in a virtual learning environment that emphasizes social media skills. Web 2.0 programs include social networking sites, wikis, blogs, presentation programs and web applications. Prezi, Animoto and YouTube are popular Web 2.0 programs that students use to communicate their ideas to their teachers and their peers. These programs offer an engaging variety of presentation and collaborative communication tools for students to enhance their learning experience. Students eagerly engage these programs to communicate their findings on assigned research topics.

In years past, I have traditionally used the Internet as a glorified encyclopedia or textbook. My students were often given a task or worksheet to complete using teacher assigned websites. This method of utilizing the available technological resources was only partially successful. Therefore, I am seeking methods for maximizing the benefits of computer use in the classroom. At the beginning of each school year, students were enthusiastic to use technology to complete assigned tasks. However, after the second or third task completed using my traditional format, student interest and enthusiasm began to fade. This decrease in student enthusiasm made me wonder if this was an effective way to use the available technology for learning. Therefore, I set out to discover how to maximize student benefits associated with using technology for completion of assignments.

Background

In the spring of 2010, one-third of the teachers in our school district were given laptop computers and instructed on the use of Web 2.0 technologies for educational purposes. Many teachers began utilizing these technologies in their classes; however

several of the teachers commented on a lack of educational value in the use of the Web 2.0 programs. Therefore, I have made it a personal goal to investigate the value of Web 2.0 technologies in student learning. The results of my action research project will have an effect on how I use Web 2.0 technology in my class, and possibly how teachers in my district and other school districts use technology for teaching. Teaching with technology is a delicate balance of encouraging responsible research while maximizing the use of student skills to enhance the learning experience in a meaningful relevant way. Web 2.0 technologies have the capability to extend the learning environment beyond the classroom and the school day. If teachers have a model for the use of Web 2.0 technology in the classroom, then student learning will increase as a result.

In an attempt to utilize computer time wisely, I decided to assess student learning in relation to computer use in science. Students had the opportunity to use computers for research, composition, and presentation of various scientific ideas. Students used Web 2.0 technologies in science class to: research a main idea, develop their understanding of that idea, and present the information to the rest of the class. Students enjoy getting on the Internet and using programs that they can access anywhere at any time, however I needed to understand how the programs affect their learning so I can plan more effectively. Therefore I decided to seek the answer to three separate subquestions in an attempt to assess the effect of Web 2.0 technologies on student learning. Plus, I was interested in understanding how my teaching practices are affected so I can provide an accurate depiction of changes in my professional life.

Focus Questions

The use of Web 2.0 technologies during valuable class time demands that teachers understand the effects of specific programs on student learning. In order to clearly judge how learning is affected it is necessary to examine student engagement, research skills and comprehension of scientific concepts. Teachers can then use their understanding of these effects to plan instruction to maximize learning. In order to maximize learning in my classroom, I sought to answer the following:

Main Question: How does implementation of Web 2.0 technologies affect student learning?

- o How do Web 2.0 technologies affect student research skills?
- o How do Web 2.0 technologies affect comprehension of scientific concepts?
- o How do Web 2.0 technologies affect student engagement?

CONCEPTUAL FRAMEWORK

I tried to create a dynamic learning environment where students were engaged in learning scientific concepts through collaborative communication. I hoped to see the students take over their learning in my classroom. Williams and Chinn (2009) pointed out that current practices in technological education encourage teachers to “design experiences that bring together previous experiences and combine those with new areas being explored” (p. 172). Web 2.0 technologies offer a unique tool for learners to reach that goal. Today’s classroom is full of “digital natives” (Prensky, 2001), which use social networking skills in their everyday lives. Our students have experience and technology skills that can be harnessed to maximize the effectiveness of their learning environment. Through careful planning, teachers can take advantage of those skills to increase student

research skills, classroom engagement and conceptual learning. Students have the opportunity to collaborate and improve their understanding of the world in a Web 2.0 mobile learning community. Web 2.0 offers users the ability to create and exchange information in a cooperative learning environment (Yueh-Min, Yang and Chin-Chung, 2009). One of the main goals for using Web 2.0 technologies is to increase learner-centric communication and collaboration amongst users. This goal creates an interactive learning environment that facilitates knowledge acquisition, knowledge construction and information sharing. This environment should increase student learning during the application of Web 2.0 technologies for completing research projects. Yueh-Min, Yang and Chin-Chung (2009) suggest that Web 2.0 encourages the constructivist approach for learning. This approach supports the inquiry based learning strategies which are encouraged by Montana state science teaching standards and are actively practiced in Corvallis Middle School science classrooms. Interaction between student ideas and experiences helps generate knowledge and relevance in the topics they are studying. If students are able to focus on the material that has been provided for them by others, then there may be less time devoted to finding multiple sources of new information when researching foreign topics. Therefore students may benefit from the ability to utilize the experience and knowledge of others in this interactive e-learning environment.

A cooperative learning environment must consistently be interactive. While students are using Web 2.0 technologies they should also provide a reliable resource to their peers so they can feel like they have fulfilled their end of the bargain in the cooperative learning environment. Participation increases in cyberspace when there is an interactive requirement for the class and when a facilitator participates in the learning

(Churchill, 2009). All students in Churchill's study recognized that access to and participation in blogging activities contributed to their learning. A majority cited assessment requirements (92%), facilitator participation (100%), and contributions to their learning (88%) as reasons for participating in blogging. Therefore it is probably necessary to require participation and provide facilitation to maximize learning in a cooperative learning environment. While students have the knowledge and ability to use the Web 2.0 programs for task completion, they haven't shown higher-level thinking skills in that task completion without facilitation from teachers (Luckin, Rosemary, Clark, Wilma, Graber, Rebecca, Logan, Kit, Mee, Adrian and Oliver Martin, 2009).

Well structured lessons that utilize student technology skills offer an opportunity for educators to monitor student learning with the use of the Internet. Student grades, engagement, and understanding of content material can increase with the integrated use of well planned Web 2.0 lessons (Byrne, 2009). Therefore in order to assess how Web 2.0 technologies affect student learning; it was necessary to monitor student engagement, content knowledge, and research skills.

METHODOLOGY

Treatment

I collected data for my project before the treatments to establish baseline information on student comprehension, engagement and research skills. Plus, I assessed students during both treatment cycles in order to determine the affects of Web 2.0 technology on their learning. I required the use of Web 2.0 technology during both treatment cycles of my action research project. Students used the following Web 2.0

programs during my treatments: Animoto, Edmodo, Google Maps, Prezi, Wikipedia and YouTube. Google Maps and Wikipedia provided reliable sources of educational information for research purposes. Students needed to have multiple sources for data collection during the research process, and that is where Edmodo was beneficial. Edmodo allowed students to collaborate with each other both in and out of the classroom. The use of these programs along with videos on YouTube provided sources of content knowledge when completing the student projects. Students then had the opportunity to communicate their knowledge using Animoto, YouTube, Prezi or PowerPoint.

For the first treatment cycle students completed a three week unit of study on cells. The topic was introduced with reading from the text and an accompanying study guide. Students were then able to access computers for over a week to complete a variety of teacher designed activities related to cell structure and function. Each student researched cellular structure independently by labeling a teacher produced cell diagram (Appendix D). They were instructed to “Google” cell structure and function and decide how to label the diagram. It quickly became apparent that their research skills were overrated in the initial pre-treatment student survey. After struggling with interpretation of the information independently, students used Edmodo to finish the task. Edmodo is a Web 2.0 program designed similar to a social networking site such as Facebook. Students shared information by making posts and replying to other posts in a conversational format. Following a short five minute introduction to the program, my seventh grade students quickly signed up for the program and completed the assigned cell organelle labeling diagram. This was a great opportunity to get a feel for student computer skill levels and adjust lessons accordingly. The next day students were excited

to begin using Web 2.0 programs therefore I provided demonstrations and sign-up instructions for Prezi and Animoto. These demonstrations led to a cell organelle project that was assigned in Edmodo. The project required students to use Edmodo and make entries in their cell organelle groups which were the same across all five of my classes. The organelle groups were two or three students assigned to research the same organelle in each class for a total of 12 to 15 students researching each cell organelle. These 12 to 15 student organelle groups were then required to complete a 'useful' Edmodo entry each day. Following two days of research to fulfill presentation requirements, students began construction of their Prezi, Animoto and PowerPoint presentations. While very few chose this option, I allowed some students to create their presentations in a format that was familiar such as Microsoft PowerPoint even though it's not a Web 2.0 program.

For the second treatment cycle, I changed a successful two-week class project to include the use of Web 2.0 technology for completion. In previous years I had students complete a national park ecology research project. For this project, students were required to research the following aspects of a national or international park of their choice:

- The park's climate statistics, location, declaration date and other interesting facts
- Biome classifications found within the park
- Food web interactions between 15 thoroughly researched living organisms

Following the research, students had to produce a PowerPoint presentation that communicated the researched natural history information for their park. Project requirements included: previously mentioned physical characteristics of the park, a

computer generated food web, a detailed classification of each organism and an ecological energy pyramid.

The basic requirements of the national park ecology research project were followed with a few modifications. First, students were required to choose their national park from a carefully selected list. I have 113 students that were divided into 40 groups. Each of my five classes had an average of eight groups which conducted research on eight different national parks. Next, I set up discussion groups in Edmodo for each national park. The research portion of the project was then run through these discussion groups. Each student had an assignment to post a unique relevant link to the specific national park discussion group folder in Edmodo. The link needed to be accompanied by a brief explanation on how the group could use the resultant webpage to complete their project. This part of my treatment was designed to increase collaborative learning. The national park groups increased from two or three students to 16 to 24 data collectors with five unique presentations of the material. Finally, students created presentations in PowerPoint or one of the following Web 2.0 programs: Animoto, Prezi, or YouTube. The presentations included all of their researched information, a map of the national park, an energy pyramid and an accurate food web based on their cited research.

Research Design

Completion of my research project required three phases of data collection (Table 1). Those three phases included a non-treatment cycle, followed by two treatment cycles. First, baseline data was collected during a non-treatment cycle to help verify the effects of the treatment. In attempt to answer my research question, it was necessary to assess:

student research skills, level of engagement, and content knowledge prior to beginning treatments. Then, the treatment cycles included the use of Web 2.0 technology for completion of two different research projects. The three phases of data collection provided enough information to sort through for recognition of meaningful patterns in the effects of Web 2.0 technologies on student learning. Instruments used for data collection included: Likert surveys, quizzes, tests, and research presentation rubrics. Plus, effects on my teaching were noted with reflective journaling following my research project.

Table 1
Data Collection and Sub-questions

<u>Research Sub-questions</u>	Data Collection Instruments		
	Pretreatment Baseline Data	Treatment Cycle One	Treatment Cycle Two
How do Web 2.0 technologies affect student research skills?	1. Likert Survey 2. Research Presentations	1. Internet Worksheet 2. Research Presentations	1. Likert Survey 2. Research Presentations
How do Web 2.0 technologies affect comprehension of scientific concepts?	1. Quiz and Unit Test	1. Quiz and Unit Test 2. Research Presentations	1. Quiz and Unit Test 2. Research Presentations 3. Likert Survey
How do Web 2.0 technologies affect student engagement?	1. Likert Survey 2. Research Projects	1. Research Projects 2. Formative Assessments	1. Research Projects 2. Formative Assessments 3. Likert Survey

Methods

I collected data on all 113 seventh grade students in my five life science classes. Many of the students (43%) qualify for free and reduced lunches. In their previous two years of middle school they used computers very little while learning sixth grade physical science and fifth grade life science. In fifth grade my students are introduced to some of

the concepts I teach them in seventh grade, which gives me the opportunity to go into greater detail with class projects. A total of 54 girls and 59 boys made up the population of students that were treated with my project. Approximately 89% of the students are from Caucasian families. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained.

I collected baseline data when students completed a unit of study on scientific inquiry without the use of Web 2.0 technology. During this unit, students: participated in topical lectures, read material from the textbook, completed a chapter study guide, inquiry based class activities and an independent inquiry project. The topical lectures and readings provided instructional information for students to learn which steps scientists use when conducting research. Students then completed inquiry based activities to learn how to use the steps of the scientific method. I provided objects in a variety of formats and students were then asked to design an experiment using the steps of the scientific method with the materials provided. Students were given: Legos, popsicle sticks, glue, tape, paper, paperclips, ketchup packets, tacks, tennis balls, string, vegetable seeds, soil, paper cups and other various items found in my classroom to use in their experiments. I would also suggest a problem and ask for a hypothesis and possible steps for answering their problem. Later, I provided students with a problem and a possible hypothesis that required them to practice data collection and analysis order to test their hypotheses. Following practice with asking scientific questions, forming hypotheses, designing experiments, collecting and analyzing data; class activities then led to an independent project where the students had to come up with their own problem and go through the

process of scientific inquiry to answer their problem. This project ended with students presenting their information to their peers in a poster or PowerPoint format.

I measured student understanding of content knowledge through teacher produced quizzes and a unit test on the scientific inquiry process. I assessed research skills during student presentations of the independent inquiry projects. Plus, I collected engagement baseline data with a Likert survey (Appendix A) and formative assessments. I assessed student understanding of material and topical interest periodically with Minute Papers, Muddiest Points and Exit Cards. These formative assessments provided valuable insight into student progress on conceptual understanding prior to finishing their research projects. Reliability of data was established through repetition of the previously mentioned data collection techniques. Also, it was necessary to assess content understanding through formative assessments to ensure that my project scoring rubrics were valid in assessing students' ability to do scientific research as well as level of engagement. How were the students spending their time collecting research? How much time were they using working with learning scientific concepts versus presentation construction? How was the time they spent in class utilized? I consistently used the same assessment techniques to measure content knowledge, research skills and level of engagement while completing each unit. However, the Likert surveys were only conducted twice, before and after both treatments.

DATA AND ANALYSIS

For my action research project I was interested in assessing the effects of Web 2.0 technology on student learning. I utilized a variety of data collection tools to assess the effects of Web 2.0 technology on student learning in my class (Table 1). Most

specifically I was interested in targeting how the technology affected student research skills, comprehension of material, and level of engagement. I measured engagement with student reports of time spent using the Web 2.0 technologies and self reported time-on-task during science class. I also decided that students would be engaged with lessons that they found valuable, therefore I polled them to find out if they found the lessons in class to be valuable. Pre and post-treatment surveys (Appendices A & B) allowed students to internalize and report their opinions on all three targeted sources of information. I assessed comprehension of scientific concepts with pre and post-tests, presentation rubrics, and unit tests. Plus, the presentation rubrics (Appendices F, G & H) allowed me to examine how well the students researched the required material on their national park and cell organelle projects. Finally, to better assess student research skills, I included individual pre and post-treatment research exercises on cell organelles (Appendix D) and national parks (Appendix E) that required the use of computers. It was also insightful to reflect on how the format of the different lessons during the treatments affected my teaching.

Pretreatment Student Attitudes

My first data collection instrument was a pretreatment student survey (Appendix A) which aimed to provide baseline data on all three of my information targets. Students answered questions both quantitatively and qualitatively. First they were asked to grade their answers on a scale from 0-10 based on their feelings about the questions. Then each quantitative question was followed with an opportunity for the students to make qualitative comments relating to their answer.

Each survey question was designed to help answer my research sub-questions by collecting baseline information on student perceptions of their research skills, level of engagement in science and computer skills. I categorized the student survey questions as being related to research, engagement and comprehension (Appendix C). Then I organized student responses to those questions from each category searching for patterns in their statistical means (Table 2). Finally, I provided a brief explanation of the nature of the survey question before presenting an analysis of the results. I found the information to be very helpful in gauging student experience with research, computers, interest in science, and level of engagement in my class. This information was imperative for effective design of my treatments. Knowing which skills the students had prior to the treatment enabled differentiation of instruction to minimize non-treatment factors that may have affected student learning.

Table 2
Student Quantitative Responses to Survey

Information Category	Pre-treatment Survey		Post-treatment Survey		Nature of Question
	Question #	Mean Response Range 0-10; N=103	Mean Response Range 0-10; N=103	Question #	
Research Skills	10	6.52	7.31	7	Computer research skills self-confidence
Research Skills	11	2.16	2.68	8	Hours spent researching each week
Comprehension	12	5.57	6.5	9	Learning benefits from computers
Engagement	1	7.92	7.94	1	Time on task in science class
Engagement	2	7.67	8.21	2	Valuable assignments
Engagement	3	5.16			Assignments not valuable
Engagement	4	7.26	7.38	3	Interest in science topics
Engagement	5	4.08			Learning science outside of class
Engagement	9	1.33			Completing science on computers
Engagement			6.3	4	Level of engagement with Edmodo
Computer Use	6	98/103			Students with computers at home
Computer Use	7	4.18	3.5	5	Weekly hours spent on computer
Engagement	8	2.07	1.38	6	Homework hours on computer

I found the results of my pre-treatment survey to be very interesting. When asked if the computer helped them learn science better than traditional methods, students responded with an average answer of 5.57 which suggested they believe it may be helpful. Plus, students were only modestly confident in their research skills. An average of their responses, to questions #10 and #11, shows that many students believe that they can conduct research better than the average seventh grader. When asked how many hours per week they spend doing research, students responded that they average about two hours each week researching information. When probed about which programs were used to do research, the responses varied between: Google, YouTube, Bing, the Discovery Channel, National Geographic, Wikipedia and Ask.com. Student confidence in their computer skills suggested that assistance would be necessary to complete all assigned research for my class. Students were indeed capable of reading an assigned webpage and finding information on that page, however they were not very efficient at open-ended research. Prior to my treatment, students didn't know how to go out on the Internet and find information from reputable resources. Therefore I believe that the students were good at finding information in an assigned reading; however I don't believe that they were good at conducting research.

I measured the effect of Web 2.0 technology on learning by looking at levels of student engagement including perceived value of assignments and total time spent to complete those assignments. Students were asked their opinions about their level of engagement in questions #1-5 and #9. Students responded that they believed they spent most of their time (79.2%) in science class on task completing meaningful assignments. The results for a survey of time on task showed that students believed that they were on

task when they were completing their assignments in a timely manner. If the student completed assignments on time, then they believed they were on task. I explained to the students prior to their post-treatment survey that time on task was synonymous with being engaged in class activities and exercises. When asked if they use class time wisely, one student responded: “I think I do because I get everything done and don’t get horrible grades.” This also showed that students think they are on task if they are able to get “good grades” or if they get assignments done “on time or sooner.”

One additional way to assess if students are engaged in class is to determine if they find lessons valuable. I asked students if they think the assignments in class are valuable (question #2) and most of them responded positively. Students commented that they find assignments valuable if they have “meaning” or relevance, if they are “learning new information”, or if the assignments are “affecting their grade.” In order to test the consistency of student responses, I asked if they find assignments in class to have little value (question #3). Most students realized that this was the opposite of the previous question; however the results of the two questions should have shown their opinion on the value of assignments as positive or negative. This was not the case. While students stated that we do valuable assignments approximately 77% of the time, they said the assignments were of little value about 52% of the time. Students responded that assignments which were “not graded, worth too few points, or contained information that they already knew” were of little value. I eliminated the second quantitative question (#3) that asks about lessons that are of little value prior to the post-treatment survey. This shortened the survey and provided an opportunity for students to respond with more precise and accurate qualitative answers. Overall student opinions were consistent with

my observations as we agreed that they are engaged in learning science for a majority of the time they are in my classroom.

Finally, questions #6-8 addressed student home computer use. Most of the students (95%) have a computer at home. They claimed to use these computers an average of 4.18 hours each week. Nearly half of the time (2.07 hours) that they were on computers, students were completing school work. When asked which programs they use to complete that work, students responded they were using Microsoft Office products most of the time. Many students also connected to textbook sites and teacher webpages to complete their homework.

Following my pre-treatment survey I found that students did use computers at home. Plus, it appears that they were interested in learning science this year. Therefore if students are taught good research skills then they may stay engaged in science both inside and outside of the classroom. Next we will examine the treatment data.

Post-treatment Student Attitudes

Prior to administering the post-treatment survey I revisited my pretreatment survey and made changes to more accurately meet my research needs. I dropped some of the questions to shorten the survey and added others to specifically answer a few questions that I still had following both treatments. I eliminated questions that appeared confusing to the students, irrelevant to my study, or repetitive. Then I added questions to find out if Edmodo helped them complete the projects and also identify which computer programs helped them learn the most. The remaining survey format was kept the same (Appendix B).

Following both treatments, many student opinions varied only slightly (Table 2) from the pre-treatment to the post-treatment survey. Student confidence in learning science with the aid of the computer saw an increase of 17% ($N= 103$). When asked about their confidence in conducting research, I expected the students to be much more confident in their own abilities. However, students only reported a 12% increase from the pre-test scores. At first I didn't believe that these gains were substantial, however after looking at all of the data collected during both surveys I think that these were the greatest benefits in the opinion of the students. Confidence in research abilities and level of engagement were already rather high; so any gains can be viewed as being positive. The programs that students reported using to conduct research did shift to heavy reliance on Google and Wikipedia, whereas the pre-treatment survey showed an even distribution of a wide variety of online programs. Students responded that Edmodo helped them complete the second project at a level that was slightly higher (6.3) than the average program they utilized for data collection. When given the opportunity to declare which programs helped them complete research the most; students responded that Edmodo, Google and Wikipedia were their Web 2.0 programs of choice.

The fact that the students reported above average use of Edmodo for data collection on the project suggested that they were engaged with the Web 2.0 program for task completion during my treatments. As mentioned before I also considered the students to be engaged in learning science if they found the class assignment valuable. I saw a slight increase in student opinion (7%) on the value of assignments in my class. I attribute this modest gain to the 77% approval rating of the assignments to begin with. It

is hard to please everyone all of the time, but I am happy to please most of the people most of the time.

Next, students were asked to determine how much time they spent engaged in science class. The results of the first survey showed that they were on-task during my class nearly 80% of the time and that number only increased by less than one-quarter percent. Therefore students were apparently highly engaged in class prior to the treatments and thus showed only slight improvement in the measured areas of engagement.

Finally, I was interested in assessing how home computer use changed during my treatments. The results were by far the most shocking of all. I expected student home computer use to increase with more opportunity for homework completion online. The results of the survey; however, painted a different picture. Hours spent on computers per week for each student decreased by a total of 16.3% from a modest average of 4.18 hours to a mere 3.5 hours. Plus, student time spent doing homework on computers decreased from 2.07 to 1.38 average hours. That is a 33% decrease in time spent doing homework online. This may be perceived as being discouraging; however there could also be another explanation. Simply, students may be more efficient at completing tasks online now that they have more confidence in their ability to conduct research. When asked about benefits of participating in my research, one student replied: "All of our homework is easier now that we know how to use the Internet, Mr. Chimo." Thus they may need to spend less time working on computers to complete the same amount of work as before.

Research Skills Assessment

In order to assess the effects of Web 2.0 technologies on student learning, I prepared some simple assessments (Appendices D & E) of their research skills and comprehension of content. Students began each treatment by completing baseline research data with a computer worksheet. Then they completed a similar worksheet following the first treatment with the opportunity to utilize Edmodo in their research. I decided to disallow the use of Edmodo during the individual research phase of my second project in attempt to isolate the effects of the treatment on individual research skills. Finally, my research project rubrics (Appendices F, G & H) were designed to quantitatively determine both student research skills and comprehension of the topics we were studying.

Before I taught students how to use Edmodo, they had to complete an animal cell labeling diagram (Appendix D). Cell organelles were a foreign concept to students so they were complaining about not knowing how to complete the worksheet or even what it was that I was asking them for. I insisted that they would be able to label all of the organelles if they took the time to read about them on the websites they were using for research. One student then commented: “hey Mr. Chimo, it says here that the spaghetti looking stuff with bumps is the rough endoplasmic reticulum. Those bumps are ribosomes, which make proteins.” It was clear that the students needed direction in their research process, however I erred on the side of caution and did not provide too much guidance on where to find their answers. Students were able to complete the worksheet with 63.45% ($N=103$) accuracy. Then, following Edmodo instruction student success on the worksheet jumped to 87.47% correct. We did complete a variety of other types of

instruction which may have attributed to the increased student achievement. Therefore I needed to find a way to measure the effects on student research ability using this format more accurately in my second round of treatments. I decided that another worksheet would be researched and completed during the second treatment with minor changes.

I asked the students to complete research on national parks in California without using Edmodo or any other form of social communication program. They were able to individually complete an average of 20.5/50 points of information in a forty minute time frame prior to the national parks project. Following the national parks project they were asked to research the exact same information on national parks in Hawaii (Appendix E). The result was very positive. Their ability to conduct research increased dramatically. On average the students were able to complete 41/50 points of information in the same forty minute time frame. Using the same format on the worksheet and asking for the same information about each state's national parks isolated the student research ability as the only variable factor. Both the animal cell labeling diagram and national park research worksheets showed that the use of Web 2.0 technology increases student abilities to do research (Figure 1).

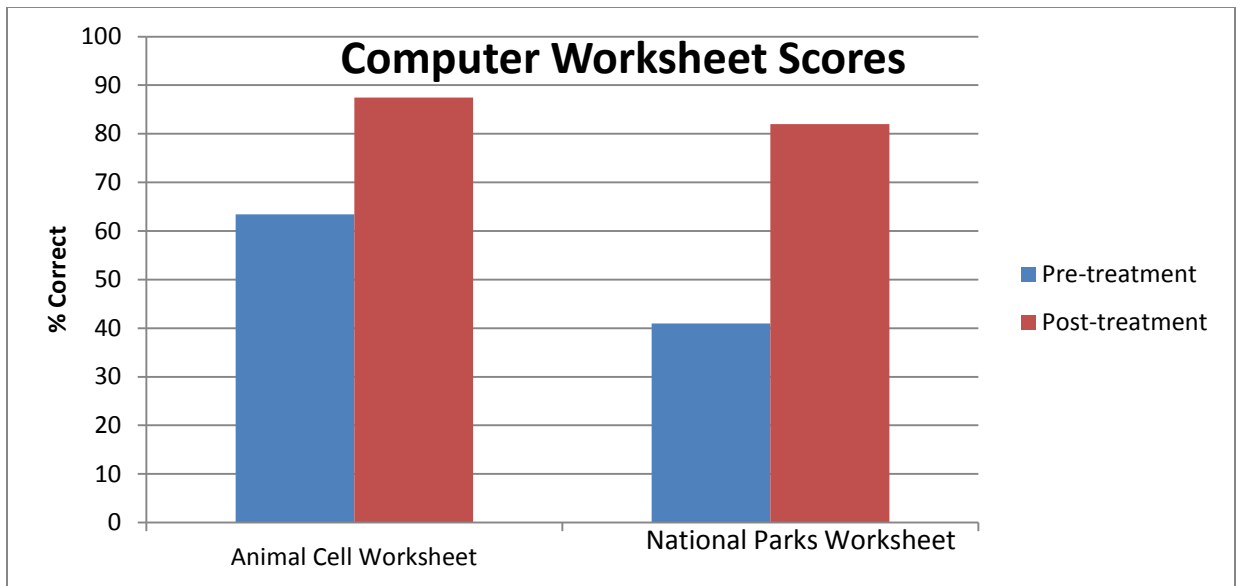


Figure 1. Student research performance, (N=103).

These assessment tools measured individual student research skills. I was impressed to see that there was an increase in student ability to gather information in a limited time frame. This should help students be more efficient at gathering information for research projects and allow more time for focusing on the completion of presentations.

Presentation Performance

Students completed three separate research projects this year in science. The first project of the school year was an individual scientific method project that was completed without the use of Web 2.0 technologies for research or presentation. Students were asked to brainstorm a topic and then gather research on it to produce a science fair type project to be presented to the class with PowerPoint. This project provided additional baseline data on student research abilities and comprehension of the scientific method. The other two research projects were completed as part of my treatment.

The cell organelle research project was an individual project and the national parks project was a group project. I thought that it would be helpful to compare the scores on the three projects to gauge student comprehension and research ability. The first assignment students completed for my treatment was the cell organelle research project. For this project it was necessary to research information on the cell organelle and to demonstrate comprehension in a presentation format. Edmodo was used for the research portion of this project and students presented their projects using Animoto, Prezi or PowerPoint. Students were graded on the quality of information on their assigned cell organelle as well as their knowledge of the structure and function of that organelle.

Finally, students completed the last treatment project on national parks. Students worked in groups of two or three to gather information on an assigned national park and presented with Animoto, Prezi, PowerPoint or Movie Maker. This was different from the other two projects due to the fact that it was completed as a group ($N=40$) rather than individually. However I felt like the data would be interchangeable and easily compared to the data collected from the two previous student research projects. I found all three of the average scores to be rather interesting.

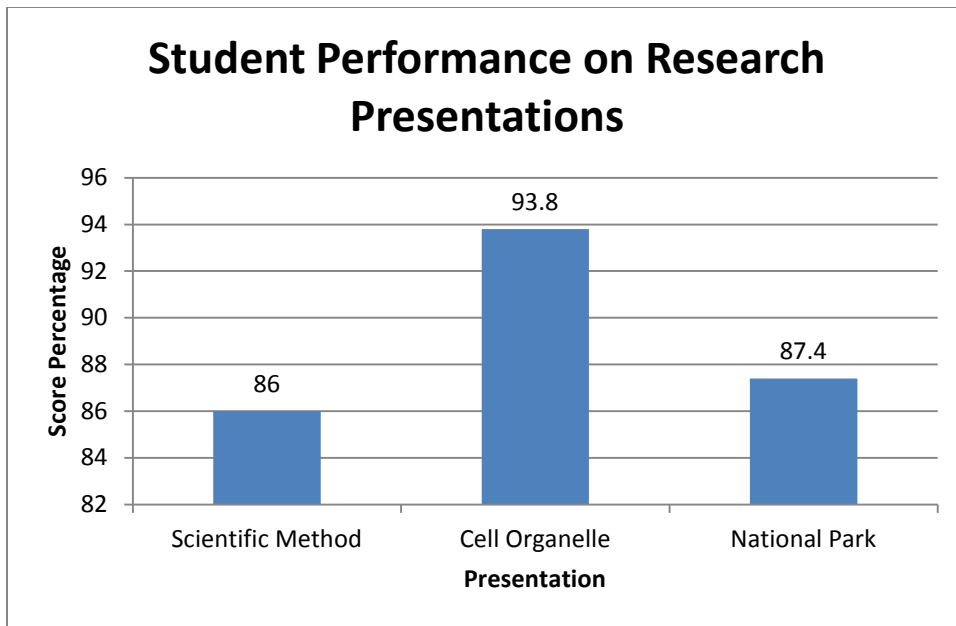


Figure 2. Presentation Scores for Research Projects, ($N=113$: Scientific Method and Cell Organelle Presentations. $N=40$: National Park Presentation).

The baseline data showed that the students scored an average of 86% on the scientific method research project. Then, the average score for the cell organelle project was 93.8%. These results suggested that the Web 2.0 technology must have had a positive effect on student research abilities and comprehension of material. Thus I expected their scores to increase again with the national parks project. However I was surprised to see a regression in average score to 87.4%. This was still higher than the baseline data, but I never expected the average score to go down when the students were working in a group rather than alone to complete the research project. There are a myriad of factors that may have contributed to this decline. The data that was collected during the final project was more extensive than the other two. Plus, students had been asked to complete three other group assignments prior to the national park project; therefore they may have been overly confident in their ability to pull together this more extensive

project. However, the overall student performance on presentations did increase with the use of Web 2.0 technology (Figure 2).

It is evident that there was some inconsistency in the measurement of student performance for these three projects. The first two projects were completed individually and the third was in groups of two or three students. Therefore I was measuring the effects of Web 2.0 technology on more students during the Cell Organelle Project ($N=103$) than the National Park Project ($N=40$). The dynamics of the group project may have affected the outcome of their presentations more than I realize. So it will be imperative to look at individual student research and content assessments to see how the Web 2.0 technologies affected each participant.

Content Comprehension

At the end of each unit students completed a summative assessment over material learned in that unit. We completed unit tests and quizzes over the scientific method, cell organelles and ecosystems. The first two tests corresponded to the material that they covered in the scientific method and cell organelle research projects and the ecosystem quiz covered the national park project material. The results from the assessments are interesting even though inconsistent with my expectations.

The first summative assessment students completed was the Unit 1 Test. Students were asked to recognize and define the steps of the scientific method. Then they had to identify which steps of the scientific method were used during Alexander Fleming's famous bacteria/penicillium experiment. Students were proficient at defining the various steps of the scientific method. These results were consistent with the repetition of instruction on how the steps of the scientific method were intended to be used. However

students did struggle when it came to the practical use of each step and recognition of the steps in an actual experiment. This may be remedied by asking the students to complete the in-class inquiry activities individually rather than in groups of two or three. The average score for all 103 students was 70.1%, or a bit less than average.

I expected an increase in average scores for the next unit test over cell organelles. It made sense to me that scores would go up after using the Web 2.0 technologies and viewing peer presentations on the various organelles. I was surprised when I saw that students dropped to an average score of 56.7% on the second unit test. It wasn't clear why the scores went down until I examined my teaching methods for the unit as compared to previous years. I expected students to get more out of the student presentations so I didn't bother presenting the material as thoroughly as previous years. I now realize that each student was only researching a single organelle thus was only an expert on that one part of the cell. I had spent an additional week with a variety of different exercises in the past for reinforcement of the material. Therefore, I think that the lack of repetition affected the outcome of the test for most students. In order to thoroughly cover each subject, it is necessary to integrate traditional teaching methods

with the Web 2.0 technology projects.

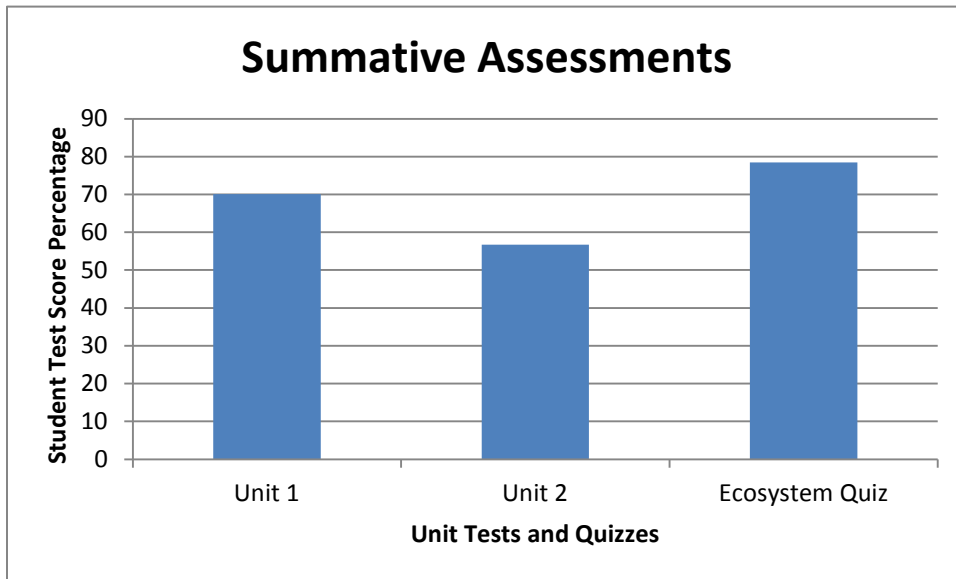


Figure 3. End of unit test scores, (N=103).

Finally, I tested the students on ecosystems following their national parks projects. Students were quizzed on food webs, energy pyramids and biomes. I was pleased to see the results shift towards higher achievement. Students averaged 78.5% on this quiz; which was their highest overall score on the three assessments. After examining the data from the first two assessments I made sure that I covered the material thoroughly prior to giving the quiz. Students responded with a higher overall achievement. I would like to think that it was due to the use of the Web 2.0 technology; however I think that the other factors probably played just as important a role as the computer instruction. Therefore I am not sure the data supports the hypothesis that Web 2.0 technologies increase student comprehension of science concepts.

Even though there was a decrease in test scores on the assessment that followed the cell organelle unit; I think it is evident that the Web 2.0 technologies had a positive

effect on student learning. I did not have students complete research with Web 2.0 programs during the scientific method unit. Whereas they did complete research on the computer; they did not use Edmodo. Thus the use of Edmodo during the national park research project appears to have had a positive impact on student understanding of the material covered during that particular unit. Students were required to participate in data gathering which led to them taking ownership of their learning by becoming a productive member of the interactive community.

Two out of the three units were taught with traditional teaching methods, Unit 1 on the scientific method and the Ecology Unit. I abandoned some of my reinforcement teaching practices such as note taking, CATs and hands-on labs during the cell organelle unit. When I integrated the traditional strategies used in Unit 1 and the Web 2.0 technology research project from Unit 2, the student achievement was highest. Therefore it is evident that teaching with Web 2.0 technologies has the most positive effect on student learning when combined with a variety of other teaching practices.

INTERPRETATION AND CONCLUSION

It is evident that students benefit from the use of interactive Web 2.0 technologies. These technologies increase student engagement, research skills and comprehension of scientific concepts. Increases in engagement were noted in student surveys (time on task: .25%, assignment value: 7%, and interest in topics: 1.7%). The pretreatment survey showed that students were highly engaged in science prior to the treatments. Students reported being on-task during science for approximately 80% of the time. This number only increased by one-quarter percent after the treatments, however it remained consistently high. Students reported a 7% increase in their perceived value of

classroom assignments. Therefore they were more engaged in task completion during science class due to the perceived increase in relevance. However, the greatest effects on learning were observed with student research skills and comprehension.

In regards to effects on research skills, students became more confident in their ability to use the computer to conduct research and learn science. Student confidence in learning science on the computer increased by 17% between the times they took the pre and post treatment surveys. Data collected during both treatments supported their opinions. Student scores increased 24% on the cell organelle diagram and 41% on the national park research following Web 2.0 instruction. Both of these gains support an increase in student ability to conduct independent research. The ability to conduct research was also assessed during student presentations of the scientific method, cell organelles and national parks. Overall there was an increase in quality of information presented during these three student projects. The greatest increase came between the individual projects (8%) while there was a slight decrease in performance between the second individual and group project (6.4%). While the group project scores averaged higher than the first individual project it was noteworthy to mention that the quality of information decreased between the group and second individual student research project. This drop in performance may have been due to an inconsistency in my instructional practices. Therefore it became necessary to look at student performance in completing assessments that measured content knowledge to gain a clear understanding of the effects of Web 2.0 technologies on learning.

In order to assess Web 2.0 effects on student comprehension of scientific concepts unit tests were conducted following each phase of my treatments. Student performance

on these assessments was inconsistent yet enlightening. There was a decrease in overall score of about 14% between the first and second unit tests. I initially found this information discouraging; however upon reflection I realized that my teaching practices were inconsistent between my first treatment and non-treatment therefore I made the proper adjustments prior to the final treatment in my project. I am happy to report that student scores then increased by approximately 22% between the second and third unit tests. This increase supported student gains in content knowledge with the use of Web 2.0 technology as the difference between the first and final unit tests was 8%.

The effect of Web 2.0 technology on student learning is indeed positive. Students saw benefits with gains in their classroom engagement, ability to do research, as well as an increased understanding of scientific concepts. If teachers use Web 2.0 technology as an additional tool for instruction, then students will undoubtedly benefit from the interactive nature of the Internet in learning. It also must be noted that careful planning is necessary to reap the greatest benefits from this resource.

VALUE

Teachers can maximize learning by carefully planning their activities to fit their students' technology skills. Not all students are well versed in using technology. Therefore teachers must be cautious not to turn them off to using technology by moving too fast. It may be best to gauge student skill levels before requiring the use of Web 2.0 technologies on projects. Then appropriate adjustments in instruction can be made to teach all students the basic skills necessary to complete the desired tasks. Once students are introduced to the programs and become more familiar with them, they should become more comfortable using web based programs to complete graded classroom tasks.

Prior to my research project I perceived my technology instruction as cutting edge. It came to light that I may want to revisit that perception. Student performance on assessments and presentations made me revisit my planning and instructional practices between units. Initially students performed well on their research projects. The average student score on the first student project was an impressive 86%. The scores on the second student project only went up, averaging nearly 94%. I attributed this increase to great instruction and efficient use of technology. However, following the drop in score for the third project (87.4%) it became clear that my expectations were inconsistent. I realized that collaborative assignments must have the same instructional format and expectations to be able to compare the data. Students were asked to do many of the same tasks during the first and third assignments; however the second assignment that saw the highest overall score was much easier than the other two. This difference in expectations became evident when comparing unit tests scores following each of the student research projects.

Students didn't gain as much knowledge during the cell organelle project because the expectations were different than the other two. This inconsistency led me to revisit my planning practices between units. It is easy to go from one unit to the next assuming that students will use the skills that they have acquired to learn the material. This is not the case with seventh graders. I have found that it is necessary to require the use of all learned skills otherwise students tend to do the least amount of work necessary to complete their tasks. This inconsistency in expectations only decreases student ability to learn information. I have found that there is great value in project learning at the seventh grade level. Students have the opportunity to gain information both individually and

collaboratively when completing topical projects. Therefore I have decided to plan my units more effectively to increase student learning.

Social networking sites such as Edmodo keep students engaged in projects; however it is necessary to require student interaction. Participation increased dramatically with daily grades for student postings. Plus, students enjoy working with Web 2.0 programs to complete presentations. Therefore, I will develop a balanced format that utilizes both technology and traditional resources to maximize student learning. Students still need to read from textbooks, complete regular assignments, and participate in inquiry activities to understand how to practice scientific thinking. I will plan my units with that format to provide consistent expectations for my students to learn each subject. This practice proved to be effective during the final treatment of my action research project. Students were given a clear list of expectations, learning goals and checkpoints for project completion. I assessed progress through Edmodo posts and exit cards. The micromanagement of the projects led to greater student achievement during project completion and on summative assessments. Plus, an integration of traditional teaching practices reinforced the learning of the material. This integration of traditional and technological assignment completion led to the greatest student achievement and proved that Web 2.0 technology can definitely benefit student learning.

All students can benefit from the use of technology. Most students excelled with the research portion of the treatments. This shows an increased level of engagement due to an interest in the method of data gathering. Their scores increased slightly on the assessment of their understanding of scientific concepts, therefore we may want to exploit that interest in using computers with more repetition to reinforce the scientific

concepts we would like them to learn. Individuals respond differently to the dynamics of group work, therefore it is necessary to take into consideration a learning curve when moving from individual to group research projects. This learning curve can be reduced and students can be just as efficient gathering data in group projects if the expectations are the same. It is imperative to be consistent in the structure and format of each unit being taught. Web 2.0 is not an avenue for students to “figure out” how to do research. Rather it is a tool for them to complete carefully planned exercises efficiently to maximize their ability to learn scientific concepts. Active participation in interactive lessons that utilized Web 2.0 technologies resulted in a unique learning experience for both me and my students. In-depth peer discussions and research completed by students led to my ultimate goal of accomplishing a more thorough understanding of classroom material.

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APPENDICES

APPENDIX A

STUDENT SCIENCE AND TECHNOLOGY PRETREATMENT SURVEY

Appendix A: Student Science and Technology Pretreatment Survey

Participation is voluntary and will not affect a student's grade or class standing in any way.

Answer the following questions by circling a number between 0 and 10. Zero represents an answer of never or none, five is about average or half of the time, and ten will represent always or all of the time. The other numbers represent different levels of closeness to never, half of the time and always. If you feel like your answer varies from day to day, try to think of an average to report on the survey. Please consider your answers carefully.

0=never, 5=half of the time, 10=always

How much time do you spend on-task (completing lessons) in science class?

0 1 2 3 4 5 6 7 8 9 10

Do you feel you use your time wisely in science class? Why or why not?

How much time do you spend doing in-class assignments that you find valuable?

0 1 2 3 4 5 6 7 8 9 10

What makes the assignment valuable or not?

How much time do you spend doing science assignments that you feel have little value?

0 1 2 3 4 5 6 7 8 9 10

What is an example of an assignment that might have little value to you? Why?

How interested are you in the science topics that you are learning about in class this year?

0 1 2 3 4 5 6 7 8 9 10

Please give examples of topics you are interested in. Why do you think you are interested in those topics?

How much time do you spend reading about or learning about science outside of the classroom? (Include time doing homework).

0 1 2 3 4 5 6 7 8 9 10

Do you think you spend enough time? Why or why not?

Do you have a computer at home? **Yes** or **No**

How many hours, on average, during the week do you spend on the computer at home?

0 1 2 3 4 5 6 7 8 9 **10_____Other**

How much of your time spent on the computer at home is for doing homework? (Include all classes).

0 1 2 3 4 5 6 7 8 9 **10**

Which computer programs do you use for completing homework? List the class next to the program please.

How many hours do you spend doing science on the computer each week? (Include both in and out of class time).

0 1 2 3 4 5 6 7 8 9 **10**

How confident are you in your computer research skills? 1=not at all, 5=average for a seventh grader, 10=expert

0 1 2 3 4 5 6 7 8 9 **10**

How many hours do you spend each week doing research?

0 1 2 3 4 5 6 7 8 9 **10**

Which programs do you use to do research?

Does the computer help you learn science better? 1=No, 5=Sometimes, 10=Definitely

0 1 2 3 4 5 6 7 8 9 **10**

Why did you answer this way?

What could I do to make computer use more effective at teaching you science?

APPENDIX B

STUDENT SCIENCE AND TECHNOLOGY POST-TREATMENT SURVEY

Appendix B: Student Science and Technology Post-treatment Survey

Participation is voluntary and will not affect a student's grade or class standing in any way.

Answer the following questions by circling a number between 0 and 10. Zero represents an answer of never or none, five is about average or half of the time, and ten will represent always or all of the time. The other numbers represent different levels of closeness to never, half of the time and always. If you feel like your answer varies from day to day, try to think of an average to report on the survey. Please consider your answers carefully.

0=never, 5=half of the time, 10=always

How much time do you spend on-task (completing lessons) in science class?

0 1 2 3 4 5 6 7 8 9 **10**

Do you feel you use your time wisely in science class? Why or why not?

How much time do you spend doing in-class assignments that you find valuable?

0% 10 20 30 40 **50%** 60 70 80 90 **100%**

What makes the assignment valuable or not?

What is an example of an assignment that might have little value to you? Why?

How interested are you in the science topics that you are learning about in class this year?

0 1 2 3 4 5 6 7 8 9 **10**

Please give examples of topics you are interested in.

Why do you think you are interested in those topics?

How much did Edmodo help you complete your research projects this year? (Cell Project and National Park Project)

0=not very much, 5=average, 10=couldn't have done it without it

0 1 2 3 4 5 6 7 8 9 **10**

How many **hours**, on average, during the week do you spend on the computer at home?

0 1 2 3 4 5 6 7 8 9 **10_____Other**

How much of your time spent on the computer at home is for doing homework? (Include all classes).

0% 10 20 30 40 **50%** 60 70 80 90 **100%**

Which computer programs do you use for completing homework? List the class next to the program please. (LA, Sci, SS, Math, WebDesign, Computers)

How confident are you in your computer research skills?

1=not at all, 5=average for a seventh grader, 10=expert

0 1 2 3 4 5 6 7 8 9 **10**

How many hours do you spend each week doing research?

0 1 2 3 4 5 6 7 8 9 **10**

Which programs do you use to do research?

Does the computer help you learn science better?

1=No, 5=Sometimes, 10=Definitely

0 1 2 3 4 5 6 7 8 9 **10**

Why did you answer this way?

Which programs help you learn the most?

What could I do to make computer use more effective at teaching you science?

APPENDIX C

PRETREATMENT SURVEY ALIGNMENT WITH RESEARCH SUBQUESTIONS

Appendix C: Pretreatment Survey Alignment with Research Subquestions

Research Sub-Question	Information Category	Pretreatment Question #
How do Web 2.0 technologies affect student research skills?	Research Skills	10 & 11
How do Web 2.0 technologies affect student engagement in science?	Engagement	1-5 & 9
How do Web 2.0 technologies affect student comprehension of scientific concepts?	Comprehension	12
	Current Computer Use	6-8

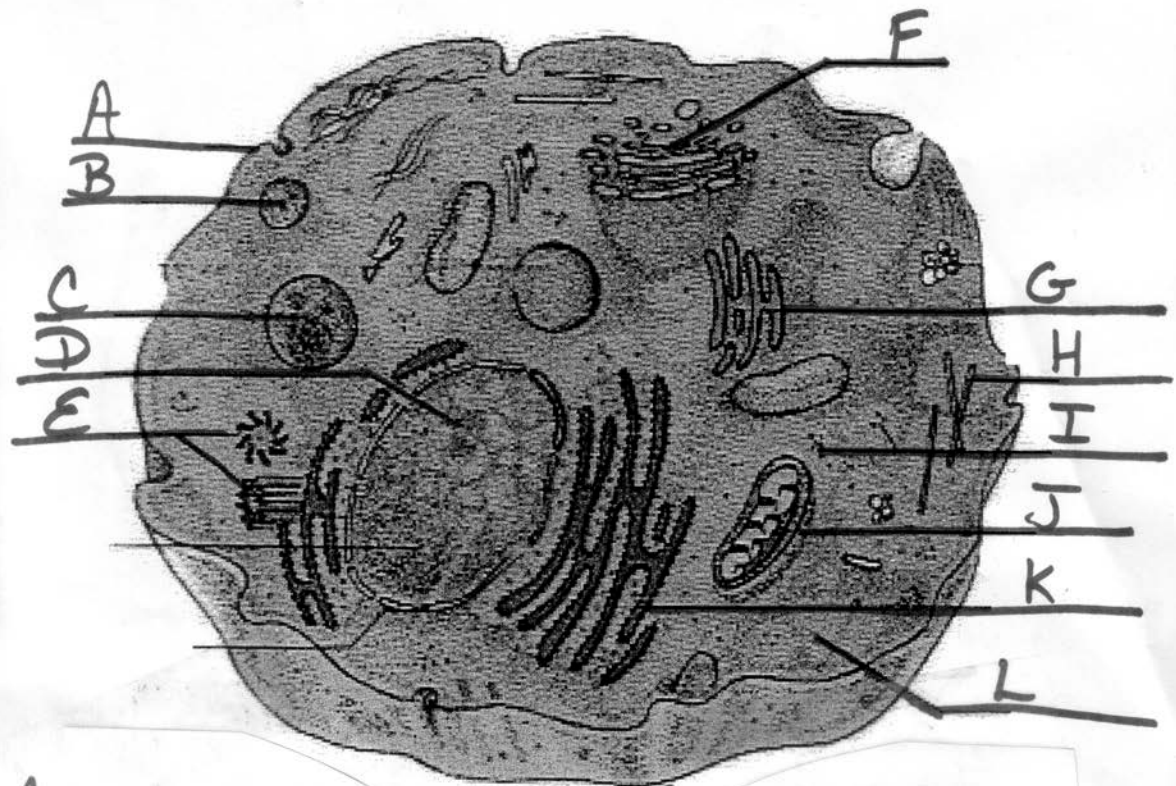
APPENDIX D

ANIMAL CELL LABELING DIAGRAM

Appendix D: Animal Cell Labeling Diagram

Label the
following
Diagram

Name:
Period:



A.
B.
C.
D
E
F.

G.
H.
I.
J.
K.
L

APPENDIX E

NATIONAL PARK RESEARCH WORKSHEET

Appendix E: National Park Research Worksheet

1. List all of the National Parks found in Hawaii:
2. Choose one park to research, list the park's name here:
3. Which year did your park become a national park?

Which part of the state is it located in?

4. List one interesting or unique non-living factor about your National Park?
5. What are the hours of operation and seasons that your park is open?
6. Make an organism list for your park:

Producers

1

2

3

Consumers

1

2

3

4

5

6

Decomposers

1

2

7. Make a food web and energy pyramid for your park using these organisms.....on the back please.

APPENDIX F

SCIENTIFIC METHOD RESEARCH PROJECT RUBRIC

Appendix F: Scientific Method Research Project Rubric.

Period	Name
Did the presentation have a character?	1 2 3 4 5
Was there a story that explained the inspiration of the scientist?	1 2 3 4 5
Did the student clearly state their problem?	1 2 3 4 5
Was the research clearly stated?	1 2 3 4 5
Is the hypothesis an IF/THEN statement that meets all requirements?	1 2 3 4 5
Could you follow the experiment and repeat it?	1 2 3 4 5
Were the results clearly stated?	1 2 3 4 5
Does the conclusion address the problem?	1 2 3 4 5
Was the plan finished on time?	1 2 3 4 5
Student comprehension of material	1 2 3 4 5
Creativity	1 2 3 4 5
PowerPoint presentation quality	1 2 3 4 5 6 7 8 9 10
Comments:	
Final Score:	/65

APPENDIX G

CELL ORGANELLE RESEARCH PROJECT PRESENTATION RUBRIC

Appendix G: Cell Organelle Research Project Presentation Rubric.

Period	Name
Did the presentation list the organelle name?	1 2 3 4 5
Were the functions listed?	1 2 3 4 5
Did the student list all types of cells the organelle is found in?	1 2 3 4 5
How well was the structure of the organelle explained?	1 2 3 4 5
Quality of organelle additional facts?	1 2 3 4 5
Was the presentation finished on time?	1 2 3 4 5
Creativity	1 2 3 4 5
Student Knowledge of Material	1 2 3 4 5
Presentation quality	1 2 3 4 5 6 7 8 9 10

Comments:

Final Score: /50

APPENDIX H

NATIONAL PARK RESEARCH PRESENTATION RUBRIC

Appendix H: National Park Research Presentation Rubric.

Park Name:

Student names:

Introduction slides	
Members/Park Name	1 2 3 4 5 6 7 8 9 10
Location/Map	1 2 3 4 5 6 7 8 9 10
History/Facts	1 2 3 4 5 6 7 8 9 10
Climate/Biome	1 2 3 4 5 6 7 8 9 10
Organism slides	
Data	1 2 3 4 5 6 7 8 9 10
13 Organisms	1 2 3 4 5 6 7 8 9 10
All trophic levels	1 2 3 4 5 6 7 8 9 10
Food Web	1 2 3 4 5 6 7 8 9 10
Energy Pyramid	1 2 3 4 5 6 7 8 9 10
Presentation Quality	1 2 3 4 5 6 7 8 9 10

Final Score:

/100

APPENDIX I

IRB EXEMPTION PROOF



INSTITUTIONAL REVIEW BOARD
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MEMORANDUM

TO: David Chimo
FROM: Mark Quinn, Ph.D. Chair *Mark Quinn*
 Institutional Review Board for the Protection of Human Subjects
DATE: November 16, 2011
SUBJECT: "Effects of Web 2.0 Technology on Student Learning" [DC111611-EX]

The above research, described in your submission of November 16, 2011, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal Regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- ☒ (b)(1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
- ☒ (b)(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.
- ☐ (b)(3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
- ☐ (b)(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.
- ☐ (b)(5) Research and demonstration projects, which are conducted by or subject to the approval of department or heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs or procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or under those programs.
- ☐ (b)(6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for which the FDA has determined that the food is safe, or agricultural chemical or environmental contaminant at or below the level found to be safe by the EPA, or the Food Safety and Inspection Service of the USDA.

used for the above research, the Comm
 of the usual app