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THE EFFECTS OF WEB-BASED TECHNOLOGICAL RESOURCES IN A RURAL SCIENCE CLASSROOM

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THE EFFECTS OF WEB-BASED TECHNOLOGICAL RESOURCES IN A RURAL SCIENCE CLASSROOM

By

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A REPORT

Submitted in partial fulfillment of the requirements for the degree of

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This report has been approved in partial fulfillment of the requirements for the Degree of MASTER OF SCIENCE in Applied Science Education.

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Abstract

Today's technology is evolving at an exponential rate. Everyday technology is finding more inroads into our education system. This study seeks to determine if having access to technology, including iPad tablets and a teacher's physical science webpage resources (videos, PowerPoint® presentations, and audio podcasts), assists ninth grade high school students in attaining greater comprehension and improved scientific literacy.

Comprehension of the science concepts was measured by comparing current student pretest and posttest scores on a teacher-written assessment. The current student posttest scores were compared with prior classes' (2010-2011 and 2009-2010) to determine if there was a difference in outcomes between the technology interventions and traditional instruction. Students entered responses to a technology survey that measured intervention usage and their perception of helpfulness of each intervention.

The current year class' mean composite scores, between the pretest and posttest, increased by 6.9 points (32.5%). Student composite scores also demonstrated that the interventions were successful in helping a majority of students (64.7%) attain the curriculum goals. The interventions were also successful in increasing student scientific literacy by meeting all of Bloom's cognitive levels that were assessed.

When compared with prior 2010-2011 and 2009-2010 classes, the current class received a higher mean posttest score indicating a positive effect of the use of technological interventions. The survey showed a majority of students utilized at least some of the technology interventions and perceived them as helpful, especially the videos and PowerPoint® presentations.

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Chapter 1 – Area of Focus

Introduction

Many teachers today are faced with the challenge of educating students with various ability levels and socioeconomic backgrounds. Many of those students have little interest in or motivation for school. State and national legislation provide a framework for instruction, but also seem to place all the accountability for student education on the teachers. Within finite class periods and contact time, educators must help students to make connections between science content and their everyday lives. Teachers are also tasked with ensuring that all students become scientifically literate, life-long learners - who embrace all the science knowledge that will enable them to be active, knowledgeable citizens in our democratic society.

Education itself has evolved by developing varying pedagogical approaches to address the seemingly overwhelming challenges presented to teachers by students and curriculum. Armed with educational methodologies and research, teachers strive to meet these contemporary challenges. One emerging strategy for teachers is to utilize technology to meet students' educational needs.

This study sought to determine if having access to technology, including iPad tablets and the teacher's physical science webpage resources, could affect students' learning. The use of technological interventions (videos, PowerPoint® presentations, and audio podcasts) was assessed to determine their impact on (1) improving my ninth grade physical science students' comprehension of the content standards and (2) scientific literacy compared to traditional instruction.

Motivation for the Study

I have taught science for fourteen years in the United States (Michigan and Idaho) and Africa (Kenya). Currently, I teach at Calumet-Laurium-Keweenaw (CLK) High School, which is the most northern school district in Michigan. There are approximately thirty teachers and 420 students at CLK high school, with approximately 67% of the students receiving free or reduced-price lunches. The school's mission statement reads, "The mission of Calumet High School is to educate all students in a supportive, challenging, and disciplined environment to become lifelong learners whose performance is a credit to themselves and society."

The courses I teach include tenth grade biology and ninth grade physical science. The physical science class encompasses the physics and chemistry "essentials", as defined by the Michigan High School Science Content Expectations. In a typical year, the top 15 to 20 percent of the ninth grade students choose to bypass the physical science course and start their high school career in biology. Many of the students who enter physical science are unmotivated and have had little previous success in science. Several have failed all their science classes in middle school. However, the standard middle school practice is to pass these students on to the next grade level. When I refer to information that should have been learned in middle school, students claim they do not know or recall the material.

An additional challenge for me and my students is their inadequate reading skills. Each year, I have one or more students at very low reading level. I believe that reading from books or other resources is an important skill to have. As a science teacher, I encourage students to focus on reading for comprehension, not to simply pass a test.

Curriculum Goals

I hypothesize that students will comprehend the physical science course objectives more readily if they are able to review supplemental videos, PowerPoint presentations, and audio podcasts covering the earth science and chemistry curriculum.

The videos, PowerPoint presentations, and audio podcasts that I selected to use with my physical science class served several purposes. Students used these interventions to:

1. Review lecture materials to strengthen their comprehension of the material.
2. Clarify confusing material or misconceptions.
3. Find out about authentic perspectives of past and present science contributors. The teacher provided links to PowerPoint presentations, videos, and audio podcasts relating contributions by historical figures and modern scientists. These interventions are intended to solidify the idea that science is an active process with many goals and differing paths and practitioners.
4. Help students explore and support the idea that the science content learned in this class may be helpful in their future career.

Governor Rick Snyder proposed a new public school learning model on April 11, 2011 entitled “Any Time, Any Place, Any Way, Any Pace” (Snyder, 2011, p.7). Snyder stated that, “Michigan’s education system must be reshaped so that all students learn at high levels… they must think and act innovatively, demonstrate high performance, and meet the highest expectations (Snyder, 2011, p.1). He goes on to say that, “Education opportunities should be available 24 hours a day, 365 days a year” (Snyder, 2011, p. 7).

The CLK school system is utilizing several approaches to meet the challenge set by Governor Snyder and the needs of our community. The CLK school has adopted the phase, “Anytime, anywhere” - using an abbreviated version of Snyder’s new learning model. Teachers are encouraged to utilize technology for greater student comprehension and achievement. This study will help determine the success of the CLK school system’s efforts to meet this goal.

This study also aligns with CLK school’s technology mission, "CLK - Leading with technology for teaching and learning” and our philosophy, “Today’s students will be part of an ever-changing technological society. Our graduates must have sufficient understanding of technology to ensure that they will continue to be competitive in the workplace and engage in lifelong learning.”

Chapter 2 – Literature Review

Scientific Literacy

The Michigan Department of Education (MDE) has identified scientific literacy as one of the most important goals of science education. At the very beginning of the Michigan Essential Goals and Objective in Science Education (MEGOSE) document, the authors begin with "Scientific Literacy for All Students". This section starts with a quote from the American Association for the Advancement of Science, "By all accounts, America has no more urgent priority than the reform of education in science, mathematics, and technology" (Rutherford and Ahlgren, 1990, p. viii). The MEGOSE authors go on to say that, "the primary purpose of K-12 science education, therefore, must be scientific literacy – an understanding of those aspects of science that are essential to full participation in a democratic society – for all students" (MEGOSE, 1990, p. 3).

The MEGOSE (1990) document maintains that building scientific knowledge is complex and challenging; students would have a difficult time navigating the language and concepts without direction. Teachers must provide this guidance and support. It is not enough for educators to cover science concepts, such as Michigan's Grade Level Content Expectations (GLCEs) (2010). The goal is to empower students to comprehend intricate, multifaceted topics that transcend any specific science discipline, such as earth science, biology, or physics.

Scientific literacy is the understanding of science concepts that is necessary for students to participate in making rational decisions in a democratic society. A scientifically literate person is empowered to construct knowledge, reflect on the implications and meaningfulness of the knowledge, and use this knowledge to describe, process, explain, and control the world around them in a meaningful way. Scientifically literate students need to be able to reflect on the content and determine the weaknesses and limitations of arguments that are presented as scientific. These individuals can use their science knowledge to explain phenomena (real world situations) and design solutions for current problems and future challenges. Scientifically literate students use these skills and motivation to become lifelong learners and actively participate in a democratic society.

Michigan establishes a goal of education to empower students so they are able to think for themselves and use the skills necessary to solve the challenges of today and tomorrow. Students need to be able to construct new knowledge through research, reading, and discussions. Students should develop the skills to debate and critique the scientific knowledge that they have learned. As educators, we do not want students to simply be a sponge – absorbing the information and then simply giving it back to us on an assessment as we squeeze the information back out of them. The intent is to have students evaluate the information that is presented.

The MDE has used the *Science for all Americans* report from the American Association for the Advancement of Science Project 2061 as a guide for establishing curriculum to build scientific literacy. The authors of *Science for all Americans* organized the curriculum objectives around three components – knowledge, activities, and contexts.

The knowledge facets are centered on "describing ideas, strategies, and the connections among them." Again, the goal of Michigan education is not for students to memorize facts and figures, but to understand the connectedness and relationships of underlying themes and systems. *Science for all Americans* identified six characteristics of scientific literacy that are related to "knowledge":

- Being familiar with the natural world and recognizing both its diversity and its unity.
- Understanding key concepts and principles of science.
- Being aware of some of the important ways in which science, mathematics, and technology depend on one another.
- Knowing that science, mathematics, and technology are human enterprises and what that implies about their strengths and limitations.
- Having a capacity for scientific ways of thinking.
- Using scientific knowledge and ways of thinking for individual and social purposes (MEGOSE, p. 5).

The MDE scientific literacy activities component is centered on the "Social Nature of Understanding" (MEGOSE, p. 6). In a productive, democratic society, individuals communicate, debate, and work together to solve problems using scientific knowledge. Using the *Science for all Americans* report, the MDE grouped "objectives" (intended learning outcomes) into three broad categories of activities (not processes) that were considered characteristic of scientifically literate individuals. These categories were USING scientific knowledge, CONSTRUCTING new scientific knowledge, and REFLECTING on scientific knowledge (Yarroch, 2003). These three activities are "common in scientifically literate communities" (MEGOSE, p. 6).

The MDE organized the primary science content objectives around the "using" component. Yarroch (2003) explains that, "This was knowledge to be employed in describing, predicting, explaining, and controlling the environment about the literate individual, rather than just regurgitated facts for the sake of passing tests".

The third element of Michigan's scientific literacy agenda is the understanding of scientific knowledge in a real-world context. Scientifically literate individuals can differentiate between concepts, including those within a specific discipline. In a physical science class, students must identify and distinguish different types of phenomena, including motion, electromagnetic relationships, and physical, chemical, and nuclear changes in matter. Other contexts include natural (life science), geological (earth science), technological, historic, and economic systems (MEGOSE, p. 7).

The National Science Education Standards (NSES), published by the National Research Council (NRC), provide structure and guidance for all states in the Union. They identify major benchmarks that should be attained by all students, with a focus on scientific literacy. The NSES state that scientific literacy "is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity" (NRC, 1996, p. 22)

The NSES incorporates not only science concepts, but also science as inquiry, science and technology, science in personal and social perspectives, unifying concepts and processes in science, and history and nature science. As a comparison, Michigan specifies certain objectives to include social implications, technology, and historical perspectives.

The NSES and Michigan Curriculum Framework Science Benchmarks (MCF), produced by the MDE, both focus on the general theme of scientific literacy: that science is something students do, not something that is "done to them" (NRC, 1996, p. 20). Science is an "active process" (NRC, 1996, p. 62) and "scientifically literate students are learners as well as users of knowledge" (MDE, 1996, p. 2) who can: construct, reflect, and use science to describe, predict, explain, and design. Science needs to be a "minds-on" experience (NRC, 1996, p. 20), so students can attain the knowledge and understanding of scientific concepts and phenomena for use in their daily lives.

Reflecting on the MCF and the NSES goals and benchmarks, I feel schools have the foundation to build scientific literacy amongst Michigan students. Implementation and usage of these benchmarks is however a challenge to many educators. Unfortunately, there are other factors that teachers need to help students overcome before they can become successful.

"Research indicates that gender, cultural and psychological barriers, and curricular teaching strategies are the major contributing factors to low participation, interest, and achievement by minority students in science and mathematics" (Fraser-Abder, 2005). Educators need to be conscious of their students' learning environment, previous knowledge, strengths and weaknesses, and even their socio-cultural background. As a principal that I worked with once said, "Students won't care what you [teacher] know, until they know that you care" (Horton, 2005a). Caring educators help students develop a passion for learning that does not stop at a high school diploma.

Another goal of science literacy education is to empower students to be lifelong learners. "From this 'life-long learning' perspective, the goal of compulsory school science education is to provide a basis for future learning… it is important that school science promotes a positive attitude towards engaging with science by giving students a sense that science is a subject that they are capable of interacting with as adults" (Ryder, 2001, p. 4). Thomas Carruthers adeptly summarizes the role of teachers in helping students become lifelong learners with, "A teacher is one who makes himself progressively unnecessary."

The schools foster the expectations and guide the life-long learner toward science understanding. However, students need to continue their science education beyond the classroom. "Few if any students can be said to be scientifically literate upon graduation from high school in any meaningful sense of the word. At best, students have been introduced to science and the issues that science raises in society, and they like science and care enough about it to stay informed as adults" (DeBoer, 2000, p. 597).

Identifying similar themes that characterize scientific literacy, Jim Ryder (2001) refers to the American Association for the Advancement of Science (AAAS) publication Benchmarks for Scientific Literacy. This AAAS Benchmarks document aims to provide "a set of recommendations on what understandings and ways of thinking are essential for all citizens in a world shaped by science and technology" (AAAS, 1990, p. xiii). A large array of science issues are identified under the headings "nature of science", "historical perspectives", "common themes" and "habits of mind".

The NSES also identifies another key attribute of scientifically literate citizens – the ability to critique scientific data, while evaluating the sources and techniques used to produce the information. "Scientific literacy also implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately" (National Science Education Standards, 1996, p. 22)

To emphasize the need for scientifically literate citizens to think critically, Ryder (2001) illustrated a real-world example. A cement company took emission measurements near a village in the United Kingdom, but only made public one value. Scientists discovered that the cement company had frequently conveyed the lowest of the emission measurements taken: "for example, one of the three baseline measurements was selected to show a 75% reduction in heavy metals whereas choosing another would have shown a 10 fold increase' (Ryder, 2001, p. 3). The cement company gave only a single measurement with a trouble-free emissions value, "without any communication of the inherent variability associated with the measurement. For the local residents, an appreciation of the fact that measurements do carry variability may have enabled them to engage critically with company officials by asking about the number of measurements taken, and the spread in these measurements" (Ryder, 2001, p. 3).

It is not only regular citizens that need to be scientifically literate, but also teachers and administrators. Educators make important decisions that affect students, such as choosing curricula, textbooks, or readings. Bracey (2000) highlights this by comparing two different reading programs – "the remedial program, *Success for All*, in one school and… [the] regular reading program in another" (Bracey, 2000, p. 58). Then Bracey posed the question, if student reading scores are higher in the *Success for All* program compared to the standard reading program, should the district simply adopt the new program? The decision could affect thousands of students and cost the district millions for dollars. Is this the right choice? As educators, we too must not let a single number charm us into a decision without thinking critically and evaluating the situation.

We need our citizens to be knowledgeable (scientifically literate) on the economic, political, and cultural topics that affect our society. The NSES serve as a template for the development of each individual state's benchmarks and standards for scientific literacy and inquiry. Each state prepares and assesses its own standards, but should emulate the goals and aspirations of the national standards. Finally, the knowledge identified in the standards is necessary to maintain and foster an active and informed democratic society.

Historical Audio-Visual Supplemental Instruction

Every day, you hear radio announcements telling you that their programming can also be heard on the internet via podcasts; there are countless television programs stating their highlights can be seen on video feeds also found on the web. Educators are beginning to catch on to this new method of educating our youth. However, the idea of audio-video learning has been around for almost half a century.

In 1967, educators at St. Petersburg Junior College in Clearwater, Florida were looking for a new way to bolster student test scores in their earth science program. Since the opening of the school in 1964, "nearly 40% of the students registered for earth science received less than 'C' as a final grade (Gould et al, 1972, p. 81). St. Petersburg Junior College created a learning center that included a "Burgess reel-to-reel audio tape machine, a Kodak Carousel slide projector, and other material needed during a specific unit [film strips, brief single-concept movie, etc.]" (Gould et al, 1972, p. 81). Students were able to hear the professors' lectures at their own pace. They could rewind and play back material that they needed to review. Also, the slides gave students the opportunity to see what the professor was describing in their lectures. At different points in the professors' lectures, students were instructed to stop the tape and carry out an activity or observe a demonstration. "The pauses serve a two-fold purpose – to prevent fatigue and to encourage a more active approach to the audio-visual lesson." (Gould et al, 1972, p. 82).

At the end of the first semester, the randomly selected students in the audio-visual group only had 19 percent of the students receive a grade lower than a C, while the standard students had 29.2 percent (Gould, et. al, 1972). In the second semester the results were more dramatic, with only 12 percent of the audio-visual students not achieving a C, at the same time as the conventional students had 30 percent. After the second semester of the program, all earth science classes included the audio-visual tutorial program. Mott (1980) reviewed the program ten years later and found that the program now serves five times the number of students. He also stated that "the students come away with better grades and more positive attitudes" (Mott, 1980, p. 233).

Podcasts and Videos

In recent years, videos and podcasts accessed via the internet have evolved into a technological phenomenon. This wave of new technology is used daily by a majority of grade school students. However, there is limited research data on the learning effects of videos and podcasts when used in conjunction with a high school setting. On the other hand, many colleges and universities around the world have also begun utilizing these resources.

Higher education has been the vanguard in seeking ways to embrace this new technology, especially podcasts. In 2004, Duke University gave away iPods to each person in the freshmen fall semester, which totaled 1,650 students (Read, 2005a). Professors incorporated this new technology in their classrooms. The main focus was on having professors' lectures available as podcasts.

After a year of implementation, it was reported that "75% of freshmen surveyed said they used the devices for at least one course… [of the] almost 50 courses, with a total of more than 1,200 students, made use of the technology" (Read, 2005c, p. A28). An array of professors utilized this technology in their various disciplines including language, economics, and engineering. However, the iPod project did have its critics. One student complained that the iPods "gives the message that coming to lecture or paying attention is not important because everything will be online later anyway" and "campus officials have already announced that Duke will scale back its iPod giveaway next year" (Read, 2005c, p. A28).

Another set of researchers, Guertin et al. (2007), examined the use of podcasts by university students. At Penn State University, an introductory geoscience professor recorded her classroom lectures and made them available to students as podcasts via the internet. The researchers tracked the number of times podcasts were downloaded, surveyed students on their familiarity with downloading the lectures, and to what extent students felt that the podcasts were beneficial to their education. At the conclusion of the semester, more than fifty percent of the students knew how to access and use the podcasts of the professor's lectures. Even so, 100% of the students surveyed believe that the podcasts should be available for students to assist in their educational needs.

Alan J. Cann, a professor at the University of Leicester, England had made audio podcasts of lectures and supplemental support materials for over two years. However, the number of students downloading the audio podcasts was low. Cann (2007) began a study to determine if short video summaries of lectures and supplemental information would have greater frequency of utilization compared to podcasts. The video format "generated an average 1.75 downloads per student per video, over five times the response rate from the same cohort to the audio files [podcasts] provided the previous semester" (Cann, 2007, p. 2).

Today, even secondary and elementary level educational institutions have the opportunity and means to tap into the enormous popularity of on-line videos, including YouTube, TeacherTube, NASA, Discovery, and the Public Broadcast System (PBS). With online videos and podcasts teachers can create free, interactive, self-paced learning environments for their students. Additionally, students can access these resources from devices their already possess, including computers, game consoles (i.e. Xbox, Sony PlayStation, etc.), and mobile devices such as phones, MP3 players, and video players.

iPad Tablet Research

At the time of this writing, I have not found published research on the effectiveness of the iPad tablet in instruction. This includes educational studies done at the primary, secondary, and post-secondary levels.

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Chapter 3 – Design

This study sought to determine if having access to technology, including iPad tablets and a teacher's physical science webpage resources, could help ninth grade high school students meet outcomes specified by specific state standards for earth science and chemistry (Table 1). It was hypothesized that access to technology would enable students to achieve greater comprehension and become more scientifically literate as compared to traditional classroom instruction.

Overview

The study took place during the second semester of the 2011-2012 academic year and lasted for five weeks. The study included four ninth grade physical science classes with approximately twenty-five students each. All four of these classes were designated the treatment group with access to the teacher's physical science webpage. These classes were then divided into two subgroups – the non-aggressive treatment group (second and third period) and the aggressive treatment group (fourth and fifth period). In addition, the students in the treatment group were compared with students from the two prior year classes who did not receive any of the technological interventions.

All students in the 2011-2012 physical science classes had been issued iPad tablets. In addition, the teacher's physical science webpage had several technological resources that were directly and indirectly related to the curriculum objectives. A standard curriculum was used for all three classes being compared, but the current third (2011-2012) year included the technological interventions (Table 2).

Table 1. Michigan High School Content Expectations and Michigan Curriculum Framework Codes Used in the Earth Science and Chemistry Curriculum.

Framework Code*	Expectations
E1.1B	Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design and/or the dependence on underlying assumptions.
E1.2f	Critique solutions or problems, given criteria and scientific constraints.
E5.3e	Determine the approximate age of a sample, when given the half-life of a radioactive substance along with the ratio of daughter to parent substances present in the sample.
E5.3f	Explain why C-14 can be used to date a 40,000 year old tree, but U-Pb cannot.
C2.2B	Describe the various states of matter in terms of the motion and arrangement of the molecules (atoms) making up the substance.
C4.2d	Given the name, write the formula of ionic and molecular compounds.
C4.3B	Recognize that solids have a more ordered, regular arrangement of their particles than liquids and that liquids are more ordered than gases.
C4.7b	Compare the density of pure water to that of a sugar solution.
C4.8A	Identify the location, relative mass, and charge for electrons, protons, and neutrons.
C4.8B	Describe the atom as mostly empty space with an extremely small, dense nucleus consisting of the protons and neutrons and an electron cloud surrounding the nucleus.
C4.9A	Identify elements with similar chemical and physical properties using the periodic table.
C4.9b	Identify metals, non-metals, and metalloids using the periodic table.
C4.9c	Predict general trends in atomic radius, first ionization energy, and electronegativity of the elements using the periodic table.
C4.10A	List the number of protons, neutrons, and electrons for any given ion or isotope.
C5.2B	Distinguish between chemical and physical changes in terms of the properties of the reactants and products.
C5.5A	Predict if the bonding between two atoms of different elements will be primarily ionic or covalent.
C5.5c	Draw Lewis structures for simple compounds.

* E is for Earth Science Expectations, C is for Chemistry Expectations

Table 2. Summary of Standard Instruction of Earth Science and Chemistry Curriculum.

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	Mid-Winter Break No School	Introduction to Earth Science &Chemistry Unit Assign Reading Guide Part 1 Pretest MTU Research Study	Snow Day No School*	Snow Day No School*	Introductory Lab Activity
Week 2	Introduction to the Periodic Table – Notes and Identify Patterns	Presentation Addendum Notes: Half-Life and Radioactive Decay	Assign Reading Guide Part 2 Video + Notes: Introduction to Chemical Reactions	Presentation Chapter 19 Notes 1 of 3 Group Activity 1 Periodic Table Elements Quiz 1	Work on Atomic Model Project – Posters & Models Group Activity 2 Bohr Diagrams
Week 3	Assign Reading Guide Part 3 Presentation Chapter 19 Notes 2 of 3 Diagram atoms on Dry Erase Boards	Video + Notes: Periodic Table Diagram atoms on Dry Erase Boards	Group Activity 3 Chemical Bonding Elements Quiz 2	Atomic Model Project Presentations: - 3D Model - Poster - Paper	Mini-Quiz 1 Finish Atomic Model Project Presentations
Week 4	Assign Review Review Periodic Table Diagram atoms, ions, isotopes on Dry Erase Boards	Mini-Quiz 2 Presentation Chapter 19 Notes 3 of 3 Diagram atoms, ions, isotopes on Dry Erase Boards	Diagram ions, isotopes, chemical bonding on Dry Erase Boards Elements Quiz 3	Review Half Life & Radioactive Decay Sample Problems	Mini-Quiz 3 Overview of Chapter – Review Presentation
Week 5	Practice Quiz Questions Jeopardy Review Chapters 16, 17, 18,19	Posttest MTU Research Study	Scheduling Day for next year's classes See students in the morning for a short time	Technology Survey	End of Third Marking Period

* No School was for current year and not typical for the curriculum

A multifaceted approach was used to assess student knowledge gain over the intervention period, which served to triangulate the data more decisively (Mills, 2003, p. 52). First, students' comprehension of the science content was assessed by comparing the current year pretest and posttest scores which utilized the same assessment items (Appendix A). Second, students completed a technology survey two days after the posttest. Third, assessment data (posttest) from the previous two years was utilized as a means of comparison with the current year scores.

The entire second semester of instruction for physical science followed the standard teaching practices used for all three classes being compared. The instruction encompassed Michigan's High School Content Expectations (HSCE) in earth science and chemistry. The primary expectations covered, during the five weeks of this study, included the following: Inquiry, Reflection, and Social Implications (earth science standard E1), The Earth in Space and Time (earth science standard E5), Forms of Energy (chemistry standard C2), Properties of Matter (chemistry standard C4),and Changes in Matter (chemistry standard C5) (Table 1).

The approach to the physical science curriculum was multifaceted to ensure that all students meet these expectations. Students were encouraged to not only learn the course material, but also to question and reflect on the information. It is apparent that many of today's students simply want to "Google" the correct answers without trying to comprehend the information. To counter this trend, the curriculum focused on bridging what students learned in class with what they knew from previous experiences; students were encouraged to find deeper connections to what they already knew.

Students did not learn the curriculum by being lectured to, but rather experienced information through reading, active investigations, and research projects. Students were expected to analyze data, form educated predictions, modify them based on new information, identify possible sources of error, and propose changes for future investigations.

The students were also expected to cultivate the basic skills needed to be successful in today's modern workplace. Universities and employers desire the skills students learned in physical science, including being active learners who ask thoughtful questions, plan and organize their work, and collaborate with their peers.

General procedure for each week. The lesson plans for the week were displayed on the front white board in the classroom (Appendix B). Each Monday, students were required to write down the activities for each day of the week. The activities were color coded to help students become more organized and cultivate time management skills – green lettering indicated when something was assigned and red indicated when something was due. Each assignment was printed on different color paper, which further assisted students in fostering their own organization skills; students also had at least three days to complete assignments. There were no "pop-quizzes" and students knew a week in advance when quizzes and tests would be held.

Students were assigned reading guides that outlined the science textbook and focused on the chapter objectives. After the reading guides were completed, the instructor reviewed the information with the class via PowerPoint presentations. Class discussions, along with question and answer sessions, helped to round out students' comprehension of the earth science and chemistry objectives. The five PowerPoint presentations were used for all three classes being compared (Appendix B).

General procedure for starting each class period. A warm up activity was displayed on the front board, before the beginning of every class period. With each activity, questions were assigned to help students focus their attention and serve to introduce and review pertinent chemistry information. Students' responses demonstrated their knowledge of chemistry vocabulary terms and periodic table patterns, their ability to identify and differentiate between physical and chemical changes, and their comprehension of chemical bonding.

General activities for the Earth Science and Chemistry Unit. The earth science and chemistry unit began with an engaging, introductory laboratory activity (Table 2). Students were required to take several measurements and calculate the density of fifteen unknown cylindrical objects; each cylinder had a different chemical composition. Students were then given the known names and densities of the fifteen objects. Students had to identify the unknown objects based on the known densities. In the final step, students were required to identify possible sources of error, calculate percent error, and propose ways to increase the accuracy of their measurements.

Students completed and presented an "atomic model project" during the third week of instruction (Table 2). Students could choose to work alone or in a group to research information about their selected element, including the discovery and history of the element, the physical and chemical properties, and general uses. For their element, students wrote a summary paper, produced a poster display and created a three-dimensional model of an atom. Students were required to critique each other – scoring poster displays, atomic models, presentations, and identifying positive attributes and areas of improvement for each group (Appendix B).

Student progress was quantitatively measured via "Mini-Quizzes," during the third and fourth week of instruction (Table 2). These quizzes (five questions) reflected the earth science and chemistry content covered in the reading guides and direct instruction (Appendix B).

Students were occupied with an interactive, diagramming activity using individual white boards in the third and fourth weeks of instruction (Table 2). Students elaborated and solidified their comprehension of specific earth science and chemistry objectives through this hands-on technique. Each student was provided with a periodic table, white board, different color dry erase board markers, and an eraser. Students started diagramming basic, individual atoms, utilizing the scaffolding technique. At the end of the third week and through the fourth week, the activity evolved into depicting more complex chemical bonds between atoms and explaining their interactions.

The diagramming activity always began by giving students an element's symbol. On their individual white boards, students had to recall the element name and correctly identify the mass number, atomic number and discern the number of subatomic particles (protons, electrons and neutrons) using the periodic table. Students then drew a Bohr diagram of the atom. Students were required to place the correct number of protons and neutrons inside the nucleus. Likewise, the correct number of electrons had to be place in each energy level. With each successful attempt, students were required to provide more information, including element type (metal, nonmetal, metalloid); if the element would lose, gain, or neither gain or lose valence electrons and its new ion name (if applicable); and whether it has isotopes.

The more complex diagramming activities involved combining two or more atoms. Students were required to identify the compound name, chemical formula and bond type. Several examples, demonstrating the progression of difficulty for this activity, include: (1) diagramming a lithium atom and showing how it becomes a lithium ion; (2) depicting a carbon-14 isotope; and (3) displaying the subatomic particles for lithium and oxygen atoms and then describing how they interact to create lithium oxide (Appendix B).

The day before the summative assessment (posttest) in week five, the instructor provided sample questions and the solutions. Class discussion assisted in correcting any misconceptions. The "Jeopardy" review provided a dynamic means of reviewing the earth science and chemistry objectives.

Intervention

The standard curriculum was kept the same in all three classes, but in the current year, the following technological resources were incorporated into the instruction: student iPad tablets, videos, audio podcasts, and access to the PowerPoint presentations used in class through the teacher's webpage. These technological additions were intended to target the following:

1. Learning of the periodic table, chemical bonding, half-life, and radioactive atoms. (Videos, PowerPoint presentations, podcasts and iPad tablet periodic table applications or apps)
2. Student organization and minimizing missing or late assignments (on-line lesson plans)
3. Ability of absent students to access daily curriculum and down-load assignments (teacher's webpage)
4. Creation of an individualized, self-paced learning environment for students through use of videos, PowerPoint presentations, and podcasts (teacher's webpage)
5. Improvement of communication between teacher and students (email)
6. Visualizing and recalling information (iPad tablet camera – pictures of demonstrations, labs, activities and the Flashcard® app)
7. Increased capacity for students to work on projects, papers, assignments "anytime – anywhere" (iPad tablet apps (Keynote®, Pages®, Periodic Table®, and EMD PTE®) and the iPad tablet camera)

The current year was designed for students to fully embrace the Calumet motto for learning "any time - anywhere", with individual iPad tablets and the school's wireless network. Students could access teacher webpages, view current events and work on their research papers anywhere within the school. For longer athletic trips, the high school chartered buses with internet access so students could watch instructor videos or email teachers with questions, even while traveling.

The teacher's webpage was designed to permit students and their guardians to stay apprised of the current curriculum and what was happening in the science class. The main topics and objectives for each unit were displayed on the teacher's webpage. The tentative lesson plans for the month could be easily accessed from the webpage. With this information, students should never have been surprised to learn when an assignment was due or a test was scheduled.

All of the assignments for the earth science and chemistry curriculum were uploaded and displayed on the teacher's webpage. Even when students were sick or out of town, they were provided the opportunity to download the assignments directly to their iPad tablet or home computer. Through the webpage, students could also access the chapter review and practice problems to reinforce the main concepts of the unit.

The instructor placed links to interactive webpages reviewing the periodic table, half-life, and radioactive atoms. In previous years, students have had difficulty comprehending these topics. The instructor identified several interactive webpages and encouraged students to visit these sites. The websites allowed students to manipulate variables, reflect on changes, and experience the information in a more visual fashion.

Another intervention was designed to allow students access to technological resources including eight videos, five PowerPoint presentations, and two podcasts through the teacher's webpage (Appendix B). The videos and audio podcasts were novel strategies used only during the current year. The five PowerPoint presentations were part of the standard curriculum and were used during the previous two years. However, one of the main tenets of the study is that these resources were accessible online to students at any time during the study.

The eight videos were selected to enhance student comprehension of the earth science and chemistry objectives. Students who used the videos were able to review key concepts, correct any misconceptions, and reach a deeper comprehension of the curriculum at their own pace. The videos were arranged in the order that they should be viewed using the scaffolding technique. The first videos introduced and enforced basic ideas, while later videos focused on more complex concepts such as chemical bonding. A majority of the videos posted on the teacher's webpage were created by Educator®. This company employs experienced professors who walk students through each concept step by step. (The technology for creating teacher videos was not available at Calumet High School during the time period of the research study).

In previous years, the instructor went over the five PowerPoint presentations in class only once. During the intervention period, after the teacher reviewed the PowerPoint presentations in class, students could retrieve this information at any time. Two different audio podcasts were linked on the teacher's webpage that gave overviews of physical and chemical changes.

The school district down-loaded many iPad tablet applications (apps), which allowed students to use this mobile computer in many new ways. Students were able to access information from the internet in real-time. They could look up current events, research science topics, and access teacher webpages.

The iPad tablet's camera allowed students to take pictures during lab investigations, demonstrations, and especially the white board diagramming activity. Later, students used these images when reviewing for the posttest.

Students used the Flashcard application (app) when learning the periodic table. Students were required to create 28 flashcards, either using index cards or their iPad tablet Flashcard app; most students chose the app alternative. Students needed to know the elements' names, symbols, and element type (metal, nonmetal, or metalloid). On three different occasions, students were assessed on their recall of this information (Appendix B).

During the atomic model project students used Keynote (similar to PowerPoint) to create their class presentations. The Pages app, a word processor similar to Word®, was used to type the summary paper on their particular element.

Two free periodic table apps (Periodic Table® and EMD PTE®) allowed students to experience a substantial amount of information for each element. The apps allowed students to quickly identify the phase of matter, group, period, orbitals, Bohr diagram, real life pictures and even an abbreviated history for each element on the periodic table. Students used these apps for the atomic model project, creating their element flashcards, and learning about chemical bonding.

Part of the intervention process included increasing communication with students. Since every student had an iPad tablet and email access, the instructor was able to communicate vital information with each individual student at any point in the day. There were nine emails sent to students during the intervention period. The instructor kept students informed with regular communications pertaining to the curriculum, resources on the webpage, when assignments were due, and when quizzes and tests would be held (Appendix C). Even when the teacher forgot to cover details of a specific objective in class, this problem was easily corrected through electronic correspondence.

Having the ability to directly correspond with each student greatly increased the capacity for two-way communication. Students could ask the instructor questions about a particular chemistry problem or to clarify instructions for an assignment. This mode of communication was particularly effective for students who were not comfortable asking questions in class.

Two treatment subgroups (non-aggressive and aggressive) were established to compare the effects of teacher communications and the subsequent use of technological resources on the teacher's webpage. Six times during the earth science and chemistry unit, the teacher notified or reminded both subgroups when technology resources were available on the teacher's webpage. This was done at the start of class and the information was projected on the front board.

The aggressive treatment group (fourth and fifth periods) differed in that they were given time in class to identify the technological resources. On two separate occasions, the aggressive treatment group was required to use their iPad tablets to access the teacher's webpage during class. The teacher directed students to the webpage and then to identify the technology resources that were available. The teacher circulated around the classroom to ensure that students were able to get to the correct webpage and locate the interventions. Students were told the number of interventions and the order that they should be accessed by the end of that particular week of the study. The premise was that if students went to the teacher's webpage and observed the resources, students would use them more frequently. A communication log was kept (Appendix C).

School

Calumet-Laurium-Keweenaw (CLK) School District is a rural school. It is in the most northern school district in Michigan's Upper Peninsula. There are approximately 1,500 students in the CLK School District with 67% receiving free and reduced lunch. The high school has thirty full-time teachers; fifteen have their bachelor's degree and fifteen have their master's degree. Based on the Annual Education Report for the academic year 2011-2012, the high school has a graduation rate of over 95% (Public Schools of Calumet, 2012, p. 10), which includes the sub-groups males, females, and economically disadvantaged. The high school also has an overall attendance rate of 95.9% (Public Schools of Calumet, 2012, p. 11).

Subjects

Current Class. There were 108 total ninth grade students. Twelve ninth grade students opted not to take physical science and instead took biology. The remaining ninth grade students in the 2011-2012 academic year were assigned to a physical science class and were the subjects. This was the first instance in which these students were exposed to a traditional chemistry curriculum. These 96 students were divided into four classes and followed the same daily schedule of 55 minute class periods. In addition, there were three physical science students who were sophomores and were repeating the class. These sophomores opted out of the research study. In total, there were 99 physical science students in 2011-2012.

Table 3. Student Demographics of Current Class Compared with Whole School.*

Student Demographics	Current Ninth Grade 2011-2012 (%)	Grades 10,11,12 2011-2012 (%)
Male	46.3	48.4
Female	53.7	51.6
Economically Disadvantaged**	52.3	48.6
Non-white	2.8	1.5
Special Education	9.3	7.0

* Raw data to create this table is located in Appendix D
** Economically Disadvantaged Students identified through free and reduced lunch program.

This ninth grade class was fairly typical of all students in the high school with respect to sex (46% males and 54% females), race (3% non-white), special needs (9%), and economically disadvantaged status (52.3%) (Table 3).

Prior Year classes. The ninth grade classes from the prior two academic years served as a control for this study. The 2010-2011 physical science class (Table 4) was the largest with 121 students, 44% males and 56% females, 0% non-white, 8% special needs, and a majority 54.5% with an economically disadvantaged status. Of the 121 students, 86 took physical science while the other 35 students took biology their ninth grade year.

The 2009-2010 physical science class (Table 4) had 96 students total with 51% males and 49% females, 1% non-white, 13% special needs, and many more students 59.4% with an economically disadvantaged status. Of the 96 students, 67 took physical science while the other 27 students took biology their ninth grade year. In addition, there were two physical science students who were sophomores and were repeating the class for a total of 69 students.

Table 4. Demographic Comparison of Current and Prior Year Classes.

Class	Class Size	Male	Female	Non-White	Special Needs	EDS*
Current 2011-2012	108	46.3%	53.7%	3%	9%	52.3%
Prior 2010-2011	121	43.8%	56.2%	0%	8%	54.5%
Prior 2009-2010	96	51.0%	49.0%	1%	13%	59.4%
Mean	108.3	47.0%	53.0%	1.3%	10.0%	55.4%
Standard Deviation	12.5	3.7	3.7	1.5	2.7	3.6

* Economically Disadvantage Students identified through free and reduced lunch program.

Instructor

The research study was conducted over five weeks from February 28 to March 30 during the third marking period of the 2011-2012 academic school year, plus the two prior 2009-2010 and 2010-2011 academic years. The instruction strategies and pacing were consistent with those of the previous two years. The researcher served as the instructor and has been the only physical science teacher for the past five years.

This was the instructor’s ninth year teaching physical science; having previously taught six years of biology, three years of chemistry, two years of physics, one year of natural resources and one year of advanced placement chemistry. The instructor has always been interested in finding ways to implement technology in the classroom and has been on the Calumet Technology Committee for a year and a half.

Variables

Formal instruction of earth science and chemistry objectives through direct and indirect classroom instruction was the independent variable. Direct instruction included class discussions, presentations, demonstrations, and laboratory experimentation. Indirect instruction included the technological resources provided through the teacher website including PowerPoint presentations, videos, and podcasts. The dependent variable was the students' overall gain in comprehension and their scientific literacy of Michigan's earth science and chemistry standards. Student comprehension of the content identified by the state standards was assessed using teacher-made tests (pretest and posttest). There were four means of comparison including the current class pretest compared with posttest scores, the current class posttest scores compared with the two prior classes' (2010-2011 and 2009-2010) posttest scores, the current class subgroups (non-aggressive treatment group compared with aggressive treatment group), and the current class technology survey results.

Procedures

Informed consent. Three weeks prior to instruction, students were informed about participating in the teacher's research study. All student participants and their guardians were given informed consent letters that stated the ethical and legal issues with the study (Appendix E). The letter discussed overall goals of the study and the fact that the research protocol was approved by the Michigan Technological Institutional Review Board.

Students were assigned an identification number for confidentiality once consent letters were signed and returned. All personal student information collected for the study was destroyed once the research was complete.

Students, who did not consent, or whose parents or guardians did not consent (five total – two ninth grade and three tenth grade students), or students who did not return the consent forms (nine) were excluded from data collection for the research study. These students were still able to access the technological resources (PowerPoint presentations, videos, and podcasts).

The school administration and Technology Committee were informed of the study and were very supportive of this endeavor. Everyone expressed great interest in learning the results of this action research study.

Pretest and Posttest. All students in the current class took a written pretest (Appendix A) prior to the earth science and chemistry curriculum to determine their comprehension of the unit objectives before formal instruction. After the completion of the earth science and chemistry unit, approximately five weeks, these same students took the same test, as a posttest, to determine their comprehension of the earth science and chemistry objectives. The posttest was also used in the two previous years as the assessment for the end of the earth science and chemistry unit. The assessment data was entered by class period on an Excel® worksheet.

The pretest and posttest included 47 questions that were created by the instructor to align with Michigan's Grade Level Content Expectations (GLCE) in earth science and chemistry (Table 5). Test items were written to measure five of six of Bloom's cognitive levels – knowledge, comprehension, application, analysis, and synthesis (Table 6). The majority of assessment items encompassed two of Bloom's Cognitive Levels Knowledge (38.3%) and Comprehension (27.7%). A bulk of the pretest and posttest questions centered on Michigan's High School Content Expectations covering Properties of Matter (63.8%) and Changes in Matter (23.4%) (Table 6).

Test Accommodations. Special education students received accommodations according to their Individual Education Program (IEP). Depending on the student, these accommodations involved administering the assessments orally, extended time for assessment completion, alternative testing environment, use of a calculator, and rewriting the assessment items to reduce the possible answers from four to three.

Students who were absent completed the activities and assignments the day they returned to school. Typically, there was up to one or two students absent per class period each day.

Table 5. Michigan High School Content Expectations and the Designated Framework Code Used in the Study.

HSCE Code*	Michigan High School Content Expectations (HSCE)
1	C2.2B Describe the various states of matter in terms of the motion and arrangement of the molecules (atoms) making up the substance.
2	C4.2d Given the name, write the formula of ionic and molecular compounds.
3	C4.3B Recognize that solids have a more ordered, regular arrangement of their particles than liquids and that liquids are more ordered than gases.
4	C4.7b Compare the density of pure water to that of a sugar solution.
5	C4.8A Identify the location, relative mass, and charge for electrons, protons, and neutrons.
6	C4.8B Describe the atom as mostly empty space with an extremely small, dense nucleus consisting of the protons and neutrons and an electron cloud surrounding the nucleus.
7	C4.9A Identify elements with similar chemical and physical properties using the periodic table.
8	C4.9b Identify metals, non-metals, and metalloids using the periodic table.
9	C4.9c Predict general trends in atomic radius, first ionization energy, and electronegativity of the elements using the periodic table.
10	C4.10A List the number of protons, neutrons, and electrons for any given ion or isotope.
11	C5.2B Distinguish between chemical and physical changes in terms of the properties of the reactants and products.
12	C5.5A Predict if the bonding between two atoms of different elements will be primarily ionic or covalent
13	C5.5c Draw Lewis structures for simple compounds.
14	E5.3e Determine the approximate age of a sample, when given the half-life of a radioactive substance along with the ratio of daughter to parent substances present in the sample.
15	E5.3f Explain why C-14 can be used to date a 40,000 year old tree, but not U-Pb cannot.
16	E1.1B Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design and/or the dependence on underlying assumptions.
17	E1.2f Critique solutions or problems, given criteria and scientific constraints.

* HSCE Code used in Table 6

Table 6. Pretest and Posttest Item Table of Specifications.*

	Bloom's Taxonomy of Cognitive Levels							
HSCE Content Idea	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total	Percent
Forms of Energy		1,3					1	2.2
Properties of Matter	5,2 8,4 5,14 9,16 10,18 6,20 7,23 5,26 32** 33** 5,34 5,35 5,36 10,40	3,1 8,10 5,15 8,19 2,22 7,25 11,28 9,29	10,11 7,21 10,24 10,27 10,30	4,12 8,44	5,47		30	63.8
Changes in Matter	11,8 5,37 12,38 13,39	11,5 11,6 11,7 11,9	12,17	11,45	12,46		11	23.4
Earth in Space & Time			14,13 16,43	15,31 17,41 16,42			5	10.6
Total	18	13	8	6	2		47	
Percent	38.3	27.7	17.0	12.7	4.3			100

* Key (HSCE code – see Table 5, Item number)
** Test Items not specifically connected with Michigan HSCE

Technology Survey. Twenty-four questions were selected for the technology survey, with input from the high school principal and the school Technology Committee. The survey, given at the end of the earth science and chemistry unit, served to quantify several pieces of information, including: (1) students who had computer and internet access at home; (2) the number times students accessed the eight videos, five PowerPoint presentations, and two podcasts through the teacher's webpage; and (3) student perception on the usefulness of the technological resources, teacher communications (i.e. emails), on-line lesson plans, and the curriculum on their future careers.

The teacher distributed an individual progress report to each student, which included their marking period grade, absences, and posttest grade. Students self-reported their information on the technology survey. Students used the iPad tablets to complete the survey.

The teacher provided two internet links to the two surveys, which posed the same questions. One survey was completed by eighty-one students participating in the study and the other was completed by fourteen students who opted out of the study or did not return their consent forms. Four students in the study refused to take the survey. Students took the survey at the beginning of their respective class periods, two days after the posttest. Any student that was absent completed the survey the following day.

This survey was created in a quiz format using SurveyMonkey®. Most questions followed the four levels of agreement scale, including agree, somewhat agree, somewhat disagree, and disagree. Survey items rated student responses quantitatively through the Likert scale. Thirteen questions also provided an opportunity for open-ended responses from students (Appendix F).

Data Analysis

The differences between pretest compared with the posttest scores were used to ascertain if and where current year students made progress in learning the objectives. Assessments were scored by the next day of class. The results were tabulated to show: (1) each student's score on each assessment item and overall score, (2) the class average per item, and (3) overall gain between the pretest and posttest for all the classes (Appendix D and Tables 7-10).

Current-Year Pretest and Posttest Analysis. The average gains in comprehension were determined by the difference in percentage of the pretest compared with the posttest assessment items. The following example illustrates the formula utilized for the average gain in knowledge (Table 7):

$$\text{Average Gain} = \overline{X}_{\text{class posttest}} - \overline{X}_{\text{class pretest}}$$

$$\text{Average Gain} = 14.70 - 8.67$$

$$\text{Average Gain} = 6.03 \ (30.1\%)$$

The effectiveness of instruction for meeting the earth science and chemistry standards for the entire classes was measured by utilizing effect size (Bracey, 2000). The difference in average scores (posttest - pretest) was divided by the standard deviation of the pretest. The physical science pretest scores were identified as the control group and the posttest scores were considered the experimental group (Bracey, 2000).

The following equation was used to calculate effect size:

$$\text{Effect Size} = \frac{\bar{X}_{\text{class posttest}} - \bar{X}_{\text{class pretest}}}{SD_{\text{class pretest}}}$$

$$\text{Effect Size} = \frac{73.5\% - 43.4\%}{0.45} = \frac{0.735 - 0.434}{0.45}$$

$$\text{Effect Size} = 0.67$$

The effect size "focuses on the meaning of the results and enables comparison between or among studies which further enables researchers to judge the practical significance of quantitative research results" (Kotrik et al., 2011, p.132). An effect size of +1.0 would signify one standard deviation of movement on a typical bell shaped curve (Bracey, 2000). The importance of pretest compared with posttest changes in effect size are as follows: an effect size greater than 0.30 would be considered practically important and 0.20-0.30 would be moderately important (Bracey, 2000). With respect to the pretest and posttest, the greater the magnitude of effect size indicates a greater effect the technological interventions had on increasing student scores.

Gains and effect size were calculated for test items #1 through #43. The average effect size for each for test items #1 through #43 for the current year classes was calculated.

Assessment items #44 through #47 were open-response test questions. The knowledge gains were not analyzed since a range of scores were given depending on student answers.

Current Year Compared with Two Prior Years Analysis. The current year pretest and posttest contained 43 multiple choice questions and four short answer questions. Items #41, #42, #43 were added during the current year assessment and were not on prior year assessments. These three assessment items were only used for the current year pretest and posttest comparisons. The scores for these three questions were removed when comparing the current year posttest scores with the prior year results.

The effect size was found by comparing the current year students' average posttest score with previous class average posttest score and then dividing by the average pooled variance from each year (Bracey, 2000). A pooled variance was used due to the standard deviation differences between the current year and prior year posttest scores. Table 17 shows the effect size results for this comparison. The following equation demonstrates the effect size for the current class compared to the prior 2010-2011 class using data from Table 17:

$$\text{Effect Size} = \frac{\overline{X}_{\text{current class posttest}} - \overline{X}_{\text{previous class posttest}}}{\text{Sqrt}\left(\left(SD^{\wedge}2_{\text{current class posttest}} + SD^{\wedge}2_{\text{previous class posttest}}\right) / 2\right)}$$

$$\text{Effect Size} = \frac{0.721 - 0.661}{\text{Square root}\left(\left((7.9^{\wedge}2) + 3.1^{\wedge}2\right) / 2\right)}$$

$$\text{Effect Size} = 0.35$$

An effect size was also calculated using the current year and two prior year science MEAP proficiency scores to establish academic similarity between the three classes being compared. The difference in average science MEAP proficiency scores (current year minus prior) was divided by the average pooled variance to calculate the effect size.

Student's t statistic was used to test the hypothesis of no difference between the mean posttest scores of the current year class and the two prior year classes and mean science MEAP proficiencies. The t-test establishes whether the mean scores of two classes are statistically different from each other. My null hypothesis (H_0) was that no change would occur with the technology interventions and my alternative hypothesis (H_1) was that a positive change would occur. A two-sample, unequal variance t-test, with a single-tailed distribution, and a 0.05 significance level was used for two of the tests. The two prior year class comparison used an equal variance t-test with a single-tailed distribution, and a 0.05 significance level. An Excel® spreadsheet was used to establish the t-test. The setup for the Excel® function is shown below:

T.TEST(array 1, array 2, tails, type)

Subgroups. The posttest scores for the two subgroups (non-aggressive and aggressive) were recorded and compared with each other. The number of times each subgroup accessed the technological interventions was also compared. Students in these subgroups were asked to qualify their perception of how helpful the teacher communications were and the results were recorded.

Technology Survey Analysis. The post-instruction technology survey was administered two days after the posttest. The survey assessed many aspects of the intervention, including: teacher communications, videos, PowerPoint presentations, and audio podcasts. The results of the questions were recorded and summarized (quantitatively and qualitatively).

Ten survey questions asked students to qualify their response with one of the following answers: agree, somewhat agree, somewhat disagree, disagree. The totals for these questions were summarized and the percent of the total calculated.

There were 13 questions that allowed students to type free response comments. The number of students responding, the number of those not responding, and their comments were recorded. The comments were categorized into four groups: (1) positive, (2) negative, (3) neutral, (4) not able to interpret, and (5) no response.

Questions 3 and 4 on the technology survey asked students to self-report their grades. These grades were categorized into a standard 4.0 grade point average (GPA). The posttest grades were quantified in following format: an A is equal to 4.0, a B is equal to 3.0, a C is equal to 2.0, a D is equal to 1.0, and an E is equal to 0.0.

The following four groups (A, B, C, and D) of comparisons were made using the data from the technological survey:

A. Survey responses compared with comprehension results on the posttest:

1. Current student internet access compared with student posttest scores.
2. Current students in treatment subgroups (non-aggressive and aggressive) compared with student posttest scores.
3. Current student usage of videos compared with student posttest scores.
4. Current Student Usage of PowerPoint presentations compared with student posttest scores.
5. Current Student Usage of audio podcasts compared with student posttest scores.

B. Subgroup assignment compared with response form the survey:

1. Current students in treatment subgroups (non-aggressive and aggressive) compared with student perception that teacher communications were helpful.

2. Technology interventions usage compared with subgroup assignment.

C. Survey response on usage compared with perception of helpfulness:

1. Current student usage of videos compared with student perception that videos were helpful.

2. Current student usage of PowerPoint presentations compared with student perception that PowerPoint presentations were helpful.

3. Current student usage of audio podcasts compared with student perception that audio podcasts were helpful.

D. Survey response on helpfulness compared to curriculum goals:

1. Current student perception that technological interventions were helpful in strengthening student comprehension of the curriculum.

2. Current student perception that technological interventions were helpful in clarifying misconceptions in the science curriculum.

3. Current student perception that technological interventions were helpful in demonstrating science is an active process with many goals and differing paths.

4. Current student perception that the teacher's science class may be helpful in student's future career.

Webpage Analytics. The software program Google Analytics® was utilized to quantify the number of times the teacher's webpage was accessed during the last 18 days (March 12 – March 30) of the research study. The software program was also able to calculate the average time spent on the webpage for all the internet users during the specific time frame. Google Analytics® summarized the origins of the internet users accessing the teacher's webpage by city (in the United States) and the country (if not from the United States). All the information was recorded and is displayed in Appendix G.

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Chapter 4 - Results

Results for student comprehension will be reported first. Two types of comprehension were looked at during this study. The first gain in comprehension between the current year pretest and posttest were measured and compared. Second, the differences in average comprehension (posttest) between the current year and the two prior years were measured and compared.

The results from the technology survey from the current students will be reported second. These results include: (1) survey responses compared with results on the posttest (comprehension), (2) treatment subgroups (non-aggressive and aggressive) assignment compared with responses from the survey, (3) survey responses on usage of technological interventions (video, PowerPoint presentations, and audio podcasts) compared with student perception of helpfulness, and (4) survey response on helpfulness of the interventions compared to the curriculum goals.

Comprehension Gains (Current Year)

The physical science students were assessed on their comprehension of the earth science and chemistry standards. A pretest was completed prior to beginning formal instruction. A posttest was completed after five weeks of instruction. The pretest and posttest utilized the same assessment items to simplify comparison of the results. The assessment included 47 items that were created by the instructor to align with Michigan's Grade Level Content Expectations in earth science and chemistry.

The data resulting from these assessments included: (1) each student's overall score, (2) student scores on each assessment item, and (3) calculations for overall gain and effect size on assessments for each class.

Pretest-Posttest Results for Individual Classes. Second period test scores increased by an average of 6.0 points (30.1%), from 8.7 points (43.4%) on the pretest to 14.7 points (73.5%) on the posttest. There were no negative gains in comprehension in this class (Table 7).

Third period test scores increased by an average of 7.3 points (31.9%), from 9.4 points (40.8%) on the pretest to 16.7 points (72.7%) on the posttest. There were no negative gains in comprehension in this class (Table 8).

Fourth period test scores increased by an average of 6.8 points (35.4%), from 6.8 points (36.0%) on the pretest to 13.6 points (71.4%) on the posttest. Negative gains in comprehension occurred on item 5 (Table 9).

Fifth period test scores increased by an average of 7.5 points (32.3%), from 9.7 points (42.4%) on the pretest to 17.2 points (74.7%) on the posttest. Negative gains in comprehension occurred on items 12, 33, and 43 (Table 10).

Pretest-Posttest Composite Results and Effect Size. The mean raw score gain was calculated for test items #1 through #43 (Table 11). The overall posttest scores improved by an average of 6.9 points (32.4%).

The mean effect size was calculated for test items #1 through #43 (Table 12). The mean effect size was 0.78 with a standard deviation of 0.3 for the current year. All assessment items had an effect size greater than 0.3, with the exception for items #32 (0.21), #42 (0.11), and #43 (0.10).

Table 7. Second Period Pretest, Posttest Scores by Item, Gain, and Effect Size.*

		Pretest			Posttest					
Item #	N	#Correct	%	SD	#Correct	%	SD	Gain	% Gain	ES**
1	20	12	60	0.5	18	90	0.3	6	30.0	0.61
2	20	9	45	0.5	11	55	0.5	2	10.0	0.20
3	20	5	25	0.4	15	75	0.4	10	50.0	1.15
4	20	14	70	0.5	20	100	0.0	6	30.0	0.65
5	20	3	15	0.4	10	50	0.5	7	35.0	0.98
6	20	5	25	0.4	11	55	0.5	6	30.0	0.69
7	20	13	65	0.5	17	85	0.4	4	20.0	0.42
8	20	13	65	0.5	17	85	0.4	4	20.0	0.42
9	20	9	45	0.5	15	75	0.4	6	30.0	0.60
10	20	9	45	0.5	16	80	0.4	7	35.0	0.70
11	20	11	55	0.5	13	65	0.5	2	10.0	0.20
12	20	6	30	0.5	10	50	0.5	4	20.0	0.44
13	20	11	55	0.5	16	80	0.4	5	25.0	0.50
14	20	4	20	0.4	14	70	0.5	10	50.0	1.25
15	20	7	35	0.5	16	80	0.4	9	45.0	0.94
16	20	5	25	0.4	14	70	0.5	9	45.0	1.04
17	20	7	35	0.5	12	60	0.5	5	25.0	0.52
18	20	6	30	0.5	13	65	0.5	7	35.0	0.76
19	20	2	10	0.3	11	55	0.5	9	45.0	1.50
20	20	15	75	0.4	18	90	0.3	3	15.0	0.35
21	20	7	35	0.5	15	75	0.4	8	40.0	0.84
22	20	12	60	0.5	18	90	0.3	6	30.0	0.62
23	20	8	40	0.5	19	95	0.2	11	55.0	1.12
24	20	4	20	0.4	13	65	0.5	9	45.0	1.13
25	20	13	65	0.5	17	85	0.4	4	20.0	0.42
26	20	15	75	0.4	19	95	0.2	4	20.0	0.46
27	20	2	10	0.3	17	85	0.4	15	75.0	2.50
28	20	8	40	0.5	18	90	0.3	10	50.0	1.02
29	20	5	25	0.4	13	65	0.5	8	40.0	0.92
30	20	8	40	0.5	17	85	0.4	9	45.0	0.92
31	20	7	35	0.5	15	75	0.4	8	40.0	0.84
32	20	15	75	0.4	18	90	0.3	3	15.0	0.35
33	20	7	35	0.5	10	50	0.5	3	15.0	0.31
34	20	11	55	0.5	17	85	0.4	6	30.0	0.60
35	20	13	65	0.5	19	95	0.2	6	30.0	0.63
36	20	15	75	0.4	17	85	0.4	2	10.0	0.23
37	20	5	25	0.4	12	60	0.5	7	35.0	0.81
38	20	5	25	0.4	6	30	0.5	1	5.0	0.12
39	20	8	40	0.5	19	95	0.2	11	55.0	1.12
40	20	4	20	0.4	4	20	0.4	0	0.0	0.00
41	20	7	35	0.5	12	60	0.5	5	25.0	0.52
42	20	10	50	0.5	11	55	0.5	1	5.0	0.10
43	20	18	90	0.3	19	95	0.2	1	5.0	0.17
Mean		8.7	43.4%	0.4	14.7	73.5%	0.4	6.0	30.1%	0.67
SD		4.0	20.0		3.6	18.1		3.2	16.2	0.4

* Raw data is located in Appendix D

** Effect Size

Table 8. Third Period Pretest, Posttest Scores by Item, Gain, and Effect Size.*

		Pretest			Posttest					
Item#	N	#Correct	%	SD	#Correct	%	SD	Gain	% Gain	ES**
1	23	13	56.5	0.5	19	82.6	0.4	6	26.1	0.53
2	23	10	43.5	0.5	14	60.9	0.5	4	17.4	0.35
3	23	15	65.2	0.5	21	91.3	0.3	6	26.1	0.55
4	23	18	78.3	0.4	22	95.7	0.2	4	17.4	0.42
5	23	11	47.8	0.5	11	47.8	0.5	0	0.0	0.00
6	23	9	39.1	0.5	14	60.9	0.5	5	21.7	0.45
7	23	16	69.6	0.5	21	91.3	0.3	5	21.7	0.47
8	23	11	47.8	0.5	19	82.6	0.4	8	34.8	0.70
9	23	10	43.5	0.5	17	73.9	0.4	7	30.4	0.61
10	23	13	56.5	0.5	21	91.3	0.3	8	34.8	0.70
11	23	15	65.2	0.5	19	82.6	0.4	4	17.4	0.37
12	23	2	8.7	0.3	7	30.4	0.5	5	21.7	0.77
13	23	15	65.2	0.5	19	82.6	0.4	4	17.4	0.37
14	23	1	4.3	0.2	16	69.6	0.5	15	65.2	3.20
15	23	6	26.1	0.4	17	73.9	0.4	11	47.8	1.09
16	23	3	13.0	0.3	14	60.9	0.5	11	47.8	1.42
17	23	7	30.4	0.5	8	34.8	0.5	1	4.3	0.09
18	23	11	47.8	0.5	15	65.2	0.5	4	17.4	0.35
19	23	5	21.7	0.4	13	56.5	0.5	8	34.8	0.84
20	23	16	69.6	0.5	20	87.0	0.3	4	17.4	0.38
21	23	7	30.4	0.5	14	60.9	0.5	7	30.4	0.66
22	23	12	52.2	0.5	15	65.2	0.5	3	13.0	0.26
23	23	6	26.1	0.4	18	78.3	0.4	12	52.2	1.19
24	23	5	21.7	0.4	18	78.3	0.4	13	56.5	1.37
25	23	13	56.5	0.5	19	82.6	0.4	6	26.1	0.53
26	23	9	39.1	0.5	22	95.7	0.2	13	56.5	1.16
27	23	5	21.7	0.4	22	95.7	0.2	17	73.9	1.79
28	23	5	21.7	0.4	20	87.0	0.3	15	65.2	1.58
29	23	6	26.1	0.4	15	65.2	0.5	9	39.1	0.89
30	23	9	39.1	0.5	17	73.9	0.4	8	34.8	0.71
31	23	4	17.4	0.4	13	56.5	0.5	9	39.1	1.03
32	23	14	60.9	0.5	16	69.6	0.5	2	8.7	0.18
33	23	9	39.1	0.5	16	69.6	0.5	7	30.4	0.62
34	23	9	39.1	0.5	17	73.9	0.4	8	34.8	0.71
35	23	8	34.8	0.5	19	82.6	0.4	11	47.8	1.00
36	23	16	69.6	0.5	19	82.6	0.4	3	13.0	0.28
37	23	3	13.0	0.3	17	73.9	0.4	14	60.9	1.81
38	23	2	8.7	0.3	10	43.5	0.5	8	34.8	1.23
39	23	12	52.2	0.5	22	95.7	0.2	10	43.5	0.87
40	23	4	17.4	0.4	11	47.8	0.5	7	30.4	0.80
41	23	6	26.1	0.4	16	69.6	0.5	10	43.5	0.99
42	23	14	60.9	0.5	15	65.2	0.5	1	4.3	0.09
43	23	19	82.6	0.4	21	91.3	0.3	2	8.7	0.23
Mean		9.4	40.8%	0.4	16.7	72.7%	0.4	7.3	31.9%	0.78
SD		4.7	20.5		3.7	16.2		4.1	17.8	0.6

* Effect Size

** Raw data is located in Appendix D

Table 9. Fourth Period Pretest, Posttest Scores by Item, Gain, and Effect Size.*

		Pretest			Posttest					
Item #	N	#Correct	%	SD	#Correct	%	SD	Gain	%Gain	ES**
1	19	11	57.9	0.5	18	94.7	0.3	7	36.8	0.75
2	19	8	42.1	0.5	14	73.7	0.4	6	31.6	0.64
3	19	10	52.6	0.5	13	68.4	0.5	3	15.8	0.32
4	19	12	63.2	0.5	19	100.0	0.2	7	36.8	0.76
5	19	8	42.1	0.5	6	31.6	0.5	-2	-10.5	-0.21
6	19	4	21.1	0.4	7	36.8	0.5	3	15.8	0.39
7	19	12	63.2	0.5	18	94.7	0.3	6	31.6	0.65
8	19	11	57.9	0.5	18	94.7	0.3	7	36.8	0.75
9	19	8	42.1	0.5	15	78.9	0.4	7	36.8	0.75
10	19	7	36.8	0.5	16	84.2	0.4	9	47.4	0.98
11	19	7	36.8	0.5	19	100.0	0.2	12	63.2	1.31
12	19	3	15.8	0.4	7	36.8	0.5	4	21.1	0.58
13	19	4	21.1	0.4	14	73.7	0.4	10	52.6	1.29
14	19	2	10.5	0.3	16	84.2	0.4	14	73.7	2.40
15	19	7	36.8	0.5	12	63.2	0.5	5	26.3	0.55
16	19	6	31.6	0.5	11	57.9	0.5	5	26.3	0.57
17	19	8	42.1	0.5	9	47.4	0.5	1	5.3	0.11
18	19	7	36.8	0.5	11	57.9	0.5	4	21.1	0.44
19	19	3	15.8	0.4	12	63.2	0.5	9	47.4	1.30
20	19	10	52.6	0.5	17	89.5	0.4	7	36.8	0.74
21	19	6	31.6	0.5	10	52.6	0.5	4	21.1	0.45
22	19	7	36.8	0.5	13	68.4	0.5	6	31.6	0.65
23	19	5	26.3	0.4	17	89.5	0.4	12	63.2	1.43
24	19	8	42.1	0.5	15	78.9	0.4	7	36.8	0.75
25	19	7	36.8	0.5	12	63.2	0.5	5	26.3	0.55
26	19	9	47.4	0.5	18	94.7	0.3	9	47.4	0.95
27	19	2	10.5	0.3	20	105.3	0.0	18	94.7	3.09
28	19	4	21.1	0.4	16	84.2	0.4	12	63.2	1.55
29	19	4	21.1	0.4	15	78.9	0.4	11	57.9	1.42
30	19	7	36.8	0.5	13	68.4	0.5	6	31.6	0.65
31	19	0	0.0	0.0	10	52.6	0.5	10	52.6	1.03***
32	19	11	57.9	0.5	14	73.7	0.5	3	15.8	0.32
33	19	4	21.1	0.4	11	57.9	0.5	7	36.8	0.90
34	19	9	47.4	0.5	13	68.4	0.5	4	21.1	0.42
35	19	7	36.8	0.5	16	84.2	0.4	9	47.4	0.98
36	19	11	57.9	0.5	16	84.2	0.4	5	26.3	0.53
37	19	5	26.3	0.4	14	73.7	0.4	9	47.4	1.08
38	19	6	31.6	0.5	10	52.6	0.5	4	21.1	0.45
39	19	5	26.3	0.4	18	94.7	0.3	13	68.4	1.55
40	19	2	10.5	0.3	9	47.4	0.5	7	36.8	1.20
41	19	8	42.1	0.5	8	42.1	0.5	0	0.0	0.00
42	19	5	26.3	0.4	7	36.8	0.5	2	10.5	0.24
43	19	14	73.7	0.4	16	84.2	0.4	2	10.5	0.24
Mean		6.8	36.0%	0.4	13.6	71.4%	0.4	6.7	35.4%	0.80
SD		3.1	16.3		3.7	19.5		3.9	20.6	0.6

* Raw data is located in Appendix D

** Effect Size

*** Calculated using posttest standard deviation since the pretest standard deviation was zero

Table 10. Fifth Period Pretest, Posttest Scores by Item, Gain, and Effect Size.*

		Pretest			Posttest					
Item #	N	#Correct	%	SD	#Correct	%	SD	Gain	% Gain	ES**
1	23	17	73.9	0.4	20	87.0	0.3	3	13.0	0.30
2	23	5	21.7	0.4	17	73.9	0.4	12	52.2	1.26
3	23	11	47.8	0.5	19	82.6	0.4	8	34.8	0.70
4	23	14	60.9	0.5	19	82.6	0.4	5	21.7	0.45
5	23	8	34.8	0.5	16	69.6	0.5	8	34.8	0.73
6	23	10	43.5	0.5	14	60.9	0.5	4	17.4	0.35
7	23	18	78.3	0.4	18	78.3	0.4	0	0.0	0.00
8	23	15	65.2	0.5	19	82.6	0.4	4	17.4	0.37
9	23	7	30.4	0.5	15	65.2	0.5	8	34.8	0.76
10	23	10	43.5	0.5	23	100.0	0.0	13	56.5	1.14
11	23	14	60.9	0.5	19	82.6	0.4	5	21.7	0.45
12	23	12	52.2	0.5	9	39.1	0.5	-3	-13.0	-0.26
13	23	9	39.1	0.5	19	82.6	0.4	10	43.5	0.89
14	23	6	26.1	0.4	17	73.9	0.4	11	47.8	1.09
15	23	10	43.5	0.5	21	91.3	0.3	11	47.8	0.96
16	23	2	8.7	0.3	13	56.5	0.5	11	47.8	1.70
17	23	5	21.7	0.4	17	73.9	0.4	12	52.2	1.26
18	23	7	30.4	0.5	17	73.9	0.4	10	43.5	0.94
19	23	7	30.4	0.5	17	73.9	0.4	10	43.5	0.94
20	23	17	73.9	0.4	26	113.0	2.2	9	39.1	0.89
21	23	3	13.0	0.3	13	56.5	0.5	10	43.5	1.29
22	23	15	65.2	0.5	19	82.6	0.4	4	17.4	0.37
23	23	7	30.4	0.5	21	91.3	0.3	14	60.9	1.32
24	23	8	34.8	0.5	17	73.9	0.4	9	39.1	0.82
25	23	9	39.1	0.5	17	73.9	0.4	8	34.8	0.71
26	23	15	65.2	0.5	22	95.7	0.2	7	30.4	0.64
27	23	2	8.7	0.3	19	82.6	0.4	17	73.9	2.62
28	23	7	30.4	0.5	19	82.6	0.4	12	52.2	1.13
29	23	6	26.1	0.4	18	78.3	0.4	12	52.2	1.19
30	23	12	52.2	0.5	18	78.3	0.4	6	26.1	0.52
31	23	4	17.4	0.4	19	82.6	0.4	15	65.2	1.72
32	23	16	69.6	0.5	16	69.6	0.5	0	0.0	0.00
33	23	12	52.2	0.5	9	39.1	0.5	-3	-13.0	-0.26
34	23	15	65.2	0.5	20	87.0	0.3	5	21.7	0.46
35	23	15	65.2	0.5	21	91.3	0.3	6	26.1	0.55
36	23	15	65.2	0.5	18	78.3	0.4	3	13.0	0.27
37	23	5	21.7	0.4	15	65.2	0.5	10	43.5	1.05
38	23	5	21.7	0.4	13	56.5	0.5	8	34.8	0.84
39	23	10	43.5	0.5	22	95.7	0.2	12	52.2	1.05
40	23	3	13.0	0.3	10	43.5	0.5	7	30.4	0.90
41	23	4	17.4	0.4	13	56.5	0.5	9	39.1	1.03
42	23	8	34.8	0.5	8	34.8	0.5	0	0.0	0.00
43	23	19	82.6	0.4	17	73.9	0.4	-2	-8.7	-0.23
Mean		9.7	42.4%	0.4	17.2	74.7%	0.4	7.5	32.4%	0.73
SD		4.7	20.5		3.8	16.4		4.8	20.7	0.6

* Raw data is located in Appendix D

** Effect Size

Table 11. Mean Raw Score Gain for Test Items by Class Period.

	Class Period					
Item #	2	3	4	5	Mean Gain	SD
1	6	6	7	3	5.5	1.5
2	2	4	6	12	6.0	3.7
3	10	6	3	8	6.8	2.6
4	6	4	7	5	5.5	1.1
5	7	0	-2	8	3.3	4.3
6	6	5	3	4	4.5	1.1
7	4	5	6	0	3.8	2.3
8	4	8	7	4	5.8	1.8
9	6	7	7	8	7.0	0.7
10	7	8	9	13	9.3	2.3
11	2	4	12	5	5.8	3.8
12	4	5	4	-3	2.5	3.2
13	5	4	10	10	7.3	2.8
14	10	15	14	11	12.5	2.1
15	9	11	5	11	9.0	2.4
16	9	11	5	11	9.0	2.4
17	5	1	1	12	4.8	4.5
18	7	4	4	10	6.3	2.5
19	9	8	9	10	9.0	0.7
20	3	4	7	9	5.8	2.4
21	8	7	4	10	7.3	2.2
22	6	3	6	4	4.8	1.3
23	11	12	12	14	12.3	1.1
24	9	13	7	9	9.5	2.2
25	4	6	5	8	5.8	1.5
26	4	13	9	7	8.3	3.3
27	15	17	18	17	16.8	1.1
28	10	15	12	12	12.3	1.8
29	8	9	11	12	10.0	1.6
30	9	8	6	6	7.3	1.3
31	8	9	10	15	10.5	2.7
32	3	2	3	0	2.0	1.2
33	3	7	7	-3	3.5	4.1
34	6	8	4	5	5.8	1.5
35	6	11	9	6	8.0	2.1
36	2	3	5	3	3.3	1.1
37	7	14	9	10	10.0	2.5
38	1	8	4	8	5.3	2.9
39	11	10	13	12	11.5	1.1
40	0	7	7	7	5.3	3.0
41	5	10	0	9	6.0	3.9
42	1	1	2	0	1.0	0.7
43	1	2	2	-2	0.8	1.6
Mean	6.0	7.3	6.7	7.5	6.9	2.2
SD	3.2	4.1	3.9	4.8	3.3	

Table 12. Mean Effect Size for Test Items by Class Period.

	Class Period					
Item #	2	3	4	5	Mean ES	SD
1	0.61	0.53	0.75	0.30	0.55	0.2
2	0.20	0.35	0.64	1.26	0.61	0.4
3	1.15	0.55	0.32	0.70	0.68	0.3
4	0.65	0.42	0.76	0.45	0.57	0.1
5	0.98	0.00	-0.21	0.73	0.37	0.5
6	0.69	0.45	0.39	0.35	0.47	0.1
7	0.42	0.47	0.65	0.00	0.39	0.2
8	0.42	0.70	0.75	0.37	0.56	0.2
9	0.60	0.61	0.75	0.76	0.68	0.1
10	0.70	0.70	0.98	1.14	0.88	0.2
11	0.20	0.37	1.31	0.45	0.58	0.4
12	0.44	0.77	0.58	-0.26	0.38	0.4
13	0.50	0.37	1.29	0.89	0.76	0.4
14	1.25	3.20	2.40	1.09	1.98	0.9
15	0.94	1.09	0.55	0.96	0.89	0.2
16	1.04	1.42	0.57	1.70	1.18	0.4
17	0.52	0.09	0.11	1.26	0.50	0.5
18	0.76	0.35	0.44	0.94	0.62	0.2
19	1.50	0.84	1.30	0.94	1.15	0.3
20	0.35	0.38	0.74	0.89	0.59	0.2
21	0.84	0.66	0.45	1.29	0.81	0.3
22	0.62	0.26	0.65	0.37	0.48	0.2
23	1.12	1.19	1.43	1.32	1.27	0.1
24	1.13	1.37	0.75	0.82	1.02	0.2
25	0.42	0.53	0.55	0.71	0.55	0.1
26	0.46	1.16	0.95	0.64	0.80	0.3
27	2.50	1.79	3.09	2.62	2.50	0.5
28	1.02	1.58	1.55	1.13	1.32	0.2
29	0.92	0.89	1.42	1.19	1.11	0.2
30	0.92	0.71	0.65	0.52	0.70	0.1
31	0.84	1.03	1.03*	1.72	1.20	0.4
32	0.35	0.18	0.32	0.00	0.21	0.1
33	0.31	0.62	0.90	-0.26	0.40	0.4
34	0.60	0.71	0.42	0.46	0.55	0.1
35	0.63	1.00	0.98	0.55	0.79	0.2
36	0.23	0.28	0.53	0.27	0.33	0.1
37	0.81	1.81	1.08	1.05	1.19	0.4
38	0.12	1.23	0.45	0.84	0.66	0.4
39	1.12	0.87	1.55	1.05	1.15	0.3
40	0.00	0.80	1.20	0.90	0.73	0.4
41	0.52	0.99	0.00	1.03	0.64	0.4
42	0.10	0.09	0.24	0.00	0.11	0.1
43	0.17	0.23	0.24	-0.23	0.10	0.2
Mean	0.70	0.74	0.91	0.76	0.78	0.3
SD	0.4	0.4	0.6	0.6	0.6	

* Calculated using posttest standard deviation since the pretest standard deviation was zero

Michigan High School Content Expectations Attained on Posttest. Student raw posttest scores of 30 (70%) or greater were determined to have met Michigan's HSCE. Only three of 85 students overall met the posttest expectations on the pretest. After five weeks of technology interventions, students took the posttest. A graph of individual student raw score change between the pretest and posttest was created for each class period using an Excel® spreadsheet. The graphs (Figures 1-4) created a clear visual comparison of the raw score differences after five weeks.

Thirteen of 20 (65.0%) second period students met Michigan's HSCE (Figure 1). Sixteen of 23 (69.6%) third period students met these objectives (Figure 2). Ten of 19 (52.6%) fourth period students met these objectives (Figure 3). Sixteen of 23 (69.6%) fifth period students met these objectives (Figure 4).

Overall, every student, except for three individuals, increased their assessment scores. A total of 55 of 85 (64.7%) of the students met the Michigan's HSCE curriculum goal.

Figure 1. Second Period's Individual Pretest and Posttest Score Change

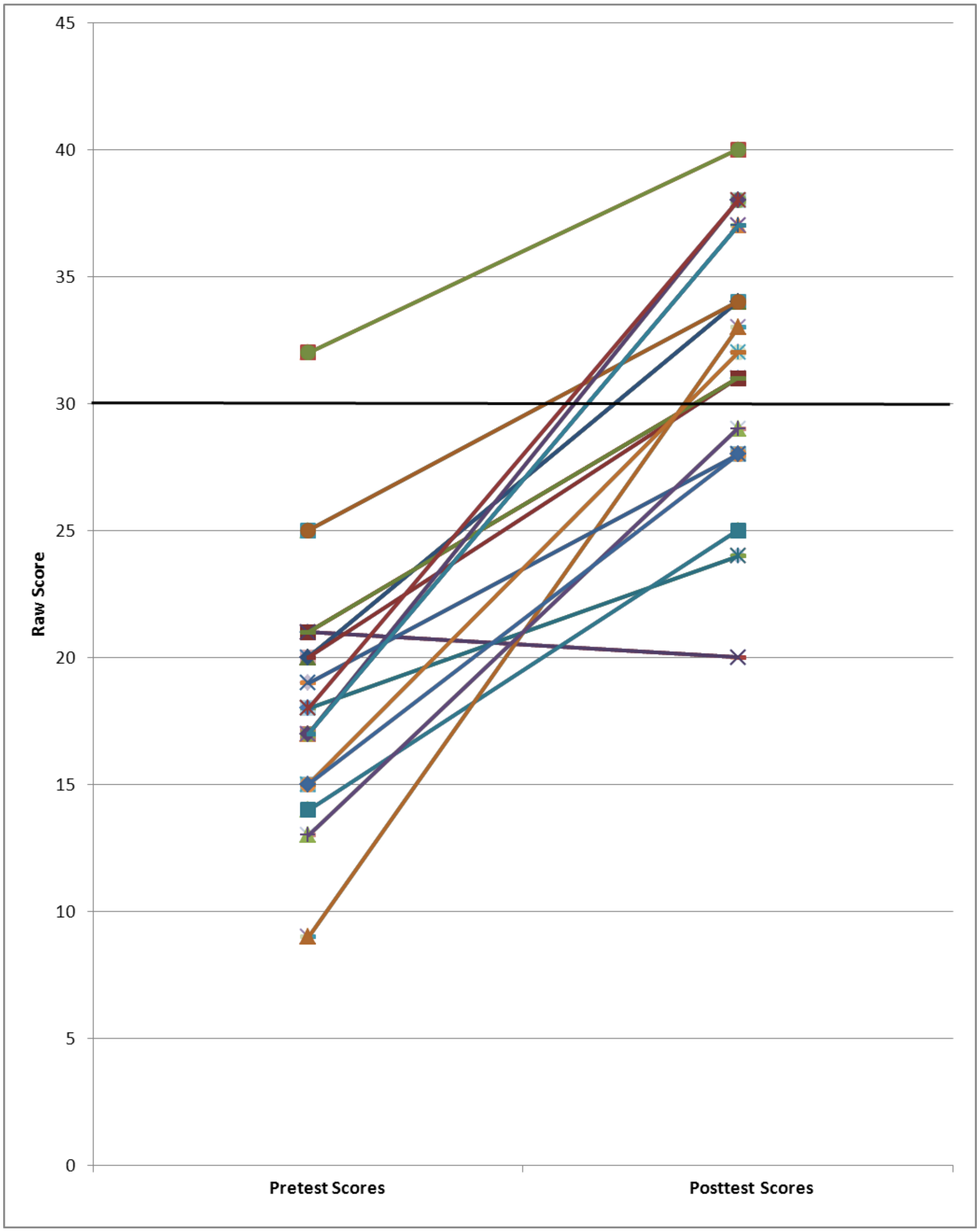

Figure 1: This chart shows changes in each individual student's pretest and posttest results for the second period class (aggressive intervention). A raw score of 30 was set to establish the met or not met criterion.

Figure 2. Third Period's Individual Pretest and Posttest Score Change

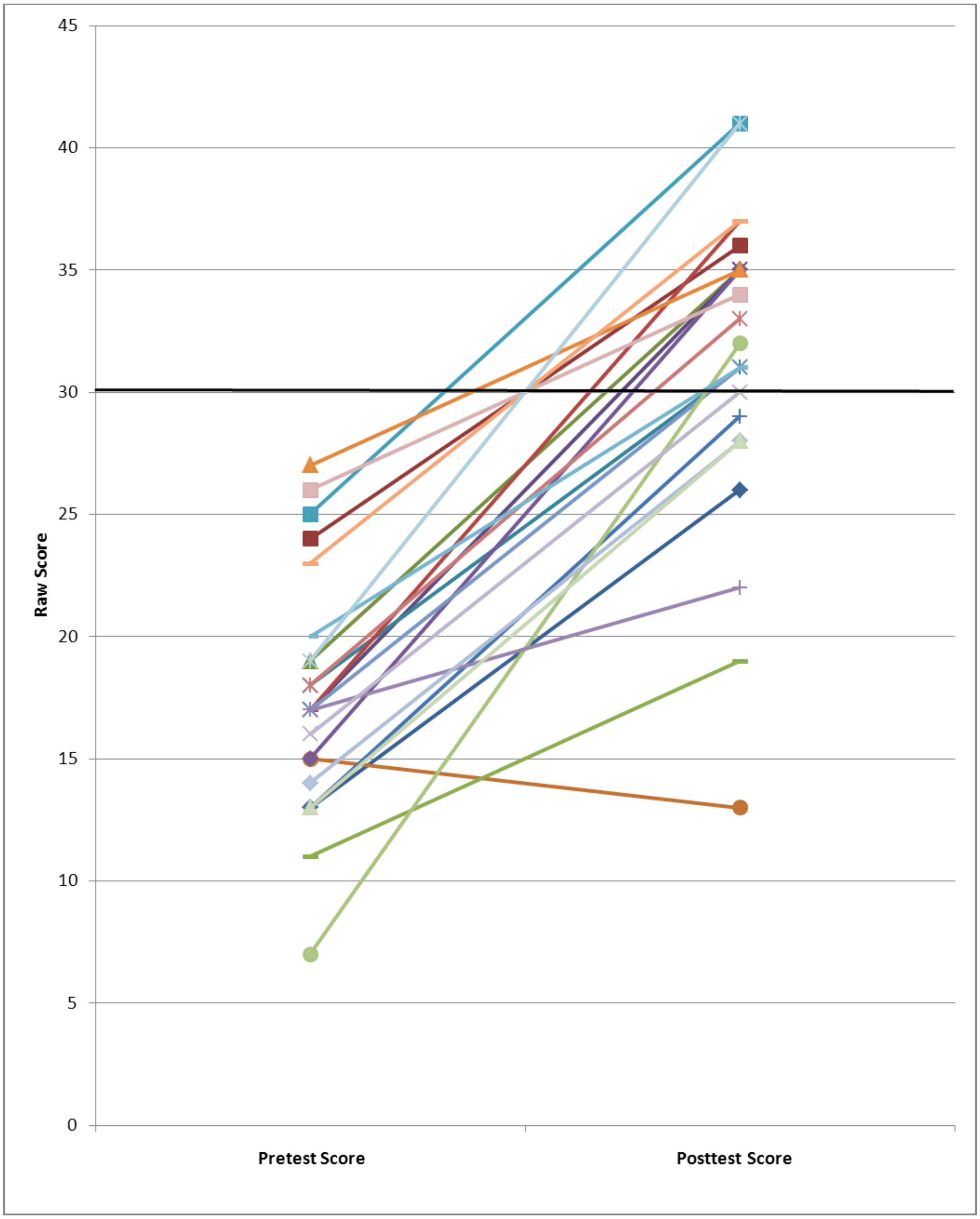

Figure 2: This chart shows changes in each individual student's pretest and posttest results for the third period class (aggressive intervention). A raw score of 30 was set to establish the met or not met criterion.

Figure 3. Fourth Period's Individual Pretest and Posttest Score Change

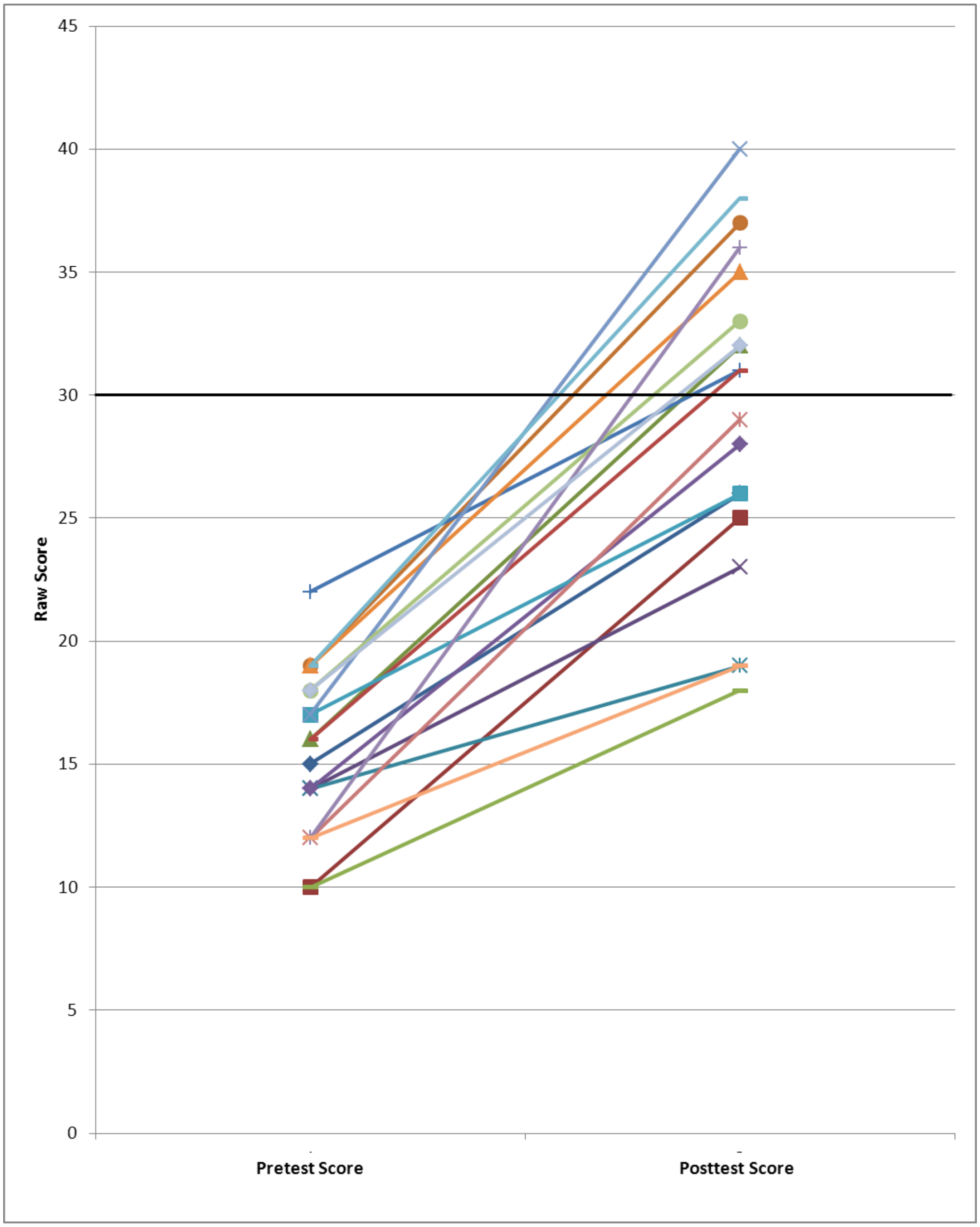

Figure 3: This chart shows changes in each individual student's pretest and posttest results for the fourth period class (non-aggressive intervention). A raw score of 30 was set to establish the met or not met criterion.

Figure 4. Fifth Period's Individual Pretest and Posttest Score Change

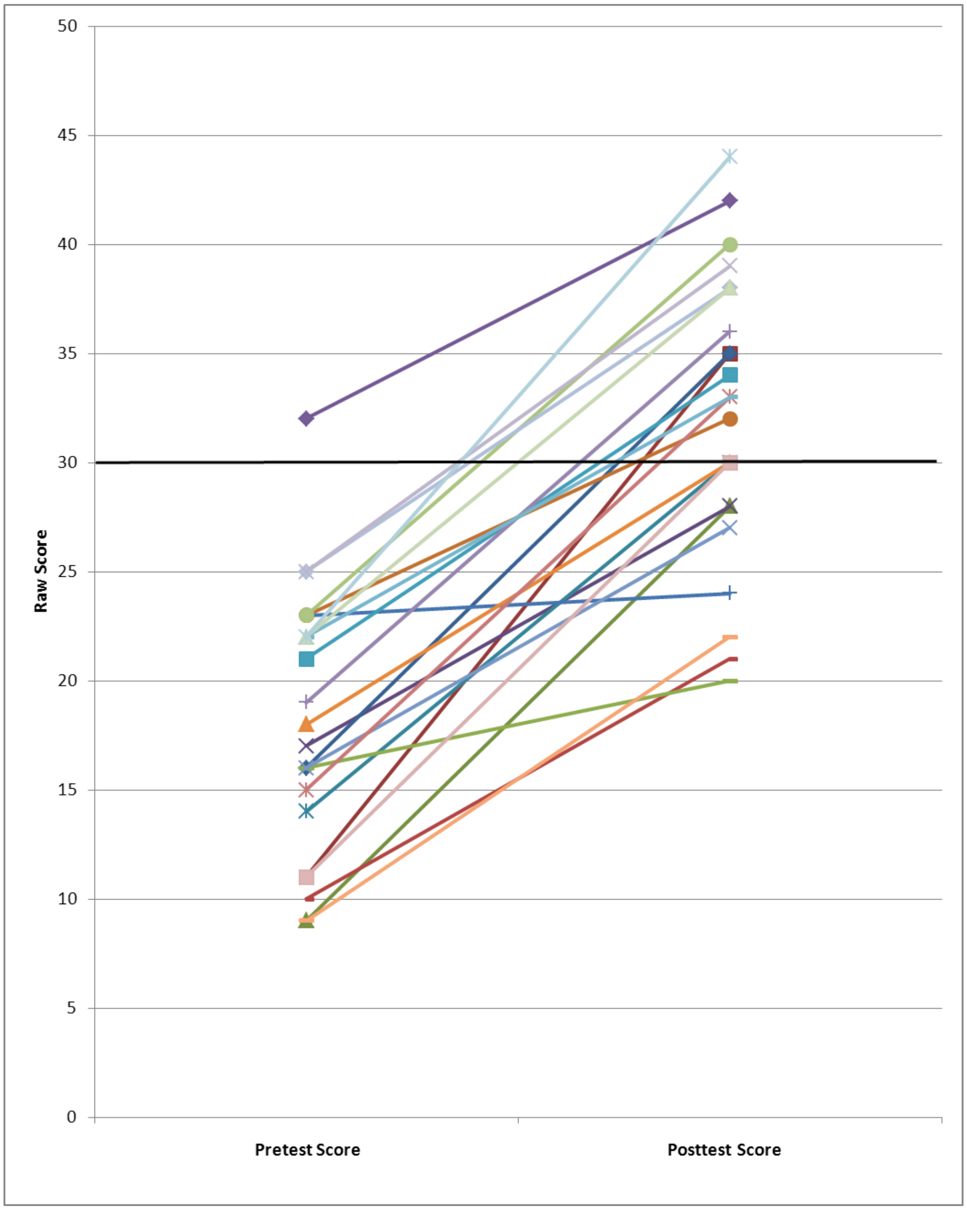

Figure 4: This chart shows changes in each individual student's pretest and posttest results for the fifth period class (non-aggressive intervention). A raw score of 30 was set to establish the met or not met criterion.

Bloom's Cognitive Levels Attained on Posttest. Test items were written to measure Bloom's higher cognitive levels (application and analysis) (Table 6). The total number of students who correctly answered each item was used to establish gains in scientific literacy (Table 13). Test items with 43 or more students (50%) correctly answering the question were determined to have met Bloom's cognitive level.

The synthesis cognitive level questions were encompassed in short answers questions that were not analyzed due to varied point sums. The evaluation cognitive level was not measured in this study.

Table 13. Bloom's Cognitive Levels Attained as a Result of Instruction.

Cognitive Level*	Item Number	Number of students correctly answering item	BCL** Met correct ≥ 43 (50%)
Application	11	70	Met
	13	68	Met
	17	46	Met
	21	52	Met
	24	63	Met
	27	78	Met
	30	65	Met
	43	73	Met
Analysis	12	33	Not Met
	31	57	Met
	41	49	Met
	42	31	Not Met

* Basic cognitive levels (Knowledge and Comprehension) were not used to established scientific literacy. Synthesis level questions were short answer and not analyzed. The Evaluation level was not measured.
** Bloom's Cognitive Levels

Comprehension Differences (Current and Prior Years)

Current Year Compared with Prior Year Results. The non-academic variables were comparable for the three classes being compared. The demographics of the current year were similar to the two prior years (Table 4). The current 2011-2012 gender distribution of males (46.3%) and females (53.7%) was similar to the mean for the three classes being compared (males 47.0% and females 53.0%). The current 2011-2012 number of non-white students (3%) and those receiving special education services (9%) were comparable to the to the mean for the three classes being compared (non-white 1.3%, special education 10.0%). The current (2011-2012) number of students classified as economically disadvantaged (52.3%) was similar to the mean for the three classes being compared (55.4%). The number of students in the current ninth grade physical science class (108) was slightly smaller than the 2010-2011 class (127), but larger than the 2009-2010 class (98) (Tables 14, 15, and 16).

It is also important to establish an external assessment of science achievement between the three classes being compared. The standardized eight grade science Michigan Educational Assessment Program (MEAP) results were utilized for this comparison. The science MEAP proficiency is categorized into four levels: level 1 (advanced), level 2 (proficient), level 3 (partially proficient), and level 4 (not proficient). All three classes being compared entered ninth grade with a science MEAP mean rating of partially proficient.

The science MEAP mean proficiency for the current year class (3.5) was 0.3 points less than the 2010-2011 class (3.2). The effect size for this difference was 0.30 (Table 14). A test of the hypothesis of no mean difference shows that the difference in

MEAP performance between these two classes was statistically significant (p = 0.002). The science MEAP mean proficiency for the current year class (3.5) was 0.4 points less than the 2009-2010 class (3.1). The effect size for this difference was 0.40 (Table 15). A test of the hypothesis of no mean difference shows that the difference in performance between these two classes was statistically significant (p = 0.001). The science MEAP mean proficiency for the 2010-2011 class (3.2) was 0.1 points less than the 2009-2010 class (3.1). The effect size for this difference was 0.10 (Table 16). A test of the hypothesis of no mean difference shows that the difference in performance between these two classes was supported (p = 0.257)

Table 14. Current and Prior 2010-2011 Class Comparison of Science MEAP Proficiency.*

MEAP Proficiency**	Current 2011-2012	Prior 2010-2011	Difference	ES	t-Test***
N****	113	127			
Mean	3.5	3.2	0.3	0.30	0.002
SD	0.7	1.0			

* All School Years MEAP Proficiency Detail Data Results, Middle School, Science, 8th Grade (2012)
** Proficiency Levels: (1) Advanced, (2) Proficient, (3) Partially Proficient, (4) Not Proficient
*** Probability associated with Students' two-sample, unequal variance t-test, with a single-tailed distribution, and a 0.05 significance level.
**** N reflects 8th grade student numbers, which differ from their entire ninth grade class and physical science class totals.

Table 15. Current and Prior 2009-2010 Class Comparison of Science MEAP Proficiency.*

MEAP Proficiency**	Current 2011-2012	Prior 2009-2010	Difference	ES	t-Test***
N****	113	98			
Mean	3.5	3.1	0.4	0.40	0.001
SD	0.7	1.0			

*All School Years MEAP Proficiency Detail Data Results, Middle School, Science, 8th Grade (2012)
** Proficiency Levels: (1) Advanced, (2) Proficient, (3) Partially Proficient, (4) Not Proficient
*** Probability associated with Students' two-sample, unequal variance t-test, with a single-tailed distribution, and a 0.05 significance level.
**** N reflects 8th grade student numbers, which differ from the entire ninth grade class and physical science class totals.

Table 16. Prior 2010-2011 and 2009-2010 Class Comparison of Science MEAP Proficiency.*

MEAP Proficiency**	Prior 2010-2011	Prior 2009-2010	Difference	ES	t-Test***
N****	127	98			
Mean	3.2	3.1	0.1	0.10	0.257
SD	1.0	1.0			

* All School Years MEAP Proficiency Detail Data Results, Middle School, Science, 8th Grade (2012)
** Proficiency Levels: (1) Advanced, (2) Proficient, (3) Partially Proficient, (4) Not Proficient
*** Probability associated with Students' two-sample, equal variance t-test, with a single-tailed distribution, and a 0.05 significance level.
**** N reflects 8th grade student numbers, which differ from the entire ninth grade class and physical science class totals.

The general student demographics and science MEAP mean proficiency provides evidence that the three Calumet High School ninth grade classes being compared in this research study were similar, except that the current year class performed significantly lower on the eighth grade MEAP proficiency test compared with the two prior year classes.

The posttest assessments used in this study for the current and two previous years were identical with respect to the items used, except for the addition of three multiple choice items (#41, #42, and #43) that were added during the current year. These three assessment items were used during comparison of pretest and posttest scores only for the current year. Assessment items #41, #42, and #43 were removed from the current mean posttest scores for comparison with the two prior year classes' (2009-2010 and 2010-2011) mean posttest scores.

The current year class received an average posttest score of 37.5 points (72.1%), which was 3.1 points (6.0%) higher than the 2010-2011 year class with 34.4 points (66.1%) (Table 17). Figure 5 shows the raw score distributions for these two groups of students. The difference between the current year class and 2010-2011 year class on mean posttest scores resulted in an effect size of 0.35 (Table 17). A test of the hypothesis of no mean difference shows that the difference in performance between these two classes was statistically significant ($p = 0.013$).

Table 17. Current and Prior 2010-2011 Class Comparison of Posttest Scores, Effect Size, and t-Test Probability.

	Current 2011-2012	Prior 2010-2011	Difference	ES	t-Test*
N	85	86			
Mean	37.5 (72.1%)	34.4 (66.1%)	3.1 (6.0%)	0.35	0.013
Standard Deviation	7.9	9.9			

* Probability associated with Students' two-sample, unequal variance t-test, with a single-tailed distribution, and a 0.05 significance level.

Figure 5. Current and Prior 2010-2011 Class Comparison of Posttest Scores.

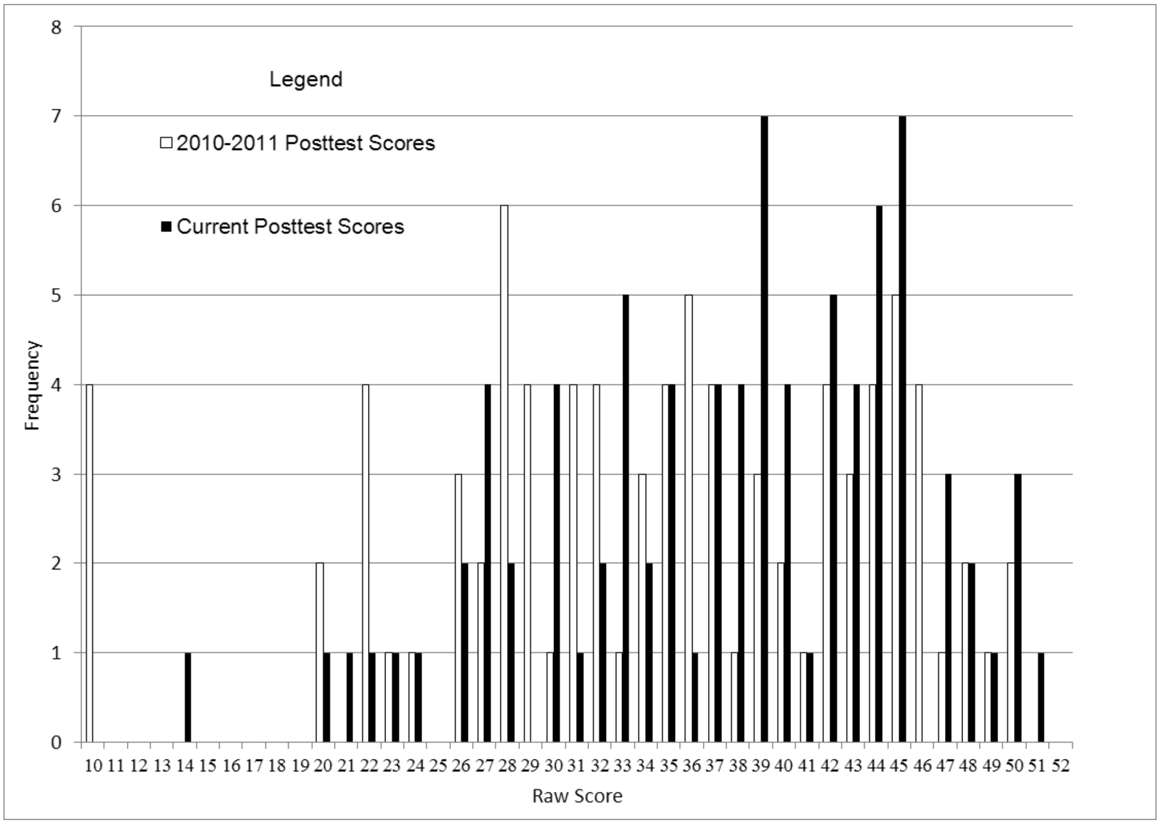

Figure 5: This chart shows the frequency distribution of the current and prior 2010-2011 year classes' raw posttest scores. The posttest was composed of 43 multiple choice questions and four short answer problems (Appendix A).

The second comparison was with the current ninth grade class average posttest score of (37.5 points) was 2.8 points (5.4%) higher than the 2009-2010 class with 34.7 points (66.7%) (Table 18). The current year class posttest score distribution was compared to the 2009-2010 year class (Figure 6). The current difference between the current class compared and the mean posttest scores for 2009-2010 class resulted in an effect size of 0.32 (Table 18). A test of the hypothesis of no mean difference shows that the difference in performance between these two classes was statistically significant ($p = 0.029$).

Table 18. Current and Prior 2009-2010 Class Comparison of Posttest Scores, Effect Size, and t-Test Probability.

	Current 2011-2012	Prior 2009-2010	Difference	ES	t-Test*
N	85	69			
Mean	37.5 (72.1%)	34.7 (66.7%)	2.8 (5.4%)	0.32	0.029
Standard Deviation	7.9	9.8			

* Probability associated with Students' two-sample, unequal variance t-test, with a single-tailed distribution, and a 0.05 significance level.

Figure 6. Current and Prior 2009-2010 Class Comparison of Posttest Scores.

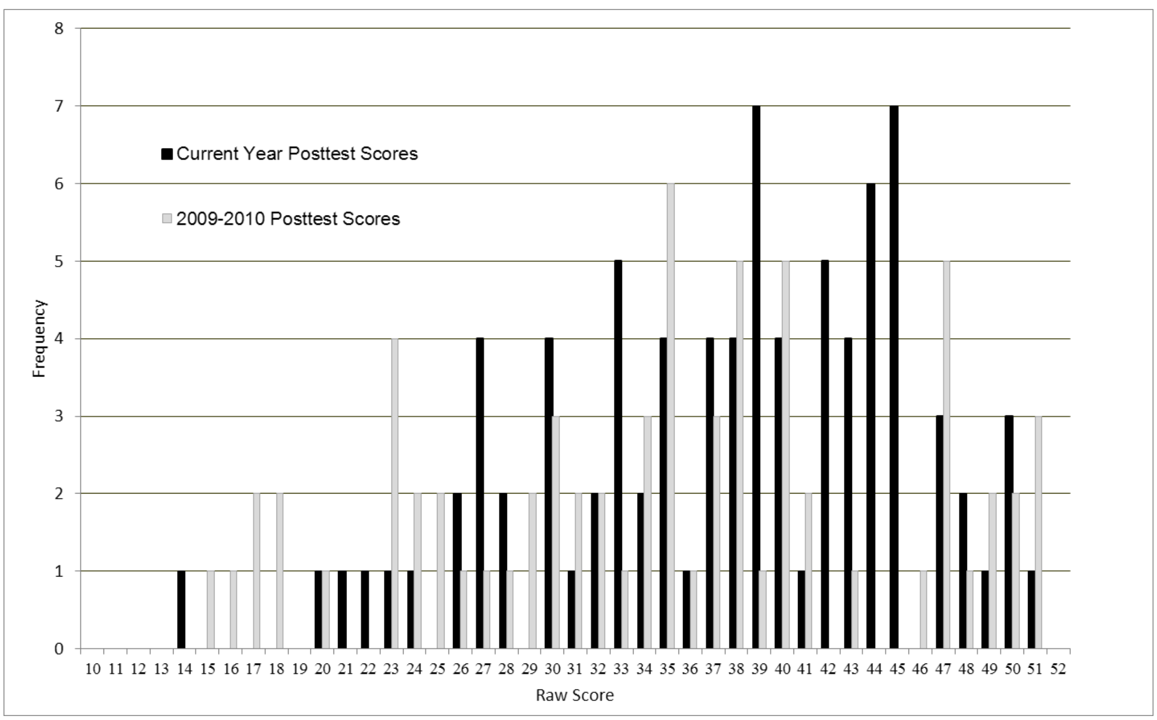

Figure 6: This chart shows the frequency distribution of the current and prior 2009-2010 year classes' raw posttest scores. The posttest was composed of 43 multiple choice questions and four short answer problems (Appendix A).

The third comparison was between the two prior year ninth grade classes, which had similar mean posttest scores and standard deviations. The 2010-2011 year class mean posttest score of 34.4 points (66.1%) was 0.3 points (0.6%) less than the 2009-2010 year class with 34.7 points (66.7%) (Table 19). The 2010-2011 year class posttest score distribution was compared to the 2009-2010 year class (Figure7). The 2010-2011 year class mean posttest scores compared with the 2009-2010 year class resulted in an effect size of 0.03 (Table 19). A test of the hypothesis shows that there was no significant difference in performance between these two classes (p = 0.427).

Table 19. Prior 2010-2011 and 2009-2010 Class Comparison of Posttest Scores, Effect Size, and t-Test Probability.

	Prior 2010-2009	Prior 2009-2010	Difference	ES	t-Test*
N	86	69			
Mean	34.4 (66.1%)	34.7 (66.7%)	-0.3 (-0.6%)	0.03	0.427
Standard Deviation	9.9	9.8			

* Probability associated with Students' two-sample, equal variance t-test, with a single-tailed distribution, and a 0.05 significance level.

Figure 7. 2010-2011 and 2009-2010 Class Comparison of Posttest Scores.

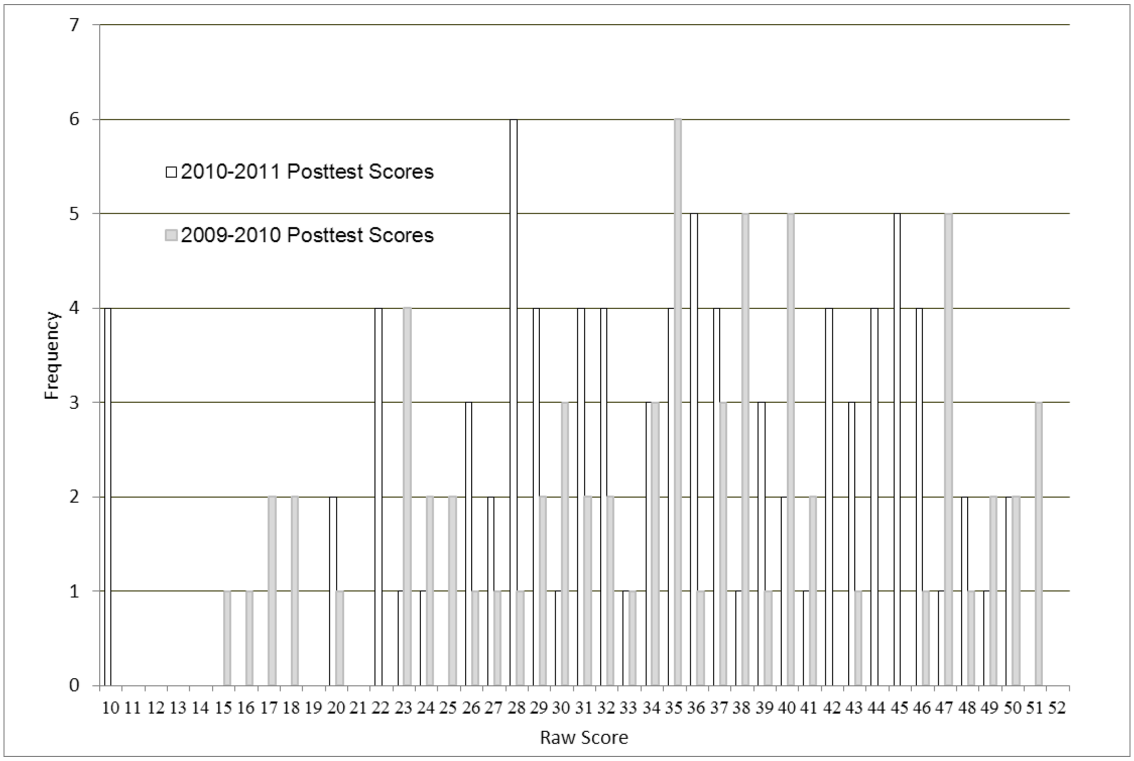

Figure 7: This chart shows the frequency distribution of the prior 2010-2011 and 2009-2010 year classes' raw posttest scores. The posttest was composed of 43 multiple choice questions and four short answer problems (Appendix A).

Technology Survey Results

The technology survey also served to evaluate the extent to which the research study goals were attained. These goals included: (1) determine if providing iPad tablets, videos, PowerPoint presentations, and audio podcasts on a school webpage would improve ninth grade, physical science students' "comprehension of the content" and (2) improve the connections students make with what they are learning in the classroom and the "real world" applications of that information.

The study consisted of 85 of the 99 students from the current physical class. Fourteen students opted out of the study or did not return their consent forms. The technology survey was administered to the 81 of the 85 students in the research study. Four students from the study refused to complete the survey.

The teacher distributed an individual progress report to each student, which included their marking period grade, absences, and posttest grade. Students self-reported their individual information when answering the technology survey questions. Students used the iPad tablets to complete the survey.

Internet Access and Comprehension (Posttest Grades). The technology survey assessed current student internet access compared with the grade received on the posttest (Table 20). A majority of students were able to work on their iPad tablets or complete on-line assignments at home or in the community. The survey showed (Appendix F), almost all students had wireless internet (86.2%) and could use their iPad tablets in their home. Still more students had access to a home computer and internet access (93.8%). A majority of students (70.4%) indicated that they used their iPad tablets before and after school in the public library, study hall, and the student commons area (Appendix F). Each of these locations had wireless internet access available.

Students with internet access and those without internet access were compared using their posttest grades (Table 20). Of the five students without internet access at home (6.2%), three of these students received a B, one received a C, and another a D. None of the students without internet access at home failed the posttest. The mean grade for the students with internet access was a D (1.8) and a C (2.4) for the five students without internet access.

Table 20. Current Student Internet Access Compared with Posttest Grade.

Student Grade on Posttest	Students with Internet Access	Students without Internet Access	Total	Percent of Total
A (90-100%)	5	0	5	6.2
B (80-89.9%)	20	3	23	28.4
C (70-79.9%)	19	1	20	24.7
D (60-69.9%)	16	1	17	21.0
E (0-59.9%)	16	0	16	19.7
Total	76	5	81	100.0
Mean Grade*	D (1.8)	C (2.4)	D (1.8)	

* Mean grade based on four point grade point average (GPA)

Treatment Subgroups and Comprehension (Posttest Grade). The technology survey assessed current students in treatment subgroups (non-aggressive and aggressive) compared with their posttest grade (Table 21). Two treatment subgroups (non-aggressive and aggressive) were established to compare the effects of teacher communications and the resulting posttest grade for each subgroup. The non-aggressive treatment group (2nd and 3rd hours) had 42 students (52%) and the aggressive treatment group (4th and 5th hours) had 38 students (48%) (Table 21).

Students were able to receive and respond to the teacher's electronic communications with their iPad tablets. Both groups received six email notifications pertaining to the availability of the intervention technologies. The aggressive treatment groups were twice instructed to access the teacher's webpage with their iPad tablets and visually locate the technology interventions. The communication log can be found in Appendix C.

The students in the non-aggressive treatment group had a mean grade of a D (1.8). The aggressive treatment group had a mean grade on the posttest of a D (1.8).

The non-aggressive treatment group grade had a greater number of students with above average grade (A and B) 16 (19.8%). Comparatively, the aggressive treatment group only had 12 students (14.8%) with above average grades (A and B) (Table 21).

Table 21. Treatment Subgroup (Non-Aggressive and Aggressive Treatment) Compared with Student Posttest Grades.

Student Grade on Posttest	Non-Aggressive Treatment Group (2nd and 3rd Periods)	Aggressive Treatment Group (4th and 5th Periods)	Total	Percent of Total
A (90-100%)	2	3	5	6.2
B (80-89.9%)	14	9	23	28.4
C (70-79.9%)	9	11	20	24.7
D (60-69.9%)	9	8	17	21.0
E (0-59.9%)	8	8	16	19.7
Total	42 (52%)	39 (48%)	81	100.0
Mean Grade*	D (1.8)	D (1.8)		

* Mean grade based on four point grade point average (GPA)

Video Viewing and Comprehension (Posttest Grade). The technology survey had students report the number of videos watched from any of the eight videos made available on the website. This number was compared with the corresponding grade received on the posttest for the unit (Table 22). The premise being that the greater number of videos each student watched would result in higher posttest grades. Three of the 5 students (60%) who received an A on the posttest did watch 5-6 videos (medium-high usage). Also, the nine students (11.1%) who had medium-high video usage (5-6 videos) and the nine students (11.1%) who had high video usage (7-8 videos) were the only two video usage categories who did not earn an E on the posttest.

Of the 81 students, 28 students (34.6%) did not watch any of the videos (Table 22). Of these students, no one received an A on the posttest. Interestingly, this was also true for nine students (11.1%) who had high usage of videos (7-8 videos).

Table 22. Video Viewing Compared with Posttest Grade.

Student Grade on Posttest	No Usage (0 Videos)	Low Usage (1-2 Videos)	Medium Usage (3-4 Videos)	Medium-High Usage (5-6 Videos)	High Usage (7-8 Videos)	Total	Percent of Total
A (90-100%)	0	1	1	3	0	5	6.2
B (80-89.9%)	11	4	5	1	2	23	28.4
C (70-79.9%)	5	6	4	3	2	20	24.7
D (60-69.9%)	4	2	4	2	5	17	21.0
E (0-59.9%)	8	5	3	0	0	16	19.7
Total	28	18	17	9	9	81	100.0
Mean Grade*	D (1.7)	D (1.7)	D (1.8)	C (2.6)	D (1.7)		

* Mean grade based on four point grade point average (GPA)

PowerPoint Presentation Viewing and Comprehension (Posttest Grades). The technology survey had students report the number of PowerPoint presentations watched from any of the five PowerPoint presentations made available on the website. This number was compared with the corresponding grade received on the posttest for the unit (Table 23). The teacher predicted that students who watched a greater number of PowerPoint presentations would achieve higher posttest grades. Each PowerPoint presentation usage category had the same mean grade (D); however, students who did not watch any PowerPoint presentations had the lowest mean grade (1.6). The other three usage groups (low, medium, high) had a higher mean grade (1.9, 1.9, and 1.7).

Students with a higher PowerPoint presentation usage (medium and high) had a greater number of individuals with average (C) and below average (D) posttest grades and fewer failing grades (E). The data showed lower numbers of students with above average grades (A and B) on their posttest grades for this same group (medium and high usage).

Table 23. PowerPoint Presentation (PPt) Viewing Compared with Posttest Grade.

Student Grade on Posttest	No Usage (0 PPt)	Low Usage (1-2 PPt)	Medium Usage (3-4 PPt)	High Usage (5 PPt)	Total	Percent of Total
A (90-100%)	1	2	1	1	5	6.2
B (80-89.9%)	6	8	6	3	23	28.4
C (70-79.9%)	6	3	11	0	20	24.7
D (60-69.9%)	3	2	8	4	17	21.0
E (0-59.9%)	7	6	1	2	16	19.7
Total	23	21	27	10	81	100.0
Mean Grade*	1.6 (D)	1.9 (D)	1.9 (D)	1.7 (D)		

* Mean grade based on four point grade point average (GPA)

Audio Podcast Usage and Comprehension (Posttest Grades). The technology survey had students report the number of audio podcasts listened to from either of the two audio podcasts made available on the website. This number was compared with the corresponding grade received on the posttest for the unit (Table 24). Of all the technology interventions, the audio podcasts were the least utilized. Seventy students (86.4%) did not listen to any audio podcasts, eight students (9.9%) listened to one, and a mere three students (3.7%) listened to both. Of the three categories of usage (no usage, low usage, and high usage), only the high usage category did not have any students whom failed the posttest.

Table 24. Audio Podcasts Usage Compared with Posttest Grade.

Student Grade on Posttest	No Usage (0 Podcasts)	Low Usage (1 Podcast)	High Usage (2 Podcasts)	Total	Percent of Total
A (90-100%)	4	1	0	5	6.2
B (80-89.9%)	21	2	0	23	28.4
C (70-79.9%)	17	2	1	20	24.7
D (60-69.9%)	13	2	2	17	21.0
E (0-59.9%)	15	1	0	16	19.7
Total	70	8	3	81	100.0
Mean Grade*	D (1.8)	C (2.0)	D (1.3)		

* Mean grade based on four point grade point average (GPA)

Treatment Subgroup and Overall Technology Usage. The assigned treatment subgroups (non-aggressive and aggressive) and their frequency of intervention usage (videos, PowerPoint presentations, and audio podcasts) were recorded and compared

(Table 25). Only interventions that were utilized more than one time by a student were counted in the overall frequency usage. To clarify, the number of times students watched 2 to 8 videos, watched 2 to 5 PowerPoint presentations, and listened to both audio podcasts were calculated and recorded for each treatment subgroup. The treatment subgroup composite frequency usage for each intervention was compared.

The number of students in the aggressive subgroup (39) was few than the non-aggressive subgroup (42); however, the students in the aggressive subgroup utilized the technological interventions with higher frequency (Table 25). The aggressive subgroup used the videos 11.5%, PowerPoint presentations 7.3%, and audio podcasts 2.6% more often than the non-aggressive subgroup.

Table 25. Treatment Subgroup Compared with Overall Frequency of Technology Usage.*

Treatment Subgroup	N	Videos	PowerPoint Presentation	Audio Podcasts	Total	Mean
Non-Aggressive	42	21 (50.0%)	26 (61.9%)	1 (2.4%)	48	16.0
Aggressive	39	24 (61.5%)	27 (69.2%)	2 (5.1%)	53	17.7
Difference	3	11.5%	7.3%	2.6%	5	1.7
Mean	40.5	22.5	26.5	1.5	50.5	
SD	1.5	1.5	0.5	0.5	2.5	

* Frequency based on more than one use of technology intervention

Treatment Subgroup and Teacher Communications. The technology survey asked students in treatment subgroups (non-aggressive and aggressive) their perception that teacher communications were helpful (Table 26). Seventy-seven (95%) students responded (agree and somewhat agree) in both subgroups (non-aggressive and aggressive) that the teacher's email communications were helpful (Table 26). In the non-aggressive treatment group (2nd and 3rd hours) 28 students (34.6%) "agree" and 11 students (13.6%) "somewhat agree" the teacher's communications were helpful. In the aggressive treatment group (4th and 5th hours) 33 students (40.7%) "agree" and 5 students (6.1%) "somewhat agree" the teacher's communications were helpful.

Table 26. Treatment Subgroups Compared with Student Perception that Teacher Communications were Helpful.

Student Response	Non-Aggressive Treatment Group (2nd and 3rd Hours)	Aggressive Treatment Group (4th and 5th Hours)	Total	Percent of Total
Agree	28	33	61	75.3
Somewhat agree	11	5	16	19.7
Somewhat disagree	2	0	2	2.5
Disagree	1	1	2	2.5
Total	42	39	81	100.0

Video Viewing and Perception of Helpfulness. The technology survey asked students to report the number of videos they watched from any of the eight videos made available on the website. This number was compared with the student rating of perceived helpfulness of having access to these videos (Table 27). Seventy-six students (93.8%) responded (agree and somewhat agree) that having videos on the teacher's webpage was helpful. Though a majority of students thought the videos were helpful, there was no difference between the aggressive (D, 1.8) and non-aggressive (D, 1.8) subgroup posttest grades (Table 19).

Table 27. Student Report of Videos Viewed Compared with Perception that Videos were Helpful.

Student Response	No Usage (0 Videos)	Low Usage (1-2 Videos)	Medium Usage (3-4 Videos)	Medium-High Usage (5-6 Videos)	High Usage (7-8 Videos)	Total	Percent of Total
Agree	16	12	11	7	7	53	65.4
Somewhat agree	9	5	6	2	1	23	28.4
Somewhat disagree	2	1	0	0	0	3	3.7
Disagree	1	0	0	0	1	2	2.5
Total	28	18	17	9	9	81	100.0

PowerPoint Presentations Viewing and Perception of Helpfulness. The technology survey asked students to report the number of PowerPoint presentations they watched from any of the five PowerPoint presentations made available on the website. This number was compared with the student rating of perceived helpfulness of having access to these PowerPoint presentations (Table 28). Seventy-six students (93.8%) responded (agree and somewhat agree) that having PowerPoint presentations on the teacher's webpage was helpful. This response (93.8%) to the PowerPoint presentations parallels the same response to having videos (93.8%) on the teacher's webpage. Students responded that the five PowerPoint presentations were helpful in learning the curriculum with 61 students (65.4%) who "agree" and 15 students (28.4%) "somewhat agree". Only 1 of the 81 students (1.2%), who did not access any of the PowerPoint presentations, felt that they were not helpful (disagree).

Table 28. Student Report of PowerPoint Presentations Viewed Compared with Perception that PowerPoint Presentations Were Helpful.

Student Response	No Usage (0 PPt)	Low Usage (1-2 PPt)	Medium Usage (3-4 PPt)	High Usage (5 PPt)	Total	Percent of Total
Agree	12	16	23	10	61	65.4
Somewhat agree	8	4	3	0	15	28.4
Somewhat disagree	2	1	1	0	4	3.7
Disagree	1	0	0	0	1	2.5
Total	23	21	27	10	81	100.0

Audio Podcast Usage and Perception of Helpfulness. The technology survey asked students to report the number of audio podcasts they listened to from the two audio podcasts made available on the website. This number was compared with the student rating of perceived helpfulness of having access to these audio podcasts (Table 29). Fifty-eight students (71.6%) responded (agree and somewhat agree) that having audio podcasts on the teacher's webpage was helpful, even though few students utilized this technological resource (Table 29). Twenty-six students (32.1%) "agree" and 32 students (39.5%) "somewhat agree" that having audio podcasts on the teacher's webpage was helpful to their learning.

Table 29. Student Report of Audio Podcasts Usage Compared with Perception that Audio Podcasts were Helpful.

Student Response	No Usage (0 Podcasts)	Low Usage (1 Podcast)	High Usage (2 Podcasts)	Total	Percent of Total
Agree	21	3	2	26	32.1
Somewhat agree	27	4	1	32	39.5
Somewhat disagree	14	1	0	15	18.5
Disagree	8	0	0	8	9.9
Total	70	8	3	81	100.0

Helpfulness and Curriculum Goals (Comprehension). The technology survey assessed the current student perception that that the overall technological intervention was helpful in strengthening their comprehension (Table 30). Seventy-three students (90.2%) responded (agree and somewhat agree) the technological resources were helpful in strengthening student comprehension of the earth science and chemistry objectives (Table 30). Student responses included 37 students (45.7%) who "agree" and 36 students (44.5%) "somewhat agree".

Table 30. Current Student Perception that Overall Technological Intervention was Helpful in Strengthening Comprehension.

Student Response	Total	Percent of Total
Agree	37	45.7
Somewhat agree	36	44.5
Somewhat disagree	4	4.9
Disagree	4	4.9
Total	81	100.0

Helpfulness and Curriculum Goals (Misconceptions). The technology survey assessed the current student perception that that the overall technological intervention was helpful in clarifying misconceptions (Table 31). Seventy-five students (92.6%) responded (agree and somewhat agree) the technological resources were helpful in clarifying misconceptions or things that students were confused about in the earth science and chemistry unit (Table 31). Students responded that the technological resources were helpful with 31 students (38.3%) who "agree" and 44 students (54.3%) "somewhat agree".

Table 31. Current Student Perception that Technological Interventions were Helpful in Clarifying Misconceptions.

Student Response	Total	Percent of Total
Agree	31	38.3
Somewhat agree	44	54.3
Somewhat disagree	4	2.5
Disagree	4	4.9
Total	81	100.0

Helpfulness and Curriculum Goals (Active Process). The technology survey assessed the current student perception that that the technological interventions were helpful in demonstrating science is an active process (Table 32). Sixty-six students (81.5%) responded (agree and somewhat agree) that the technological resources focusing on historical figures and modern scientists helped students see that science was an active process with many goals and differing paths (Table 32). Twenty students (24.7%) who "agree" and 46 students (56.8%) "somewhat agree" to this question.

Table 32. Current Student Perception that Overall Technological Intervention was Helpful in Demonstrating Science is an Active Process.

Student Response	Total	Percent of Total
Agree	20	24.7
Somewhat agree	46	56.8
Somewhat disagree	10	12.3
Disagree	5	6.2
Total	81	100.0

Helpfulness and Curriculum Goals (Future Career). The technology survey assessed the current student perception that the teacher's science class may be helpful in students' future career (Table 33). Sixty-four students (79%) responded (agree and somewhat agree) when asked if what they were learning in the science class may be helpful in their future career (Table 33). Thirty-four students (42%) who "agree" and 30 students (37%) "somewhat agree" with this question.

Table 33. Current Student Perception that the Teacher's Science Class May be Helpful in Students' Future Career.

Student Response	Total	Percent of Total
Agree	34	42.0
Somewhat agree	30	37.0
Somewhat disagree	9	11.1
Disagree	8	9.9
Total	81	100.0

Webpage Analysis Results. The teacher webpage was analyzed with the Google Analytics® software program during the last 18 days (March 12 – March 30) of the research study and the results were recorded (Appendix G). Google Analytics® identified 146 unique individuals that visited the teacher's webpage for a total of 443 visits. There were 297 returning visitors (67%) and 146 new visitors (33%) during the 18 days of analysis. The software program calculated 3:06 minutes for the average time spent on the webpage. There were 1,239 pages viewed during the 18 days of analysis and an average of 2.80 views per visit. Individuals who accessed the teacher's webpage totaled 430 (97.1%) from the United States. The majority of visitors originated from the following cities: 354 (79.9%) from Calumet, Michigan; 49 (11.1%) from Houghton, Michigan; 10 (2.3%) from Green Bay, Wisconsin; 9 (2.0%) from Appleton, Wisconsin; 6 (1.4%) from Traverse City, Michigan; 3 (0.7%) from Marquette, Michigan; and 2 (0.5%) from Chicago, Illinois.

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Chapter 5 – Conclusion

The goal of this study was to determine if having access to technology, including iPad tablets and teacher's physical science webpage resources, could assist ninth grade high school students in attaining greater comprehension with specific state standards for earth science and chemistry (Table 1). It was my intent that through careful assessment I could contribute new information on the effectiveness of these technological interventions on comprehension and scientific literacy compared to traditional classroom instruction.

Did the Students Learn the Intended Content?

This study first needs to establish that the students in the current year did indeed learn the earth science and chemistry content that was taught to them. My examination of the evidence collected, gains between the pretest and posttest, indicates that this is the case.

Evidence for Learning. The current year students were tested prior to instruction (pretest) and then again after instruction (posttest). The pretest and posttest items were identical and were designed to measure objectives specific to the Michigan Department of Education's High School Content Expectations (Table 5). The posttest scores improved by an average of 6.9 points (32.4%) (Table 11). An average effect size of 0.78, which can be considered practically important, was calculated for test items #1 through #43 for the current year classes (Table 12). Most assessment items had a positive mean effect size that was greater than 0.30, which can be considered practically important. The only exceptions were items #32 (0.21), #42 (0.11), and #43 (0.10).

There could be several factors to account for the lower effect size gain for these assessment items. Item #32 may not have been adequately covered during instruction or the question may have been confusing to students. Items #42 and #43 assessed the Michigan HSCE topic E1.1 and were novel questions for this unit. Like items #32, item #42 may not have been adequately covered during instruction or the question may have been confusing to the students. Item #43 had a low mean effect size (0.10) due to a large number of students getting the question correct on the pretest and the posttest, causing the composite gain to be lower than expected.

High School Curriculum Goals Learning. Student raw posttest scores of 30 (70%) or greater were determined to have met the Michigan's HSCE. Only three of 85 students overall met the posttest expectations on the pretest. At the conclusion of the study, all students, except for three individuals, increased their assessment scores. Negative gains between their pretest and posttest could be attributed to the time in which the class met (morning), motivation toward science class and school in general, or difficulties with learning the science content. A total of 55 of 85 (64.7%) of the students met the Michigan's HSCE. Overall, the results demonstrate that the interventions were successful in increasing student comprehension.

Scientific Literacy Learning. The study was successful in increasing student scientific literacy during the five weeks of instruction. This was assessed using posttest items assigned to Bloom's application and analysis cognitive levels. Both of Bloom's cognitive levels were determined to have been met with fifty percent or more of the test items for each cognitive level attained.

Can Learning Gain Be Attributed to the Technological Interventions?

The current year posttest scores on the earth science and chemistry assessment were higher than the prior year classes, so the reflexive answer is yes. However, it's best to safeguard against a knee-jerk assumption by asking some key questions. Were the prior year classes in most ways similar to the current year class, including: traditional instruction, non-academic variables, and external assessment? Also, what evidence can be shown that the current year posttest gains were the result of the technological interventions?

Evidence of Similarity to Prior Year Classes. The instruction and posttest[1] was the same for the three classes being compared (Table 2). Therefore, any differences in assessment data between the current and prior year classes should be the result of the technological interventions used with the current year students, if the classes can be shown to be similar.

I was able to show, with respect to demographics, that the non-academic variables of the current year class were comparable to the two prior year classes (Table 4). A comparison of gender, race, special needs, and economically disadvantaged status showed a similar distribution for all three classes. The class sizes were also similar.

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[1] Posttest was the same except for items #41, #42, #43, which were removed during prior year comparison. See Chapter 3, page 41.

In addition, a comparison between the current class and the rest of the high school student body shows that they are also similar with respect to class size, gender, race, special needs, and economically disadvantaged status (Table 3).

I was also able to compare all three classes with respect to a standardized external assessment, the eighth grade science MEAP. I used the proficiency rating for each student and created a mean proficiency for each class. The MDE categorizes proficiency into four levels: level 1 (advanced), level 2 (proficient), level 3 (partially proficient), and level 4 (not proficient). Each class achieved an approximate mean science MEAP rating of partially proficient, with mean proficiency ratings greater than 3.0 and less than 4.0. However, there were similarities and differences that should be noted.

The two prior year classes were academically similar to each other with respect to mean MEAP proficiency (Table 16). The mean MEAP proficiency for the 2010-2011 year class (3.2) is almost the same as the 2009-2010 year class (3.1) with an effect size of 0.10. A t-test of the mean proficiencies shows that the difference in performance between these two classes was not statistically significant ($p = 0.257$). With the academic similarity between the two prior year classes established, it is important to assess differences when compared to the current year class.

The current year class had a mean proficiency that was less (3.5 is a lower mean proficiency) compared with the 2010-2011 year class (mean proficiency of 3.2). This difference produced an effect size of 0.30 (Table 14). A t-test of the mean proficiencies shows that the difference between to two class is statistically significant ($p = 0.002$). Likewise, the current year class (3.5) was less proficient when compared with the 2009-

2010 year class (3.1). This difference produced an effect size of 0.40 (Table 15). A t-test of the mean proficiencies of these classes shows that the difference was also statistically significant (p = 0.001). Noting the academic differences, it might be expected that the current year class would receive the lowest mean posttest score when compared to the prior year classes. However, the current year class achieved the highest posttest mean of the three year class comparison (Tables 17 and 18).

How Much Learning Gain is a Result of the Technology Intervention? The classroom instruction was the same for the three classes being compared, except for the current year technological interventions. The interventions assisted the current ninth grade student comprehension of the earth science and chemistry standards as demonstrated by the highest mean posttest score of 37.5 points (72.1%) (Table 17). The two prior year classes each had lower mean posttest scores. The 2010-2011 year class had a mean of 34.4 points (66.1%) and 2009-2010 year class had a mean of 34.7 points (66.7%) (Table 19).

The 2010-2011 year class compared with the mean posttest scores for 2009-2010 year class showed an effect size of 0.03 (not important) (Table 19). A t-test of the means shows that the difference between the two classes was not statistically significant (p = 0.427).

The current year class compared with the mean posttest scores for 2010-2011 year class showed an effect size of 0.35 (particularly important) (Table 17). A t-test of the means shows that the difference between the two classes is statistically significant (p = 0.013).

The current year compared with the mean posttest scores for 2009-2010 year class showed an effect size magnitude of 0.32 (particularly important) (Table 18). A t-test of the means shows that the difference between the two classes is statistically significant ($p = 0.029$).

It is my finding that the student gain was due to the direct and indirect result of the technological interventions. This conclusion is based on the triangulation of the evidence provided in this single study. The current year class was similar to the prior year classes (2010-2011 and 2009-2010) with respect to the instruction, posttest, non-academic variables (demographics), and were also comparable to the rest of the high school student body (demographics). The differences demonstrate the effects of the interventions.

The distinctions between the classes started with the eighth grade science MEAP proficiencies. The current year class' mean MEAP proficiency was the lowest compared with the prior 2010-2011 and 2009-2010 year classes. Given that the mean differences were statistically significant, we would expect the posttest data to show similar results. However, when the current year class posttest score was the highest compared with the prior 2010-2011 and 2009-2010 year classes. When reviewing the data, there is supporting evidence that the posttest gains were the result of the technological interventions.

What does the Technology Survey Say about the Usage of Technological Interventions? Technology usage in the aggressive and nonaggressive subgroups was different. Even though there was not an increase in posttest scores based on the subgroup assignment, the data does demonstrate a greater use of interventions by the aggressive treatment group. Students that were required to use their iPad tablets to access the teacher's webpage and identify the technology resources that were available used the interventions more frequently.

The aggressive treatment group utilized each technological intervention (videos, PowerPoint presentations, and audio podcasts) with greater frequency than the non-aggressive treatment group (Table 25). The aggressive subgroup used the videos 11.5%, PowerPoint presentations 7.3%, and audio podcasts 2.6% more often than the non-aggressive subgroup. This result seems logical. If a teacher tells students that a very important intervention (i.e. video) is on their webpage and they should watch it, students often forget about it. However, if the teacher gives students time in class to find the resource and look at it – students have now "seen" the video and are more likely to watch it later.

Other results, regardless of subgroup assignment, included the videos that were posted on the teacher's webpage were watched by a majority of the students. A total of 53 of 81 (65.4%) students surveyed watched at least one of the eight videos (Table 22). Twenty-eight (34.6%) did not watch any of the videos. Students made several comments that it was nice to have videos available to watch. Others wanted to know why I did not make my own videos because they would be better than the current videos.

Students used the PowerPoint presentations more frequently than all the other technological interventions. A total of 58 of 81 (71.6%) students surveyed accessed at least one of the five PowerPoint presentations on the teacher's webpage (Table 23). Twenty-three (28.4%) did not watch any of the PowerPoint presentations. It is important to note that the posttest assessment data revealed that those students who accessed more PowerPoint presentations failed with less frequency than those who under-utilized this technological resource (Table 23).

Only 1 of the 27 students (33.3%) who accessed 3-4 PowerPoint presentations (medium usage) failed the posttest. Similarly, only 2 of the 10 students (12.3%) who accessed 5 PowerPoint presentations (high usage) earned an E on the posttest. Seven of the 23 (28.4%) students who did not access any of the presentations failed.

Students used the audio podcasts the least of all the technological interventions. Only 11 of 81 (13.6%) students surveyed listened to at least one of the two audio podcasts on the teacher's webpage (Table 24). Seventy (86.6%) did not watch any of the PowerPoint presentations. Throughout the study, students made negative comments about the audio podcasts. They said that just listening to someone talk about the information is boring and that they want to see what is going on. Other educators found similar results with their students (Cann, 2007; Guertin, 2007).

Dr. Cann from the University of Leicester, in the United Kingdom reached similar results with his two classes of 150 first year students and 90 second year biological science students. When surveyed, Cann discovered that his audio podcast lectures were "not popular with students" and that few students accessed his [audio] lectures with "an average of 0.30 downloads per student per file (Cann, 2007, p.1).

Dr. Guertin's assessment of her introductory-level geoscience and Earth science courses at Penn State University showed few students accessed her audio podcast lectures. Through end-of-course surveys, Dr. Guertin found that "30% of the 68 students accessed 2 podcasts, which represents 11% of the total number of podcasts available. One student accessed 10 different [podcast] files, more than 32% of the available podcasts" (Guertin *et al*, 2007, p.5) even though "over 97% of students had a home computer with speakers" (Guertin *et al*, 2007, p.3). Students did not frequently take advantage of the audio podcast lectures; however, 100% of the students responded that they felt that "it is a valuable resource to have available" to assist in their learning (Guertin *et al*, 2007, p.5). The Penn State University students' free-response comments paralleled those of the current ninth grade students at Calumet High School, which included, "You never know when you are going to need to hear it again; they were always helpful" and "It's nice to have that they're a 'safety net'. I don't always get things the first time, so it's a nice option to have" (Guertin *et al*, 2007, p. 5-6).

What does the Technology Survey Say about Helpfulness of Each Technological Intervention? Both subgroups (non-aggressive and aggressive) found the teacher's communications helpful. Seventy-seven of 81 students (95.1%) responded (agree and somewhat agree) in both subgroups that the teacher's email communications were helpful (Table 26). I started this intervention earlier in the current school year after a student commented on forgetting about a quiz. The one-way reminders to students quickly lead to an efficient means of two-way communication at any point in the day. I think it's especially effective for shy or reserved students who may feel uncomfortable asking questions in class. Now these students have a less invasive means of communicating. It took a little time and effort to group each student's email address for each class period; however, the positive responses from the students made it all worthwhile.

Fourteen of 81 students (non-aggressive and aggressive) typed comments pertaining to email communications on the technology survey. Several students wrote positive testimonials, when given the opportunity (Appendix F). One student wrote, "when he [teacher] emails me (us) I usually go to the web page within the five-ten minutes following and go over the quizzes/presentations again." Another said, "I love that I'm reminded about tests and quizzes over the weekends and weekdays. So then I can study for them in advance." A third student stated, "it got me more motivated to study/finish my work." A fourth student without internet access at home pointed out, "if I actually got the emails at my home ahead of time it would be a great deal of help to me, but because I don't have access to Wi-Fi where I live. I don't receive these at home, I instead get them all when I come to school."

Seventy-six of 81 students (93.8%) responded (agree and somewhat agree) that having access to the video interventions was helpful (Table 29). Nineteen of 81 students typed comments pertaining to videos on the technology survey. Several students wrote comments on how the videos helped them prepare for the posttest (Appendix F). One student wrote, "they [videos] helped me study for tests and quizzes." A second student explained, "some [videos] were a little long but they definitely helped me learn better." A third exclaimed, "[videos] gives a lot of information that is on the tests. One student confessed, "I only watched one, but even that worked." A professor in a university setting found his students had similar sentiments about educational videos.

Dr. Cann found his biological science students accessed an "average 1.75 downloads per student per video [lecture]" which was "five times the response rate" for his audio podcast lectures (Cann, 2007, p. 2). In a 12 student focus group, Cann found there was a “positive reception for the video format in comparison to the audio podcasts. 9/12 (75%) of students had watched one or more of the videos (c.f. 9% for the podcasts). 11/12 (92%) had watched an online video clip” (Cann, 2007, p. 2). Students in the focus group commented that the videos were “much better than the podcasts" and "I prefer the videos to your lecture” (Cann, 2007, p. 2).

Current students were just as upbeat toward the PowerPoint presentations as they were with the videos. Seventy-six of 81 students (93.8%) responded (agree and somewhat agree) that having access to the PowerPoint presentations was helpful (Table 28). Only 1 of the 81 students (1.2%), who did not access any of the PowerPoint presentations, felt that they were not helpful (disagree).

Fifteen of 81 students typed comments pertaining to PowerPoint presentations on the technology survey (Appendix F). The PowerPoint presentations received a large number of student accolades. One student exclaimed,” I really like these! They're very helpful!” Others stated they “use them before [the] test!” and that the PowerPoint presentations are “very nice for studying and making flash cards based off them.” Another student mentioned, “Every once in a while I will go through all of them again for a review.” While my students were praising the PowerPoint presentations, they were not as enthusiastic about the audio podcasts.

Though few students utilized the audio podcasts, students still thought this intervention was helpful and wanted it available as a resource for the class. Fifty-eight of 81 students (73.6%) responded (agree and somewhat agree) that having access to the audio podcast interventions was helpful (Table 29).

Twenty-two of 81 students typed comments pertaining to audio podcasts on the technology survey (Appendix F). Several students remarked more negatively to the audio podcasts compared to the other interventions. One student made an interesting remark, "it was good because I learned the curriculum but in a funny way." Another student tried to explain how audio podcasts could be useful to others, "I think if you're one of them people that learn from listening it is good." Other students explained that the other interventions were more helpful in learning the curriculum, "I think the videos or PowerPoints would be better than podcasts" and "easier to watch [videos] or else read [PowerPoint presentations]." One student bluntly explained, "I don't think people want to listen to podcasts."

What does the Technology Survey Say about the Curriculum Goals and the Helpfulness of Technological Interventions?

For the first curriculum goal, 73 of 81 students (91.1%) responded (agree and somewhat agree) that the technological resources were helpful in strengthening student comprehension of the earth science and chemistry information (Table 30). Twelve of 81 students typed remarks about the helpfulness of the interventions on the technology survey. Student comments on the technology survey included those who admitted "I had to look at them a couple times to understand something" and "I didn't watch all of them" (Appendix F). One student stated, "Sometimes I can't remember what I review but most of the time it helps to look at the presentations, etc." Another acknowledged, "I understood it more than I thought I would with these videos."

For the second curriculum goal, 75 of 81 students (92.6%) responded (agree and somewhat agree) the technological resources were helpful in clarifying misconceptions or things that students were confused about in the earth science and chemistry unit (Table 31). Ten of 81 students typed comments on technology survey about the helpfulness of the interventions in clarifying misconceptions (Appendix F). A few students described how the technology interventions were helpful. One student explained how the resources "helped me with tests," and another cited a specific example, "especially on the half-life power pt." A third person described another instance, "I remember one specific time when I had to look up a problem on the Power Points and it helped me."

For the third curriculum goal, 66 of 81 students (81.5%) responded (agree and somewhat agree) that the technological resources focusing on historical figures and modern scientists helped students see that science was an active process with many goals and differing paths (Table 32). Six of 81 students typed comments, regarding this question, on the technology survey. A few students wrote comments about this question (Appendix F). One student explained "Kinda knew that anyway. Would probably be helpful to others, though." Another student wrote, "I agree with most of these, yet I rarely used the resources. Still helpful though."

For the fourth curriculum goal, 64 of 81 students (79%) responded (agree and somewhat agree) when asked if what they were learning in the science class may be helpful in their future career (Table 33). Eleven of 81 students typed comments to this question on the technology survey. Several students were convinced that the science curriculum was beneficial to their future careers. One student stated confidently, "No doubt in my mind". Another student exclaimed, "I learned more in this class than any other science class I had yet." Other students alluded to the possibilities that they, "might go into something science related" and "I have been considering something in the medical field lately so I might be learning something useful." Others explained the uncertainty of high school students with statements like they, "might go into something science related" and "not really sure what I'm planning to be when I get older, so I'm not really sure."

What Problems Occurred?

Problems During Study. The two snow days that occurred during the first of the study disrupted the curriculum time line. With two fewer days of instruction, the depth to which student learned the content may have been adversely affected.

The number of special education students in each treatment subgroup (aggressive and non-aggressive) could have influenced the posttest grades. Even though the mean posttest grade was the same for both subgroups (D, 1.8, Table 21), I remembered that, "being in the treatment or control group is only one reason for score variability" or similar scores (Shaver, 1985b, p. 140). The non-aggressive treatment group only had two special needs students (2.5%), while the aggressive treatment group had eight special needs students (9.9%) (Appendix D). Based on my years of teaching at Calumet, special needs students typically have lower formative assessment grades.

The time of the day that the class periods met may have influenced the afternoon subgroup (aggressive) achievement on the posttest. Only the aggressive subgroup (4^{th} and 5^{th} periods) had posttest items with a negative mean effect size, including item #5 (-0.21, 4^{th} period), #12 (-0.26, 5^{th} period), #33 (-0.25, 5^{th} period), #43 (-0.23, 5^{th} period)

(Table 12). Students in the afternoon classes, may have been more “wound up” after lunch or fatigued toward the end of the school day. The instructor may have relayed specific information to the morning classes (non-aggressive subgroup), but mistakenly forget to mention it to the afternoon classes (aggressive subgroup). If I were to do this study again, I would select one morning and afternoon class for each subgroup to eliminate this potential influence on the results.

When evaluating student responses on the technology survey, a question surfaced that needed an answer. If students did not use a specific intervention (e.g. audio podcast), can they “agree” that the intervention was helpful? For example, question 17 stated, “It is helpful that Mr. Heflin put podcasts (audio only) covering the chemistry lessons and curriculum on his school webpage”. Similar phrasing was used for questions accessing videos and PowerPoints presentations.

It is my hypothesis that students believe it is helpful to have these interventions, but don't always use them. As a comparison, students know that spinach is important (helpful) to a healthy diet, but they might not always eat it. When students selected "agree” and “somewhat agree" it is evidence that the students want these interventions available. Similar findings indicated that students did not always use the technology interventions, but a high percentage (over 80%) wanted to have these interventions available (Cann, 2007; Guertin, 2007; Read, 2005). If an administer or school board is deciding to introduce or keep these technology interventions, I believe this data should be available.

Potential Validity Issues. The results of this study may contain some inherent sources of error. Students in the treatment group may be influenced by the study's "novelty; awareness that one is a participant in an experiment; and … special procedures and new patterns of social interaction…" (Isaac & Michael, 1995, p. 91). Furthermore, it is possible that student data could have been affected by "a non-treatment driven effect", such as simply participating in a study associated with Michigan Technology University (McCarney et. al., 2007, p. 7).

Suggestions for Improvement?

First, the biggest improvement I wanted to make before or during the study, ironically, did not occur until a month after completing the study. That was when the Calumet technology committee introduced a new iPad application ExplainEverything® that allowed teachers to create their own videos.

I now use PowerPoint presentations, with as many colorful pictures and diagrams as possible, to help students visualize the information. Next, I overlay my [audio] explanations and write annotations on each of the slides. Each video includes an introduction and conclusion slide summarizing the main topics discussed during the video. I relate new information on the video to previous curriculum objectives. At the end of my videos, I ask students if they could explain these concepts to another student. If not, they need to review the parts of the video that are unclear.

Second, limit the length of videos to 10-15 minutes. This is the current rule of thumb – videos should be approximately equal in length to the age of your students. One of my previous administrators told me, "Students' brains can only absorb what their bum (butt) can endure" (Horton, 2005b). What she was alluding to was that students should actively engage in their learning, not just sitting there "like bumps on a log" (Horton, 2005b).

Recommendations.

During my study, I compared entire classes within one academic school year and with classes from prior years to ascertain differences. A refinement would be to actually match individual students within classes on all demographics. In this way, only students with matched demographics would be compared and would make up the core subjects during the study. Other unmatched students would participate in the study, but would not be included in the comparisons.

Another alteration to the study would be to only focus on one type of technological intervention, such as videos. It would be beneficial for teachers to have research data that quantitates the effectiveness of each individual intervention. Another possibility would be for other educators to repeat my study and "if the results are replicated by other research, your confidence grows that the results are real" (Bracey, 2000, p. 60).

"Replications are not very common in educational research" and "maybe that's another reason that educational research has not been very helpful to school people" (Shaver, 1985a, p. 60). Science teachers instruct students on the scientific method and the need for scientists to repeat experiments for increased reliability. However, it occurs infrequently in education. "If the same research were carried out by others, with no reason to suspect the same design flaws from one study to the next, and the results were consistent with mine, then I'd certainly have a lot more confidence that my results could be relied on" (Shaver, 1985a, p. 60). As educators, we look for ways to validate what we are doing in our classroom and strive to make connections with our students.

I encourage all educators to look for ways to increase communication with their students. It can be as simple as emailing reminders about an upcoming quiz, a link to a local newspaper article, or an interactive webpage. Teachers are now "tweeting" (Twitter®) or connecting with students on Facebook®. There are iPad applications (i.e. Remind101®) that allow teachers to safely communicate a text message to students and parents, without either party having the cell phone number of the other. No matter what form it takes, communication is a positive tool for educators. However, this is not the only way teachers can feel more connected to their students and the world at large.

Using Google Analytics helped to reinforce for me the idea that teachers are not only connected to our students, but to the larger notion of learning communities. I encourage any teacher with a webpage to install Google Analytics®. Teachers, like me, often talk to their students about living in a global society, but is easy to feel isolated in our own individual classrooms. Teachers can quantitate exactly how many people are actually using their webpages and where (city, state, and country) the visitor originates. Technology has the ability to amaze us, but it also can be the source of much frustration if you rush into it blind.

From my own experience, it is imperative that teachers plan and reflect on how they will use new technology interventions in their classroom, before they implement it. Technology is not a simple fix for low grades and motivation. It is a tool like everything else. There is no "magic bullet" or perfect teaching technique. Intense technology use, like a blended classroom, may work well for some teachers and disciplines, but it is not and should not be for everyone.

Even with modern technology, such as videos, the teacher still needs to be the core facilitator of the curriculum. I encourage teachers to model the approach students should take when viewing new material. Whether it's reading a chapter from a textbook or watching a video, I create outlines and questions to help students target the main concepts. I recommend that teachers go through a sample [introductory] video with the students, with everyone taking notes or completing an outline. Afterwards, the teacher should compare their notes with students. The teacher should explain and demonstrate exactly how to dissect the information and their expectations to the students.

Technology will not make life easier for educators. I am spending more time working on curriculum than ever before. It can take hours to outline, setup, record, edit, and upload one 15 minute video. Technology can be overwhelming. It seems to be evolving exponentially with over a million iPad applications, YouTube videos, and webpages with no end in sight. That being said, I do believe technology is here to stay and can be an effective means for teaching our students. Begin with the first step. Start with one technology intervention and learn to do it well.

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Appendix A - Pretest and Posttest Measurement Instrument

This appendix contains the assessment that served as the pretest and posttest during the study. The following are also included in this appendix: the assessment answer sheet, the assessment answer key, and the grading rubric.

Physical Science Test

Properties of Matter & Changes in Matter

Multiple Choice: *Identify the letter of the choice that best answers the question:*

____ 1. Which of the following has no definite volume and no definite shape?

a. solid
b. liquid
c. gas
d. plasma

____ 2. An atom contains ____ in various chemistry levels.

a. neutrons
b. protons
c. electrons
d. ions

____ 3. List the phases in order from the lowest kinetic chemistry to the phase with the highest kinetic chemistry.

a. Gas-Liquid-Solid
b. Liquid-Solid-Gas
c. Solid-Liquid-Gas
d. Gas-Solid-Liquid

____ 4. Al and Cu are symbols for:

a. metal compounds.
b. metal elements.
c. nonmetal compounds.
d. nonmetal compounds.

____ 5. An example of a physical change is the

a. rust on a garden tool.
b. boiling a pot of liquid water.
c. change in the color of leaves.
d. process called photosynthesis.

____ 6. A solution (salt + sugar + water) is a

a. type of compound.
b. heterogeneous mixture.
c. homogeneous mixture.
d. type of molecule.

____ 7. In general, when elements combine chemically,

a. they retain their original properties.
b. a mixture results.
c. new substances with new properties.
d. solutions are formed.

____ 8. A measure of how a metal can be hammered into sheets. It can also measure a metal's flexibility.

a. hardness.
b. brittleness.
c. tensile strength.
d. malleability.

____ 9. An example of a chemical property is

a. the ability to sublime.
b. the ability to change shape.
c. the ability to rust.
d. the ability to change color.

____ 10. Which is not a characteristic of a metal?

a. ductile
b. High tensile strength.
c. found on the far right of the periodic table
d. good conductor of heat and electricity

___ 11. An element has 9 protons, 9 electrons, and 10 neutrons. What is the element?

a. Fluorine
b. Argon
c. Potassium
d. Nickel

___ 12. When poured into water, glycerol (also a liquid) falls to the bottom of the beaker. Which of the following is a true statement?

a. The water is more dense than the glycerol.
b. An object that floats in water will always float in glycerol.
c. An object that floats in glycerol will always float in water.
d. The glycerol is less dense than water.

_____ 13. You are a scientist and have collected 100 grams of a radioactive substance (parent sample). You know that this particular substance has a half-life of 20 years. How much of the original, radioactive parent sample will be left after 40 years?

a. 100 grams
b. 50 grams
c. 25 grams
d. 12.5 grams

__ 14. The atomic number of an element indicates the:

a. sum of protons plus neutrons.
b. sum of protons plus electrons.
c. number of protons.
d. number of neutrons.

___ 15. Which of the following is true for valence electrons?

a. Valence electrons are always located in the innermost chemistry level.
b. Valence electrons may be lost or gained by an atom when bonding occurs.
c. Each element in the periodic table has a different number of valence electrons.
d. Valence electrons are found only in radioactive isotopes.

___ 16. Elements in the same period or row of the periodic table have the

a. same atomic number.
b. same atomic mass.
c. same number of valence electrons.
d. same number of chemistry levels.

___ 17. Which of the following is TRUE? Covalent bonding occurs:

a. in salts like NaCl.
b. when electrons are shared between 2 atoms.
c. only when electrons are shared between two identical ions.
d. when electrons are transferred from one atom to another.

___ 18. When an atom gains or losses electrons, it has an electrical charge. It is known as:

a. an ion.
b. a free radical.
c. an isotope.
d. a monatomic molecule.

___ 19. Elements on the far right side of the periodic table (family 18) tend to be

a. inactive solids (metals).
b. active solids (metals).
c. inactive gases (nonmetals).
d. active gases (nonmetals).

___ 20. Almost all of the MASS of an atom is found:

a. outside the nucleus
b. inside the nucleus
c. in the electron cloud
d. in the chemistry levels

____ 21. Which statement is TRUE about elements in group 16 (group 6)?

a. They have an oxidation number of 1^-.
c. They have 2 valence electrons.
b. They have an oxidation number of 2^+.
d. They need 2 electrons to complete their octet.

____ 22. The correct name for the compound formed by combining oxygen with aluminum is:

a. Oxygen aluminate.
c. Aluminum oxide
b. Oxygen aluminide
d. Aluminum oxate

____ 23. Most of the elements on the periodic table are:

a. nonmetals.
c. rare-earth elements.
b. metals.
d. liquids.

____ 24. Sodium forms an ionic bond with chlorine when sodium ____ an electron and chlorine ____ an electron.

a. shares, shares
c. gains, loses
b. loses, gains
d. loses, loses

____ 25. Elements in the same family of the periodic table

a. have unrelated properties.
c. have the same number of valence electrons.
b. always keep their cool.
d. always occur in the same phase.

____ 26. The ____ is one kind of particle that makes up the atom and carries a positive charge.

a. electron
c. neutron
b. proton
d. positron

____ 27. If Carbon has an atomic number of 6 & atomic mass number of 13. The total number of PROTONS is:

a. 19
c. 12
b. 13
d. 6

____ 28. Which statement best explains why atoms form chemical bonds with other atoms?

a. Most atoms are less stable when they combine with other atoms.

a.

b. When atoms collide with other atoms, they bond automatically.
c. Atoms are always attracted to other atoms.
d. Most atoms are unstable unless they are combined with other atoms.

____ 29. Moving left to right across a period, the number of valence electrons of the atoms

a. increases steadily.
c. increases and then decreases.
b. decreases steadily.
d. remains the same.

____ 30. If Lithium has an atomic number of 3 & atomic mass number of 7. The total number of NEUTRONS is:

a. 3
c. 7
b. 4
d. 10

____ 31. As a scientist you are trying to determine the approximate age of a seemingly very old tree. Which of the following isotopes would you test for and why?

a. C-14 because it has a half-life of 5730 years and can tell the general age of an inorganic sample (non-living) up to 50,000 years old.

b. C-14 because it has a half-life of 5730 years and can tell the general age of an organic sample (dead or alive) up to 50,000 years old.

c. U-238 because it has a half-life of 4.5 billion years and can tell the general age of inorganic sample (non-living) when the Earth was foamed.

d. U-238 because it has a half-life of 4.5 billion years and can tell the general age of an organic sample (dead or alive) when the Earth was foamed.

<u>32-33 Match the piece of laboratory equipment with its use.</u>

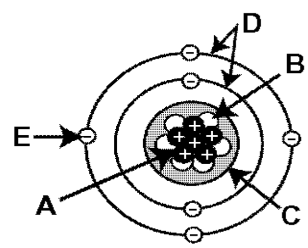
A. graduated cylinder C. mortar and pestle E. digital scale

B. Erlenmeyer flask D. beaker F. test tube

32. Used to measure the mass of a substance.

33. Good for mixing chemicals and doing experiments; is not graduated, and not usually used for measuring.

<u>Match each part of the atom with its identity from the list below.</u>



34. neutron

35. nucleus

36. electron orbital

<u>Matching:</u> *Match the following terms with the correct definition.*

a.	isotope
b.	polyatomic ions
c.	covalent bond
d.	Lewis dot diagram
e.	ions
f.	ionic compounds

____ 37. Nonmetal chemically bonded with another nonmetal (examples: O_2, N_2, Cl_2)

____ 38. Atoms which have gained or lost valence electrons (examples Na^+ or Cl^-)

____ 39. A means to show an element's symbol and an element's valence electrons

____ 40. Atoms which have gained or lost neutrons.

For Questions 41 -42 use the information below.

For unknown objects A, B, and C a student measured the length (centimeters) with a metric ruler, the mass (grams) with a digital scale, and found the volume (cm3) indirectly using a graduated cylinder. The student then calculated the density for the 3 objects. The student's data is given below. The student then compared these unknown objects A, B, and C to known samples with their densities.

Unknown Letter	Object Color	Length (~~mm~~) cm	Mass (g)	Volume (cm^3)	Density (g/cm^3)
A	Black	6.0 cm	17.2 g	12.0 cm^3	1.43 g/cm^3
B	Black	7.5 cm	17.6 g	15.0 cm^3	1.17 g/cm^3
C	Brown	6.5 cm	16.6 g	13.0 cm^3	1.28 g/cm^3

Known Material	Known Densities
Acrylic	1.17
Phenolic	1.32
Acetyl	1.42

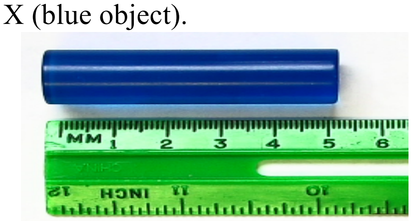
____ 41. The three unknowns are Acrylic, Phenolic and Acetyl. However, the unknown materials are not labeled. The task is to use your measured densities to identify each of the unknowns. Given the above information, do we know that Unknown C is Phenolic?

a. Yes, Unknown A's density is very close to Acetyl's known density and Unknown B's density is exactly that of Acrylic's known density.
b. Most likely, Unknown A's density is close to Acetyl's known density and Unknown B's density is very close to Acrylic's known density.
c. Not likely, Unknown A's density is not very close to Acetyl's known density and Unknown B's density is not exactly that of Acrylic's known density.
d. No, Unknown A's density is not very close to Acetyl's known density and Unknown B's density is not exactly that of Acrylic's known density.

____ 42. Which of the following could account for possible sources of density measurement error during the experiment?

a. The triple beam balance was not properly aligned.
b. The unknown object's length was not measured accurately with the metric ruler.
c. The unknown object's mass was divided by its volume.
d. Water splashed out of the graduated cylinder when the unknown objects were inserted/dropped.

____ 43. Examine the following diagram. Determine if there is a problem measuring the length of the Unknown Object X (blue object).



a. Yes there is a problem, the ruler is not correctly measuring inches.
b. Yes there is a problem, the ruler is measuring millimeters (mm), which cannot be converted into centimeters (cm)
c. Yes there is a problem, the unknown object is not being measured from the zero mark.
d. No there is not a problem with this measurement setup.

Physical Science Test
Properties of Matter & Changes in Matter
Answer Sheet

Name:
Class Period:
Test Number:

	A	B	C	D	E	F
1						
2						
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42						
43						
	A	B	C	D	E	F

*** Reminder for Problems 44-47 = 3 points each**

44.Compare3-4 differences between metals &nonmetals.

45. Explain the differences between a physical change vs. chemical change. Give an example of each:

46. a) What is an isotope?

b) How is a positive ion formed? Give an example:

c) How is a negative ion formed? Give an example:

47. Draw a Bohr diagram of a Beryllium (Be) atom. Write the number of protons, neutrons, electrons, atomic number, and atomic mass.
Use the key below for each particle in your diagram(proton = P).

Atomic Mass:

Atomic Number:

Protons (P):

Electrons (E):

Neutrons (N):

Pretest and Posttest Answer Key

Multiple Choice Answer Key:

1. C
2. C
3. C
4. B
5. B
6. C
7. C
8. D
9. C
10. C
11. A
12. B
13. C
14. C
15. B
16. D
17. B
18. A
19. C
20. B
21. D
22. C
23. B
24. B
25. C
26. B
27. D
28. D
29. A
30. B
31. B
32. E
33. F
34. B
35. C
36. D
37. C
38. E
39. D
40. A
41. A
42. D
43. C

Preferred Answers for Short Answer Questions 44 - 47

44.Compare3-4 differences between metals &nonmetals.

Rubric: Each answer will score ½ point = max 1.5 points for metal and 1.5 for nonmetal answers for a maximum of 3 points

Metals	Nonmetals
Almost all are solid (phase or state)	Solids, liquids, and gases (phase or state)
Good conductors of heat & electricity	Not good conductors of heat & electricity or good insulators
Loss valence electrons when bonding	Gain or share valence electrons when bonding
Have a positive (+) oxidation number (+1,+2, or +3)	Most have a negative (-) oxidation number (-1,-2, or -3)
General properties: high luster or shine, malleable, ductile	General properties: no luster, not malleable, not ductile

45. Explain the differences between a physical change vs. chemical change. Give an examples of each:

Rubric: Each answer will score 1 point = max 1 point for physical change + ½ point for the example and 1 for chemical change + ½ point for the example; maximum of 3 points

Physical Change	Chemical Change
A change in the phase/state of matter Example: Liquid water changes into ice (solid water)	A change in the chemical bonds of the substances Example: Iron rusting, egg rotting, paper burning
The appearance changes of the substance, but it is still the same substance/material Example: Paper is ripped into smaller pieces – it is still paper	One substance is changed into a different substance/material Example: Baking a cake
One substance is dissolved into anther substance, which creates a mixture Example: Sugar (solute) is dissolved in water (solvent)	

46. a) What is an isotope?

Rubric: 1 point for the correct definition

An atom that has the same number of protons as the typical element (H = 1 proton) , but a different number of neutrons (H isotope = 2 neutrons, instead of zero).

b) How is a positive ion formed? Give an example:

Rubric: ½ point for the correct definition + ½ point for the example

An atom (metal) losses one or more valence electrons. It now has more positive protons than negative electrons – e.g. Na+

c) How is a negative ion formed? Give an example:

Rubric: ½ point for the correct definition + ½ point for the example

An atom (nonmetal) that gains one or more valence electrons. It now has more negative electrons than positive protons – e.g. F-

47. Draw a Bohr diagram of a Beryllium (Be) atom. Write the number of protons, neutrons, electrons, atomic number, and atomic mass. Use the key below for each particle in your diagram(proton = P).

Rubric: 1 point for the correct numbers listed below
2 points for a correctly drawn Bohr diagram

Atomic Mass: 9

Atomic Number: 4

Protons (P): 4

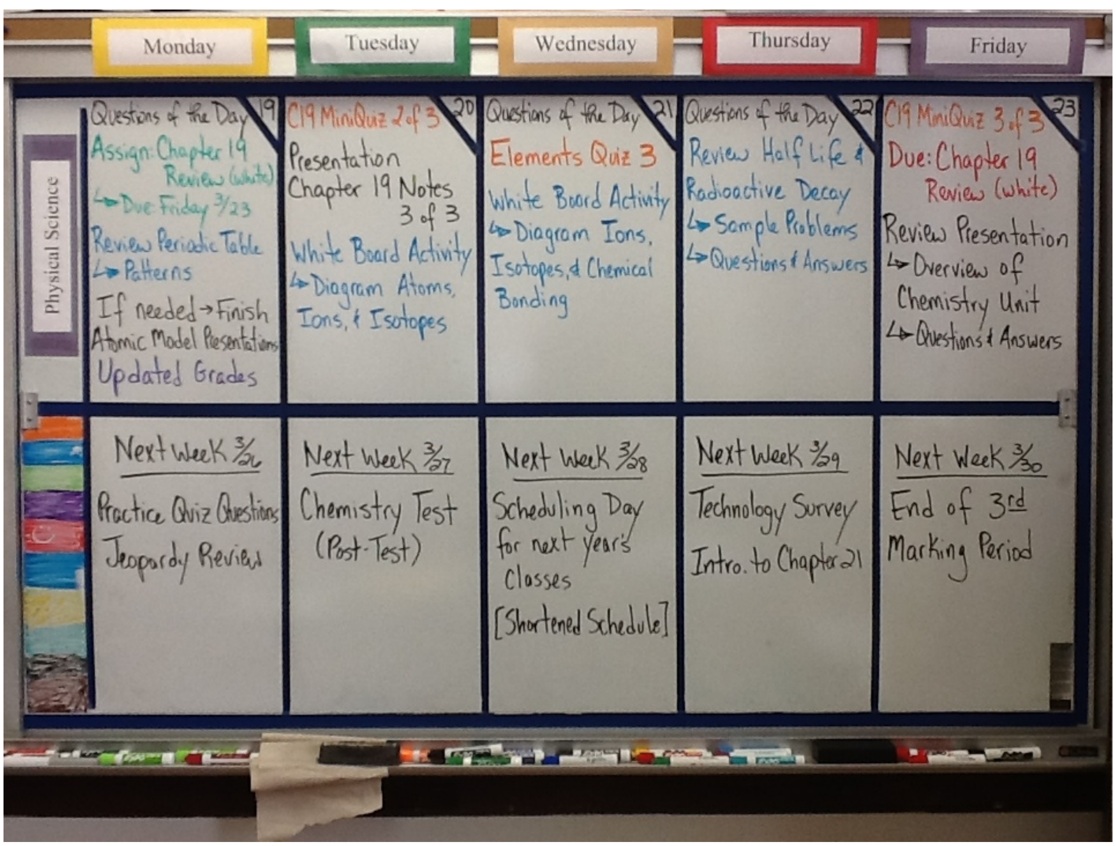
Electrons (E): 4

Neutrons (N): 5

Appendix B - Instructional Materials

This appendix contains images of the lesson plan display and instructional materials for the study. The PowerPoint® presentations include the chapter 19 notes (reading guides 1, 2, and 3), the addendum notes (half-life) and the review. The atomic model project assignment and rubric with pictures demonstrating a three-dimensional model and poster are also included. Examples of the white board activity are displayed in this appendix. The samples of mini-quizzes and element quizzes demonstrate the formative assessments.

Lesson Plans Displayed on the Front White Board - Week Four of Study



PowerPoint® Presentations

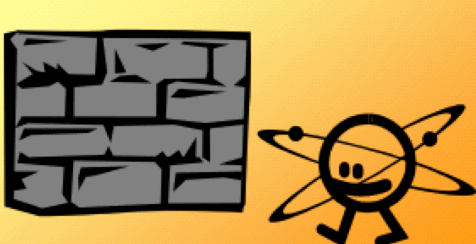
Presentation: Chapter 19 Notes Part 1 of 3 (Reading Guide 1)

Chapter 19 section 1

Chemical Bonds

- **How many different base substances make up all matter around us (Reference page 320)?**
  - 117 (111) elements → "Pure Substances," these elements make up every person, book, tree, nini everywhere

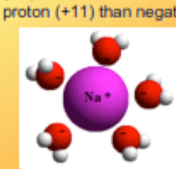
- **When are atoms said to be "unstable"?**
  - Most atoms are unstable unless they are combined with other atoms.



- **When are atoms said to be "stable"?**
  - When atoms of different elements combine together they form compounds (chemical bonds)
  - A chemical bond forms when atoms exchange or share electrons.
  - When the outer most energy level (electron shell/cloud) is full, complete (usually 8 electrons = octet rule)

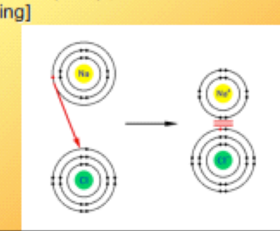
- **What determines if an atom will or will not form a compound?**
  - The electron arrangement/configuration of the outermost energy level → the valence electrons
  - The higher the energy level, the more energy is required in order for an electron to occupy that part of the electron cloud

- **How can an atom achieve stability? Give an example.**
  - It will transfer electrons (gain or lose = ionic bonding) or share electrons (covalent bonding)
  - Sodium (Na) has 1 valence electrons → Na will lose the 1 valence electron to achieve a "stable-Happy" state
  - Sodium (Na) will become a +1 ion → one more positive proton (+11) than negative electron (-10)



- **Explain why there are a few exceptions to the "Octet Rule".**
  - The first energy level only needs two electrons (NOT eight)
  - Smaller elements only need two electrons in their outer energy level/shell → helium, lithium, beryllium

- **Describe Ionic Bonding:**
  - The transfer of electrons, one atom gains electrons and the other atom loses electrons
  - Ionic bonding happens between metals + nonmetals (K-Cl) [metals + metals = metallic bonding]



Section 19.1 – Electrons and the Periodic Table (page 329):

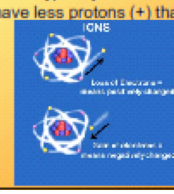
- **What are transition metals & where are they located on the Periodic Table?**
  - Transition metals are the elements in groups/families 3-12
  - These elements have electrons in the 4th & 5th energy levels → bonding is more complex
  - We will work with a few of these elements → however; overall we'll have limited interaction with them

- **Explain why elements tend to form compounds & how is energy involved in the process:**
  - **Chemical bonds are a form of potential energy → Energy is released when atoms form chemical bonds**
  - **It takes energy (absorbed) to separate bonded atoms → like pulling off duct tape from a table → takes energy**
  - **In nature/world atoms are usually chemically bonded to other atoms because chemically bonded atoms have lower energy than free atoms.**
  - **Similar to a ball rolling downhill → natural systems tend to settle in configurations of lowest energy.**

- **What is the "Lewis Dot Structure" (electron-dot diagram)? When is it used? Give 3 examples.**
  - The element symbols are used + the valence electrons (all electrons in inner energy levels = not shone)
  - Also can be used to show the sharing of electrons in covalent bonds (nonmetals + nonmetals)
  - Examples: H Cl C H O H

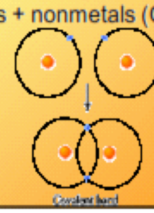
This is "Lewis Dot" and his son

- **Define Ions. Explain how positive + negative ions are formed. Give 2 examples of each:**
  - Ions = Atoms that either gain or lose valence electrons
  - Positive ions = typically metals lose electrons → they then have more protons (+) than electrons (-) → Na, K
  - Negative ions = typically nonmetals gain electrons → they then have less protons (+) than electrons (-), Cl, F



A video clip about Ionic Bonding and Ions

- **What is covalent bonding? When does it occur?**
- - Prefix "Co-" means together → atoms share electrons → each fills its outer energy level
- - Covalent bonding happens between nonmetals + nonmetals (Cl-Cl)



*** Note: in covalent bonding, the positively charged nucleus of each atom simultaneously attracts the negatively charged electrons that are being shared. This attraction between nucleus + shared electrons holds the compound (2 or more atoms) together.**

Another video on Covalent Bonding

- **Describe how Sodium (Na) and Chlorine (Cl) are bonded.**
  - Chlorine (atom) has 7 valence electrons → it needs one electron to become "Stable-Happy" (Octet Rule)
  - Once it gets an electron it becomes = Chloride ion (-1) = F-1
  - Sodium (Na) has 1 valence electron → Na must get rid of the 1 valence electrons to be "Stable-Happy"
  - Once Na loses its valence electron = Sodium ion (+1) = Na+1
  - Opposites attract → the Na+1 + Cl-1 held together by opposite charges → produces a compound = NaCl

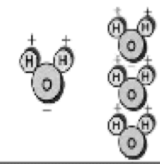
Presentation: Chapter 19 Notes Part 2 of 3 (Reading Guide 2)

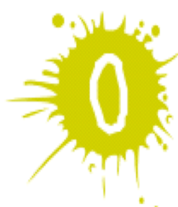
Chapter 19.2

Molecules + Compounds

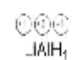
Section 19.2 – Chemical Formulas (page 334):

- **Explain what a chemical formula represents. Give two examples.**
  - The ratio of atoms of one or more elements for a particular molecule or compound
  - Examples: Water will always have 2 hydrogen atoms + 1 oxygen atom (H_20); Carbon dioxide = CO_2





- **All compounds have an electrical charge of zero (neutral). When combining different atoms/elements the net (total) oxidation number must equal zero.**

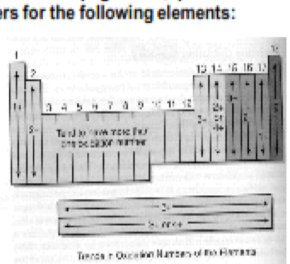


- **What is the oxidation number of an element?**
  - The number of electrons an atom gains, loses, or shares when it forms a chemical bond
  - An atoms combining capacity → the charge of the ion when it's "Happy"

*Use the oxidation numbers of elements to predict how atoms will combine & what the chemical formulas are

- **Using the Periodic Table from page 335 → predict the oxidation numbers for the following elements:**

- Li = [redacted]
- Mg = [redacted]
- C = [redacted]
- O = [redacted]
- K = [redacted]
- F = [redacted]
- Al = [redacted]
- N = [redacted]



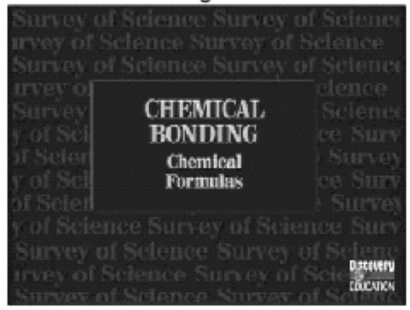
some of the above elements may have more than one oxidation number depending on what it is combining with---the above named oxidation numbers are based just off of where they lie on the Periodic Table

- **List the steps for writing the chemical formulas for a monatomic ion:**
  - 1) Write the symbol for the monatomic ion that has a **positive charge first**
  - 2) Write the symbol for the monatomic ion that has a **negative charge second.**
  - 3) If necessary, add subscripts (small numbers) to the bottom-right of each element symbol.

cation	anion
Ca^{+2}	Cl^{-1}
Ba^{+2}	O^{-2}
K^{+}	S^{-2}
[illegible]$^{+3}$	N^{-1}
Cr^{+3}	O^{-2}

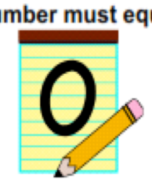
- **Describe the steps that you would use to write the chemical formula for iron (III) and oxygen:**
- 1) Find the oxidation numbers for each element in the compound = Fe+3 + O-2
  - Iron (III) has 3 valence electrons → it needs to lose those 3 electrons → becomes Fe+3
  - Oxygen has 6 valence electrons → it needs to gain 2 electrons → becomes O-2
- 2) Determine the ratios of each element (how many of each) & write the chemical formula:
  - The total number of electrons being given up (lost) must be equal to electrons picked up (gained)
  - Remember the sum of all the oxidation numbers must equal zero
- 3) The chemical formula for compound produced from iron (III) and oxygen = Fe_2O_3 = Iron oxide = Rust

Here's a little video about Oxidation numbers and writing chemical formulas



- **Describe polyatomic ions? Give 3-5 examples:**
  - A group of covalently bonded atoms that act like a single atom when combining with other atoms
  - Usually form ionic bonds
  - Think of them as a group of friends that are so alike that they act like one person
  - This group gets their own name → Examples: sulfate, phosphate, hydroxide

You will NOT have to memorize the polyatomic ions; however, you will need to know how to write them correctly in chemical formulas. Treat polyatomic ions the same as a "regular" atom → when combining atoms/ polyatomic ions the net (total) oxidation number must equal zero.

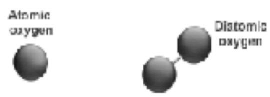


- **Describe the steps that you would use to write the chemical formula for aluminum and sulfate:**
  - 1) Find the oxidation numbers for each element in the compound = Al^{+3} + SO_4^{-2}
    - Aluminum has 3 valence electrons → it needs to lose those 3 electrons → becomes Al^{+3}
    - Sulfate needs to gain 2 electrons → SO_4^{-2}
  - 2) Determine the ratios of each element (how many of each) & write the chemical formula:
    - The total number of electrons being given up (lost) must be equal to electrons picked up (gained)
    - Remember the sum of all the oxidation numbers must equal zero
  - 3) The chemical formula for compound produced from iron (III) and oxygen = $Al_2(SO_4)_3$ = Aluminum sulfate

- **Describe how you name compounds with only monatomic ions. Give at least one example:**
  - 1) Write the symbol (name) for the first element in the compound (has a **positive charge**) - **Magnesium**
  - 2) Write the root name for the second element in the compound (has a **negative charge**) - **Chlorine**
  - 3) For almost all nonmetals you remove the original ending and add "-ide" → **Chloride**
  - 4) The compound's name = magnesium chloride = $MgCl_2$

This truck is spreading Magnesium Chloride on the road for Anti-Icing purposes

- **What are the diatomic molecules and how are they formed? (May not be easily found in the book)**
  - Prefix "Di-" mean two → two atoms are covalently bonded together → share valence electrons
  - The form the "Magic 7" = H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2
  - German Hotel – BrINCl HOF

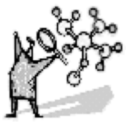


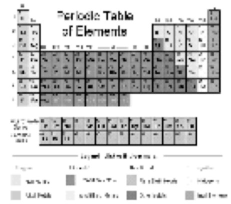
- **Sample Problems –Write the element symbol + oxidation number → then the final chemical formula.**
  - 1) Magnesium + Fluorine
    - Mg^{+2} + Fl^{-1} = MgF_2
  - 2) Magnesium + Oxygen
    - Mg^{+2} + O^{-2} = MgO
  - 3) Potassium + Sulfur
    - K^{+1} + S^{-2} = K_2S

Presentation: Chapter 19 Notes Part 3 of 3 (Reading Guide 3)

Chapter 19
Molecules + Compounds

Part 3 of 3



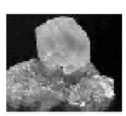


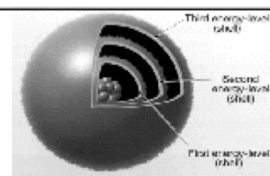
- The periodic law states that the physical and chemical properties of the elements are periodic functions of their atomic numbers. "Periodic" means repeating according to a pattern. You need to remember the patterns/relationships in the periodic table.

- Design of the Periodic Table - In general what function/purpose does the Periodic Table have?
  - Arrange all the elements (111) by their general chemical & physical properties
  - Similar to the Library's Dewey Decimal System → grouped & organized according to patterns/relationships

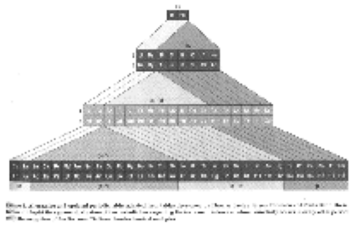
- What do the Columns of the Periodic Table represent? Describe Column 1.(Family Tree)
  - Columns are also referred to as "Families" or Groups → Each is given a general name
  - Elements in a Family/Group have similar (NOT identical) properties – primarily due to valence electrons
  - Column 1: "Alkali Metals" – soft, white, shiny metals, highly reactive (make compounds easily), 1 valence e-

- What do the Rows of the Periodic Table represent? Describe Row 1.
  - Rows are also referred to as "Periods" → What's at the end of a sentence (horizontal) → PERIOD.
  - As you move left to right ACROSS a row/period the properties change → thus periodic trends.
  - Elements in Rows/Periods have very different properties





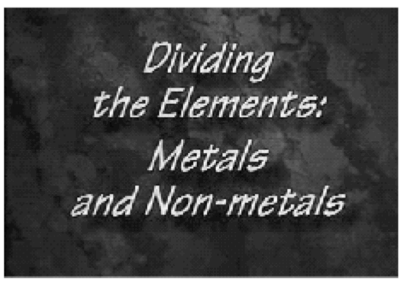
*A couple patterns of the rows on a Periodic Table
- Row number (#) = number of rings/electron shells; valence electrons increase from left → right,
  - Example – Row 1: all have only one ring/electron shell
- Size (atomic radius) decreases from left → right (opposite of what you would expect - reverse thinking)
  - Why?
    - More valence electrons = more attraction to positive protons = pulls tighter together

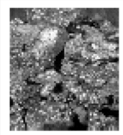


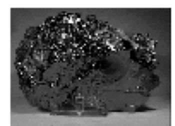
* **Remember: Different textbooks may show you Periodic Tables arranged differently than ours; however, Periodic Tables will still show you the same basic information!**

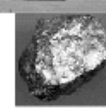
- **How many metals and metal-like elements are there? Where is the division on the Periodic Table?**
  - The metals & nonmetals are separated by a zigzag line running like steps down the right side of the table.
  - 90 elements to the left of this line = metals + metal-like

A quick movie about Metals and Non-Metals



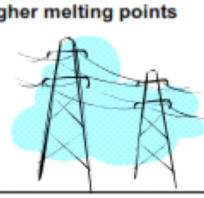






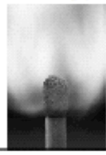
- <u>**Metalloids**</u>:
  - Elements that have properties of both metals & nonmetals, touching the zigzag line
    - Examples: Boron (B), Silicon (Si), Arsenic (As), Antimony (Sb)

- **Describe the physical properties of metals.**
  - **Luster (shininess), hardness, highly ductile (wire), highly malleable (bendable/flexible), low brittleness (not very brittle)**
  - **Good conductors of heat + electricity, higher densities, higher melting points (almost all solids)**



- **Describe the chemical properties of metals.**
  - Depends on the number of valence electrons → 1 valence e- = highly reactive = wants 8 e-
  - Metals tend to lose (**NOT SHARE**) their valence electrons → forming compounds with nonmetal elements
  - Rustability (corrosion/oxidation/tarnish) = wearing away of the original metal after forming compound
  - Usually forms compounds with oxygen → iron oxide = rust

- **Describe the physical properties of nonmetals.**
  - The nonmetals are on the right side of the zigzag line (right side of the periodic table) = ~ 21 elements
  - Low luster (shininess), low ductility, low malleability, high brittleness (brittle)
  - Poor conductors of heat + electricity, lower densities, lower melting points (solids, liquids, gases)



Match tips are made of Phosphorus

Is that a gigantic electron that they are sharing or what??? These kids must be nonmetals!

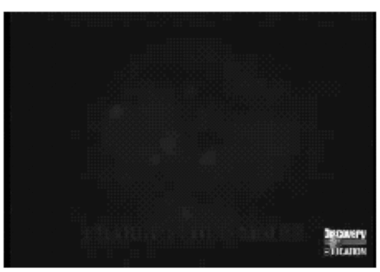
- **Describe the chemical properties of nonmetals.**
  - Depends on the number of electrons in the outermost energy level → most have 5, 6, 7, 8 valence e-
  - Nonmetals tend to gain or share other elements' valence electrons
  - Nonmetals form compounds with metals + nonmetal elements → they gain/share 3, 2, 1 valence e-

- **Describe the reactivity of nonmetals in Column 18.**
  - Mr. Heflin calls this group the "Happy, Lazy, Loners" = Noble Gases or Inert Gases
  - "Happy" = Have a complete outer energy level = typically 8 valence electrons (He = 2)
  - "Lazy" = They are inert – not reactive
  - "Loners" = They do NOT react (form compounds) with other elements

- **Quick Overview – Recap:**
  - Group I + II (metals) lose electrons to become stable (octet rule) → these metals don't share (covalently)
  - Group V + VI + VII gain electrons (gain = ionic bond or share = covalent bond)

Metals love to have 8 electrons in their outer shell---the "Octet Rule" (think about an octopus having 8 tentacles)

A very short video on the Octet Rule



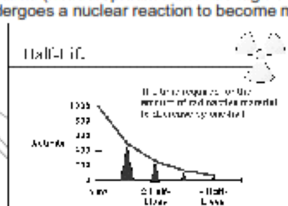
Presentation: Chapter 19 Addendum Notes - Half-Life and Radioactive Decay

Half-Life & Radioactive Decay

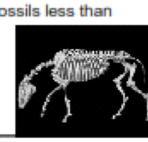
Chapter 19
Addendum Notes

- **What is an isotope? Give an example.**
  - An atom that has the same number of protons, but a different number of neutrons
  - Example: "normal" carbon has an atomic number of 6 (protons = 6), but an atomic mass of 12 [C-12]
  - An isotope of carbon still has an atomic number of 6, but a change in atomic mass (protons + neutrons = 14) due to 2 added neutrons [C-14]

- What **is the "half-life" of an element? How does it relate to radioactive decay? Give at least one example.**
  - A fixed rate of decay; the amount of time it takes for half of the atoms in a given sample to decay
  - Radioactive decay happens when a nucleus is unstable (neutron/proton ration too high or too low), it undergoes a nuclear reaction to become more stable.



- **How is carbon-14 used to date fossils? "Carbon Dating"**
  - Carbon-14 is a radioactive isotope of carbon, produced in the upper atmosphere by cosmic radiation. A small amount of the carbon dioxide in the air is C-14. Plants absorb the C-14 during photosynthesis, and it stays within the plants cells. Animals eat the plants and then have C-14 in their cells.
  - Once a plant/animal dies it, the amount of C-14 decreases (begins to break down)
  - Half life of carbon-14 is 5730 years
    - Can approximate the age of fossils less than 50,000 years old



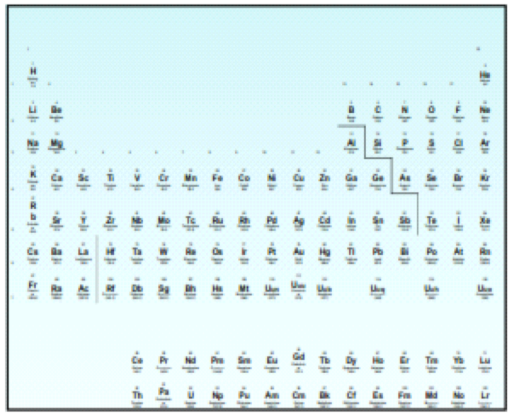
What is Uranium-238 used to date?

- Uranium-238's decay product uranium 238 has a half-life of 246,000 years and so is useful for determining the age of rocks and sediments that are between 100,000 years and 1,200,000 years in age.

Presentation: Chapter 19 Review

Physical Science

CH 19 Review



1. What do the Columns of the Periodic Table represent?

- Columns are also referred to as "Families" or Groups → Each is given a general name
- Elements in a Family/Group have similar (NOT identical) properties – primarily due to valence electrons

2. What is the common name for the Group 1 elements?

- Alkali Metals
  - H
  - Li
  - Na
  - K
  - Rb
  - Cs
  - Fr
- All have only 1 valence electron

Back to Periodic Table

3. What is the common name for Group 17 elements?

- The Halogens
  - F
  - Cl
  - Br
  - I
  - At
- VERY REACTIVE
  - Only need 1 electron to obtain an octet

Back to Periodic Table

4. What is another name for the rows of a periodic table?

- Rows are also referred to as "Periods"
- As you more left to right ACROSS a row/period the properties change → thus periodic trends
  - Number of valence electrons increases as you read across the periods (left to right)

Back to Periodic Table

5. What are 2 patterns that exist within the periods?

- Row number = number of rings/electron shells
  - Ex. Period 1 elements (H, He) have only 1 energy level (electron shell or electron rings)
  - Period 2 elements (Li, Be, B, C,N…) arrange their electrons into 2 energy levels
- valence electrons increase from left → right
  - Ex. Period 2
    - Li has 1 valence electron
    - Be has 2 valence electrons…C has 4 valence electrons…and Ne has 8 valence electrons

◀ Return to Periodic Table

6. How many metals and metal-like elements are there? Where is the division on the Periodic Table?

- The metals & nonmetals are separated by a zigzag line running like steps down the right side of the table.
  - ~ 90 elements to the left of this line = metals + metal-like
  - The nonmetals are on the right side of the zigzag line
    - ~ 21 elements
- Elements that touch this division line are metalloids (exception is Al)
  - The Metalloids are:
  - B, Si, Ge, As, Sb, Te, Po

◀ BACK TO PERIODIC TABLE

7. Describe the **physical** properties of metals.

- - Luster (shininess), hardness, highly ductile, highly malleable, low brittleness
- - Good conductors of heat + electricity, higher densities, higher melting points (almost all solids)

8.Describe the **chemical** properties of metals

- - Depends on the number of valence electrons
  - Ex. 1 valence e- = highly reactive (wants 8 e-)
    (Alkali metals all have 1 valence e-)
- - Metals tend to lose (**NOT SHARE**) their valence electrons → forming compounds with nonmetal elements

9. Describe the **physical** properties of **nonmetals**.

- - Low luster (shininess), low ductility, low malleability, high brittleness (brittle)
- - Poor conductors of heat + electricity, lower densities, lower melting points (solids, liquids, gases)

10. Describe the **chemical** properties of **nonmetals.**

- Depends on the number of electrons in the outermost energy level
  - most have 5, 6, 7, 8 valence e-'s
- Nonmetals tend to gain or share other elements' valence electrons
  - they gain/share 3, 2, 1 valence e-
- Nonmetals form compounds with metal and nonmetal elements

11. Describe the reactivity of nonmetals in Group 18.

- Group 18 is known as the **Noble Gases**
- **Their oxidation number of 0 prevents the noble gases from forming compounds readily**
  - All noble gases have the maximum number of electrons possible in their outer shell (2 for Helium, 8 for all others), making them stable.

BACK TO PERIODIC TABLE

12. When are atoms said to be "unstable"?

- Most atoms are unstable unless they are combined with other atoms.
  - Major Exception :Noble Gases

13. When are atoms said to be "stable"?

- When atoms of different elements combine together they form compounds (chemical bonds)
  - A chemical bond forms when atoms exchange or share electrons.
    - **When the outer most energy level (electron shell/cloud) is full, complete (usually 8 electrons = octet rule)**

14. Explain why there are a few exceptions to the "Octet Rule".

- The first energy level only needs two electrons (NOT eight)

Atom	Symbol	Outer Shell
Helium	He	Full
Lithium	Li	1
Beryllium	Be	2
Boron	B	3
Carbon	C	4
Nitrogen	N	5
Oxygen	O	6
Fluorine	F	7
Neon	Ne	Full

15. What are transition metals & where are they located on the Periodic Table?

- Transition metals are the elements in groups/families 3-12
- These elements have electrons in the 4th & 5th energy levels → bonding is more complex
  - We will work with a few of these elements however; overall we'll have limited interaction with them

16.Give the Lewis dot diagram for the following elements:

C ; H ; O ; Mg

(On Board)

17.Do metals tend to form positive ions or negative ions? Give 2 examples.

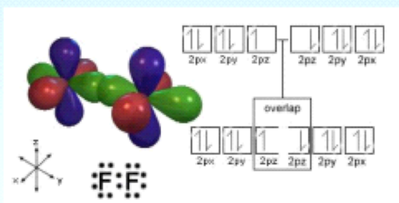
- Positive ions = typically metals lose electrons → they then have more protons (+) than electrons (-) → Na, K, Li, Mg,

18. Describe Ionic Bonding.

- The transfer of electrons, one atom gains electrons and the other atom loses electrons
- Ionic bonding happens between metals and nonmetals
  - Ex. KCl NaCl KBr

19. What is covalent bonding?

- **atoms share electrons each fills its outer energy level**
- **- Covalent bonding happens between nonmetals + nonmetals**
  - **Ex. F-F,**



20. Using the Periodic Table from page 335,predict the oxidation numbers for the following elements:

- Ca2+
- As 3-
- Si 4+
- Br 1-
- P 3-
- S 2-

Periodic table

21. Write the chemical formula for the compound formed when Ca combines with I

- Write the elements as ions using the most common ionization state from your periodic table. Write the **positive charged ion first**, followed by the negatively charged ion.
- Ca2 + I 1-
- Looking just at the number in the charge, ignore the sign for now, swap the numbers
- and write them as subscripts.
- **Ca_1 I_2, you don't have to write the one for calcium, when the subscript is not listed, it is implied to be 1.**
- CaI_2 **Yes it is that easy!**

22. Explain how to write out the name for the compound formed by K and Br

- 1. Write the name of the **metal first** without changing it's ending at all.
  - Potassium
- 2.Write the name of the nonmetal next, change its ending to –ide.
  - Potassium bromide

Atomic Model Project

Adopt An Element

Grade Sheet

Names:______________________________
(Everyone's name in group)

Advertisement = [Poster]

- **Provided basic information ....** =_________
  - Atomic #
  - Name
  - Cost
  - Atomic mass
  - Symbol
  - Student's name
- **Slogan and pictures relevant ....** =_________
- **Followed directions ....** =_________
  Neat, correct spelling/format, original

____
10

Information sheet = [Paper: 1 page]
(Times New Roman, 12 pt. font, 1" boarder, Double Space)

- **Provided basic information ....** =_________
  - Name
  - Neutrons
  - Atomic mass
  - Protons
  - Normal phase
  - Melting point
  - Boiling point
  - Atomic #
  - Symbol
  - Electrons
- **Other information ....** =_________
  - Cost
  - Nonmetal/Metal/Metalloid
  - Family
  - Origin of name
  - Discover date
  - Interesting information/uses (*Paragraph format, Descriptions)*
- **References**
  - Minimum of 3: provided required information, Correct MLA format
    .... =_________
- **Miscellaneous**
  - Black ink, complete sentences, correct spelling and grammar, neat
    .... =_________

____
10

____
20

Atomic Model = 20 points .... =_______

Total Points = ___________ out of <u>50</u> = ___________%

A B C D E

Presentation: Summary of the information

- Well prepared & organized
- Good eye contact, expressive, no gum, etc…
- Appropriate length **<u>3 Minutes</u>**

____
10

Adopt-An-Element

Requirements:

1) Complete an Adopt-An-Element information sheet.
You may use a variety of references sources. Possible ideas are encyclopedias (book, or online), science encyclopedias, science catalogs, magazines, and/or Internet sites. Information sheets must be neat, written in black in, and contain all the information requested. You also need to provide a list of your sources on the back of your information sheet. A minimum of **three sources** is required.
(at least 1 must be a print source. i.e. book)

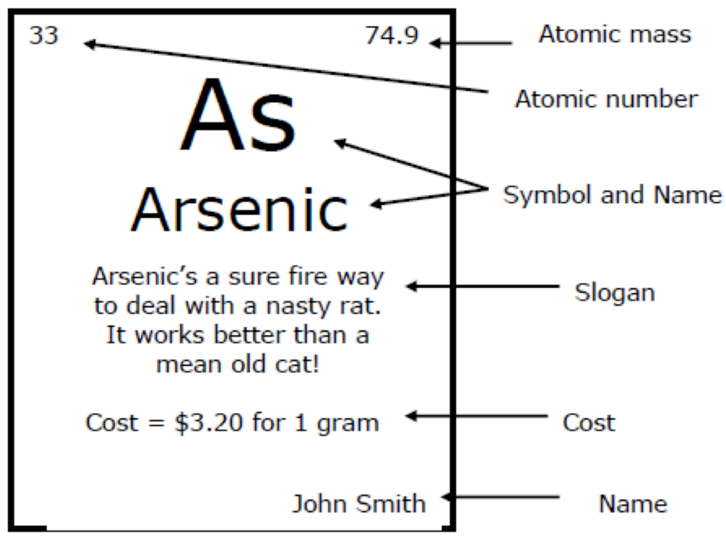
2) Create and advertisement for your element.
The advertisement must include the element's name, symbol, atomic number, atomic mass, cost, and an advertising slogan that describes one or more of its important uses. Advertisements must be neat, colorful, and contain all the information listed above. You may add pictures that relate to your advertisement theme.

Example:
Be sure to include:

- ✓ Elements symbol
- ✓ Element's name
- ✓ Atomic number
- ✓ Atomic mass
- ✓ Ad slogan
- ✓ Cost
- ✓ Your name

Your may add pictures or drawings that illustrate the various uses for your element.

Your ad must follow the same format as this example!

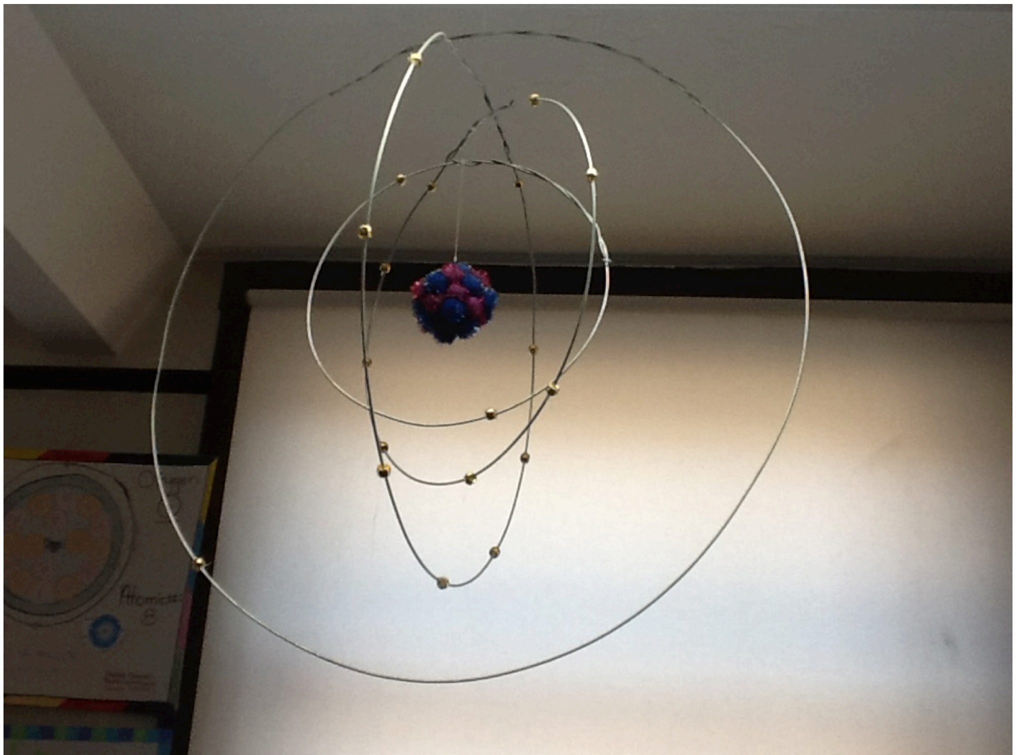


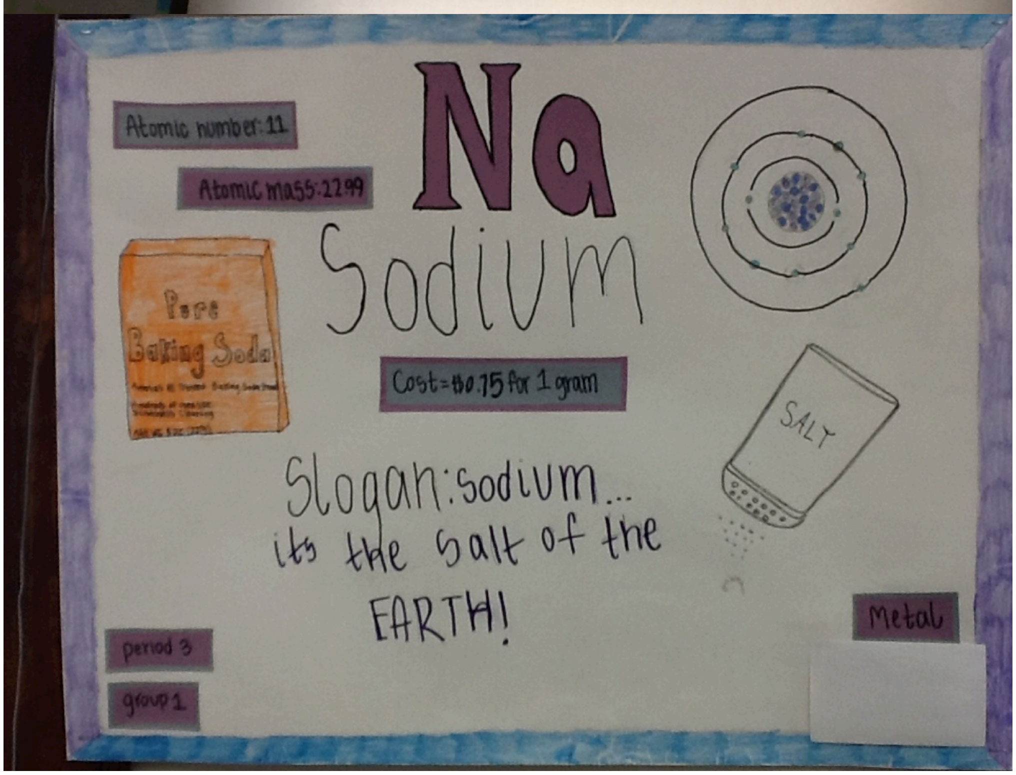
3) Atomic Model (20 points) -> See backside for specific instructions & requirements

To research your elements, use the Calumet Public Library's search engines

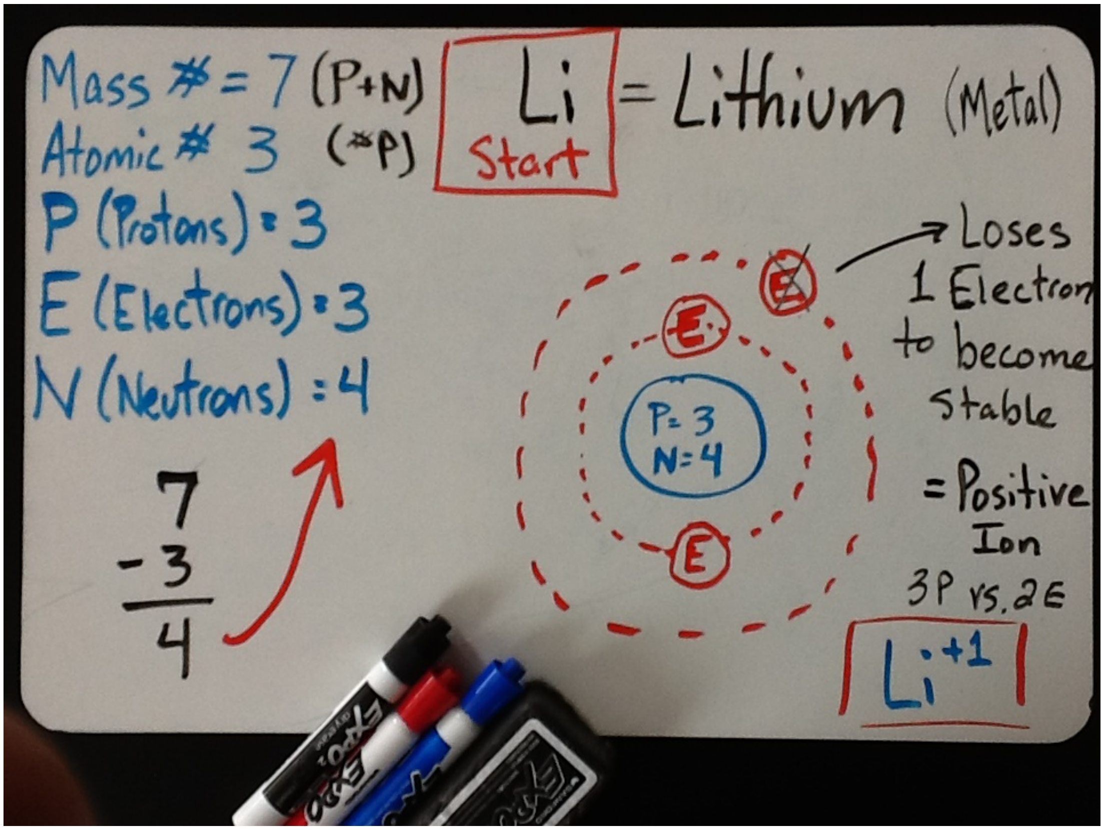
- http://www.clkschools.org/library/index.htm -> **Groliers Encyclopedia**
- http://education.jlab.org/itselemental/

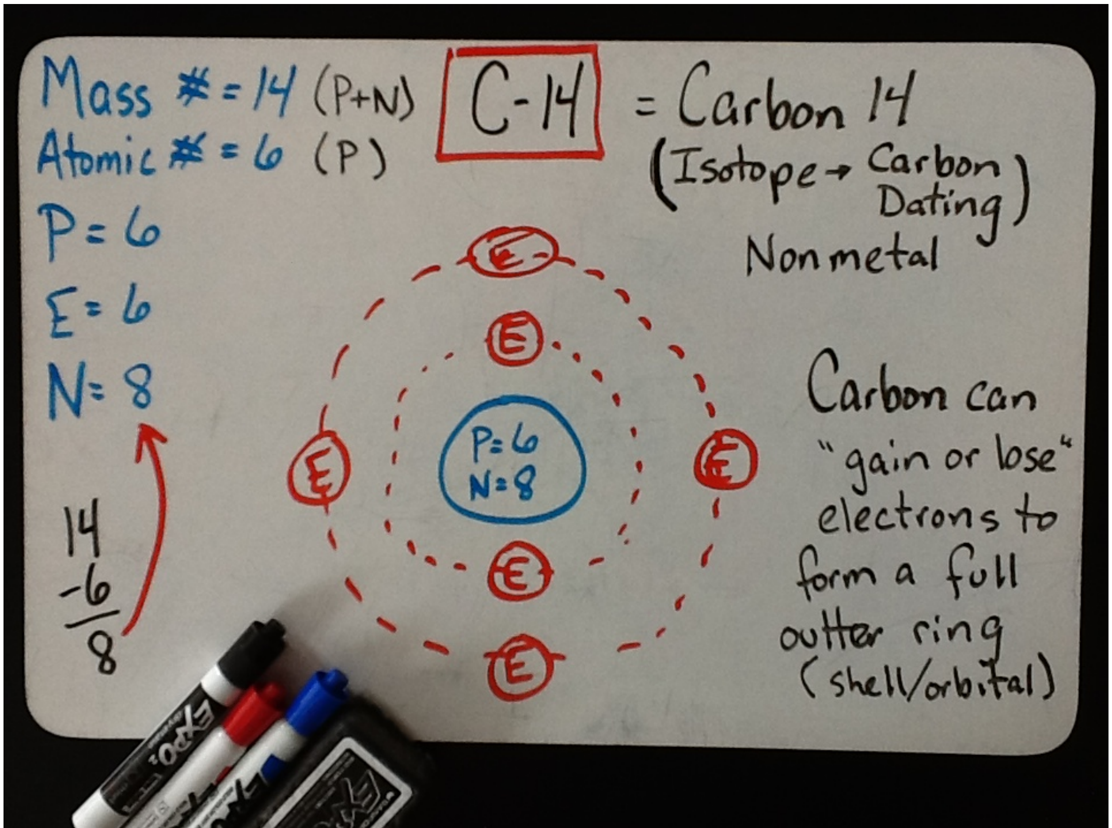
Atomic Model Project Examples – Model and Poster
Note: not the same element

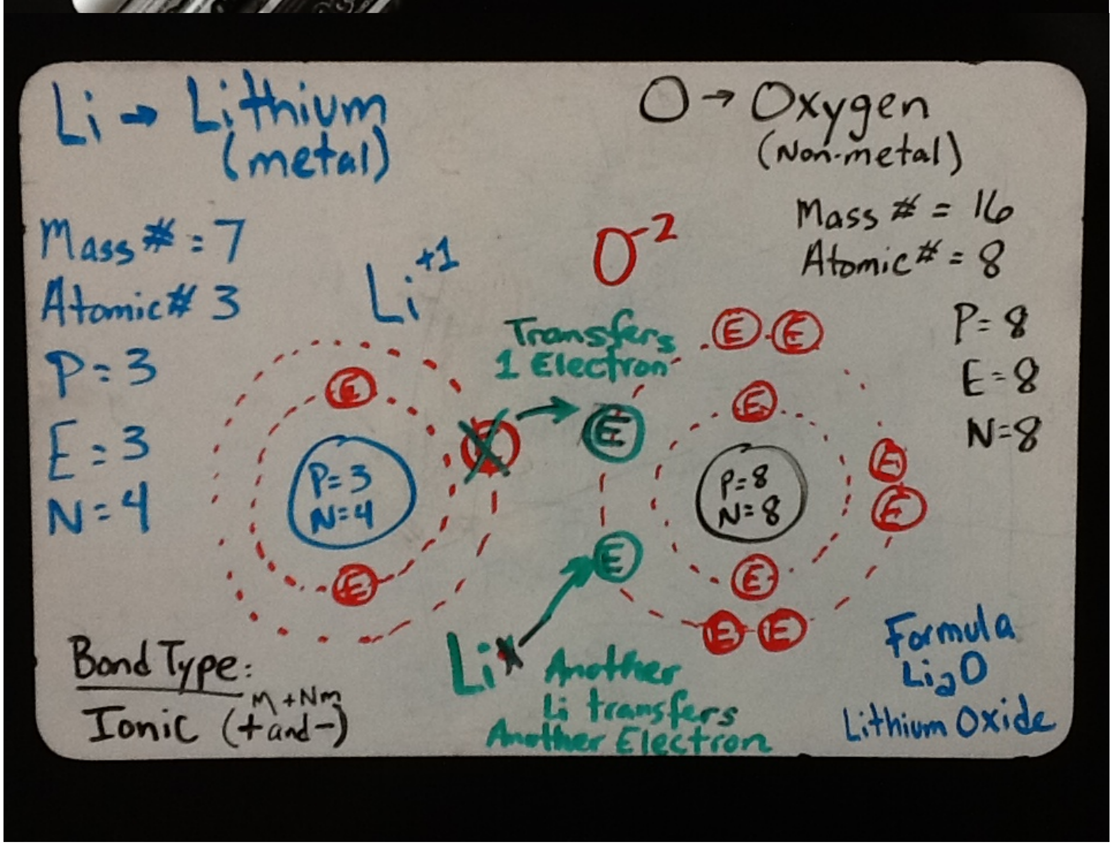




Interactive, Visual Dry Erase Board Activity




Mass # = 14 (P+N)
Atomic # = 6 (P)
C-14
= Carbon 14
(Isotope → Carbon Dating)
Nonmetal
P = 6
E = 6
N = 8
14
-6
8
P=6
N=8
E
Carbon can "gain or lose" electrons to form a full outter ring (shell/orbital)


Li → Lithium (metal)
O → Oxygen (Non-metal)
Mass # = 7
Atomic # 3
P = 3
E = 3
N = 4
Li+1
O-2
Mass # = 16
Atomic # = 8
P = 8
E = 8
N = 8
Transfers 1 Electron
P=3
N=4
P=8
N=8
E
Li
Another Li transfers Another Electron
Bond Type:
Ionic (+ and -)
M + Nm
Formula Li2O
Lithium Oxide

Chemistry Mini-Quiz

Chapter 19 MiniQuiz A	Answers
1. How many atoms are in K_3PO_4	eight
2. The nucleus of an atom contain approximately _____% of the atom's total volume.	< 1%
3. If a "normal" Carbon atom has 6 protons, 6 electrons, and 6 neutrons, what is its overall electrical charge?	neutral
4. The book defines _____ as substances that are made of ≥2 atoms chemically bonded together. Hint: it can be the same element. Examples: H_2, O_2, H_20, CO_2 (Quarks, Metalloids, Molecules, Solutions, Mixtures)	Molecules
5. When viewing the Periodic Table, you would look for an element's ____ to find out the number of valence electrons that its atoms would have. (atomic number, atomic mass, family, row, period,)	Family (group) (column)
1. Sodium is a Group I metal. Will Na gain, lose or share a valence electron to become stable?	lose
2. The type of chemical bond that occurs when electrons are shared. Usually occurs between ≥ 2 nonmetal atoms. Example: CO_2	covalent
3. Which of the following molecules is not a naturally occurring diatomic atom (Di = two)? (Br_2, I_2, N_2, Cl_2, K_2, H_2, O_2, F_2)	Potassium K_2
4. If an atom has 6 protons, 7 electrons, and 8 neutrons, what is its atomic mass?	14 (amu)
5. When viewing the Periodic Table, you would look for an element's ____ to find out the number of electron rings (orbital) that its atoms would have. (family, column, period, atomic number, atomic mass)	period (row)

Elements Quiz

Elements Quiz

Name:

Hour:

Write the name of the element (when given the symbol) or the symbol (when given the name) + if the element is a metal (M), nonmetal (Nm), or metalloid.

1) Zinc = ________________

2) Silicon = ________________

3) Ar = ________________

4) Magnesium = ________________

5) K = ________________

6) Hg = ________________

7) Silver = ________________

8) Be = ________________

9) Iron = ________________

10) Phosphorous = ________________

11) Nickel = ________________

12) Copper = ________________

Appendix C - Intervention Materials

This appendix contains the main topics, objectives, and technological interventions displayed on the teacher's webpage. A list of all the documents that could be accessed and downloaded from bottom of the webpage is included. The communication log between teacher and student can be found at the end of the appendix.

Teacher's Physical Science Webpage – Objectives and Resources

Chapter 19: Molecules & Compounds Webpage

The main topics for this chapter 19:
1. Chemical Bonds
2. Chemical Formulas
3. Comparing Molecules

Objectives for chapter 19:
1. Relate the chemical behavior of an element, including bonding, to its placement on the periodic table.
2. Explain how elements form chemical bonds and the identify the role of elements in bonding.
3. Predict the chemical formulas of compounds made up of two different elements.
4. Write chemical formulas for compounds made up of many different types of elements.
5. Calculate the formula mass of a compound and compare different compounds based on their formula mass.
6. Given a chemical formulas, identify the number of elements, atoms, molecules, and compounds.

Dynamic Periodic Table: Interactive webpage that will help you identify characteristics, patterns, and trends on the Periodic Table - families, metalloids, etc. You can also adjust the temperature scale and see the state/phase of matter change. http://www.ptable.com/

VIDEOS: The following are a few videos that help to explain chemistry. These would be very valuable to review for comprehension, correcting misconceptions, and ultimately your success in science and in life. I have arranged the videos the order that they should be viewed - starting from the more general information to the more complex (chemical bonding).

Basics of Chemistry (6 minutes) - A nice overview of chemistry, including atoms, periodic table, atomic mass, and atomic number.
http://www.youtube.com/watch?v=d8VWbv4I_js&feature=related

Properties of Matter: A great review of different types of matter, substances vs. mixtures. (5 minutes - Educator.com Video)
http://www.youtube.com/user/EducatorVids2#p/c/D2A6ED2C3065815F/0/SyGuPWVYla8

Properties of Matter - Song: A catchy song to help you remember the differences between physical and chemical properties of matter (3 minutes)
http://www.youtube.com/watch?v=uJOGy0dgmUU

Atoms and Elements: A great overview of atoms, atom structure, subatomic particles (P,E,N), electron configuration (electron arrangement: different names include - electron cloud, energy level, electron ring, electron shell, electron orbits) (12 minutes - Educator.com Video)
http://www.youtube.com/user/EducatorVids2#p/c/D2A6ED2C3065815F/3/1lqe61hWM6Y

Periodic Table (4 minutes - Educator.com Video) [Many videos on Physical Science Information]
http://www.youtube.com/user/EducatorVids2#p/c/D2A6ED2C3065815F/4/g_JbQJSSyvw

Chemical Reactions: A nice overview (5 minutes - Educator.com Video)http://www.youtube.com/user/EducatorVids2#p/c/D2A6ED2C3065815F/7/mGx40ppE134

Chemical Bonding: This video walks you through how atoms create bonds and from compounds (10 minutes - Educator.com Video)
http://www.youtube.com/watch?v=LDmM0soNXac

Chemical Bonding II: A nice overview (10 minutes - Educator.com Video)
http://www.youtube.com/user/EducatorVids2#p/c/6/cbCcy4renOw

Half Life of Radioactive atoms (elements) - Good resources to explain you visualize this challenging concept:

Virtual demonstration of Half Life atoms - it reviews a parallel [alien] example to help explain the half-life of a radioactive atom.
http://www.colorado.edu/physics/2000/isotopes/radioactive_decay3.html

A graphical demonstration of the Half Life of atoms
http://www.colorado.edu/physics/2000/isotopes/radioactive_decay3.html

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Podcasts (audio only) of Chemistry Topics:

Subatomic Particles and Nuclear Structure (5 minutes)
http://hatakappodcast.blogspot.com/search/label/Atomic%20Structure

Ionic Compounds (4 minutes)
http://podcast.iu.edu/Portal/PodcastPage.aspx?podid=eeee7c2a-9357-41bc-bb93-9e37e51a86a3

Physical Science Documents Displayed on Teacher's Webpage

Documents can be down-loaded to student iPad tablets or desktop computer

- C19 Test Review_16-17-18-19_3-19-2012.doc (33k)
- Chapter 19 Addendum Notes - Half-Life - Radioactive Decay.ppt (280k)
- Chapter 19 Practice Quiz 2_Page 1.jpg (108k)
- Chapter 19 Practice Quiz 2_Page 2.jpg (99k)
- Chapter 19 Practice Quiz_Page 1.jpg (102k)
- Chapter 19 Practice Quiz_Page 2.jpg (112k)
- Chapter 19 Practice Quiz_Page 3.jpg (89k)
- Chapter 19 Review_ANSWERS_2011-2012.ppt (382k)
- Chapter 19 Section 1 of 3.ppt (478k)
- Chapter 19 Section 2 of 3.ppt (408k)
- Chapter 19 Section 3 of 3.ppt (1446k)
- Chapter19Vocabulary.jpg (59k)
- Lab Equipment Review_WEB_2011-2012.pdf (264k)
- Outline_C19_1_of_3_Molecules-Compounds_Pics.doc (280k)
- Outline_C19_2_of_3_Molecules-Compounds_Pic.doc (66k)
- Outline_C19_3_of_3_Bonus-Molecules-Compounds_Pic.doc (38k)

Written Communication Log

Email – Friday 3-2-12 – All students (Periods 2, 3, 4, 5)

As a friendly reminder, we should have around 15 minutes in class to finish the lab on Monday. The labs will be due at the end of the day, so you could finish during King Time. Based on my observations, there might be 2 groups who will NOT need to come to King Time today or Monday to work on the Lab.

Also, the Chapter 19 Reading Guide 1 (green) is due Monday.

We will finish the Chapter 19 Reading Guide 3 (white) Addendum Notes in class on Tuesday. Again, you can review this power point on my Webpage – Chapter 19.

Have a great weekend,
Mr. Heflin

Email – Sunday 3-11-12 – All students (Periods 2, 3, 4, 5)

Good morning.

You can now submit your Atomic Model Paper to Turn-it-in.com starting today.

Remember, the paper should be standard MLA format (per your English Teacher) – 12 font, Times New Roman, 1 inch margins (top, bottom, & sides). Given all the information you need to include, your paper should be two-four pages, plus a reference page.

Please respectfully let me know if you have any questions or concerns.

Regards,
Mr. Heflin

Email – Monday 3-12-12 – All students (Periods 2, 3, 4, 5)

Greetings everyone,

I have placed short Chemistry Videos on My Big Campus. These videos are also listed on my CLK webpage along with other resources (i.e. Interactive Periodic Table).

You should watch the first three videos by Friday (3-16-2011).

Again, Chapter 19 is very challenging. You will need to review the information often. Some of this material can be confusing, but you have to work hard and figure it out.

In class, please let me know if you have any questions and I can review specific items you find confusing.

Thanks,
Mr. Heflin

Monday 3-12-12 – Periods 4, 5: (Aggressive Treatment Group Only)

Students in these periods, were instructed to connect to the teacher's CLK webpage via their iPad tablets and look at the Chapter 19 resources. The instructor showed the students the Interactive Periodic Table and pointed out the three videos they should watch by Friday(3-16-2011).

Tuesday 3-13-2012; Wednesday 3-14-2012; Thursday 3-15-2012 – All students (Periods 2-5)
The following note was projected onto the front board:

The Chemistry Videos are now on My Big Campus and my CLK webpage along with other resources (i.e. Interactive Periodic Table). You should watch the first three videos by Friday(3-16-2011).

Week 4 written communication:

Email – Sunday 3-18-12 – All students (Periods 2, 3, 4, 5)

Greetings all,

I stayed up until 10 pm on Friday grading the Atomic Model Projects. All the projects and assignments from last week are in Skyward and the grades are updated.

Remember we have a MiniQuiz Tuesday and Thursday, plus the last Elements Quiz Wednesday.

Remember the mnemonic (memorizing tool) for Diatomic Atoms = BrINCl HOF – a "German Hotel". These are the atoms that are always found as pairs in nature. It's like the buddy system. Example - Oxygen is always O_2.

Have a great Sunday and enjoy the sunshine.
Mr. Heflin

Email – Monday 3-19-12 – All students (Periods 2, 3, 4, 5)

Hello there,
A friendly reminder, the Chemistry Videos are on My Big Campus. These videos are also listed on my CLK webpage along with other resources (i.e. Half-Life and Radioactive interactive webpages).

By the end of the week you should have watched all of the videos (1-8).

Again, Chapter 19 is very challenging. You will need to review the information often. Some of this material can be confusing, but you have to work hard and figure it out.

In class, please let me know if you have any questions and I can review specific items you find confusing.

Thanks,
Mr. Heflin

Monday 3-19-2012; Tuesday 3-20-2012; Wednesday 3-15-2012 – All students (Periods 2-5)
The following note was projected onto the front board:

The Chemistry Videos are on My Big Campus and my CLK webpage along with other resources (i.e. Half-Life and Radioactive interactive webpages). You should watch the videos 4-8 by Friday. The 4th video is a "Goofy teacher" comparing physical vs. chemical properties to a modern song. Videos 5-8 involve chemical reactions and chemical bonding which are very challenging concept. You will need to review this information.

Monday 3-19-12 – Periods 4, 5: (Aggressive Treatment Group Only)

Students in these periods, were instructed to connect to the teacher's CLK webpage via their iPad tablets and look at the Chapter 19 resources. The instructor showed the students the Half-Life and Radioactive interactive webpages and pointed out the videos they should watch by Friday (3-23-2011).

Email: Tuesday 3-20-2012 – All students (Periods 2-5)
Under the Chapter 19 folder on my webpage, I have added an addendum presentation covering Half-life and radioactive decay. You should review this information when trying to answer questions 4 & 5 on the Test Review (Due Friday 3/23).

Also under the Chapter 19 folder on my webpage, There are also 3 other chemistry power point presentations that you should review for the test next Tuesday 3/27.

The Chemistry Videos are now on My Big Campus and my CLK webpage along with other resources (i.e. Interactive Periodic Table). You should watch the videos 4-8 by Friday. The 4th video is a "Goofy teacher" comparing physical vs. chemical properties to a modern song. Videos 5-8 involve chemical reactions and chemical bonding which are very challenging concept. You will need to review this information.

Periodic Table (4 minutes)

Chemical Reactions: A nice overview (5 minutes)

Chemical Bonding: This video walks you through how atoms create bonds and from compounds (10 minutes)

Chemical Bonding II: (10 minutes)

Email: Sunday 3-25-2012 – All students (Periods 2-5)

Just wanted to give you a friendly reminder that the Chapter 19 Practice Quizzes are on Mr. Heflin's Webpage (under Chapter 19).

Again, these are not going to be on Tuesday's TEST, but do cover the same basic chemistry material.

Hope you have a great weekend and are getting in some good study time.

Mr. Heflin

Email: Monday 3-26-2012 – All students (Periods 2-5)

Just a friendly reminder that Mr. Heflin's Webpage has been updated. The Chapter 19 Review (Power Point) and two different Practice Quizzes have been uploaded (see the bottom of the Chapter 19 webpage under attachments).

Remember to study in the same environment that you will take the TEST – quiet and no distractions.

Good studying,
Mr. Heflin

Email: Tuesday 3-27-2012 – Only to 5 students who missed the Summative Test

You are missing the Chemistry Test and will have to make up the test tomorrow - Wednesday 3/28.

Immediately after scheduling your classes for next year, you need to come to my room and take your Chemistry Test.

Mr. Heflin

APPENDIX D - Raw Data

This appendix contains the current year class pretest and posttest scores for each individual student on each assessment item for periods 2, 3, 4, and 5. The demographics for the current year class and two prior year classes (2010-2011 and 2009-2010) are displayed.

Class Pretest and Posttest Scores and Standard Deviations

Physical Science Class - 2nd Hour - Pre-Test Assessment
Students 201 - 220

A*	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	C**	SD
1	1	0	0	1	1	1	1	0	1	1	1	0	0	1	0	1	0	1	1	0	12	0.50
2	0	0	0	0	1	0	1	1	0	1	0	0	0	1	0	1	1	1	1	0	9	0.51
3	0	0	0	1	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	0	5	0.44
4	1	0	1	1	0	1	0	1	0	1	1	1	0	1	1	1	1	1	0	1	14	0.47
5	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0.37
6	0	0	1	0	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	5	0.44
7	1	1	1	1	0	0	0	1	0	1	1	1	0	1	1	1	1	0	1	0	13	0.49
8	1	0	1	1	1	1	1	0	1	1	1	1	0	0	1	1	0	0	1	0	13	0.49
9	1	1	0	1	0	1	1	0	0	0	0	0	0	1	0	1	1	0	0	1	9	0.51
10	1	1	0	0	0	1	1	1	1	0	0	0	1	0	0	1	0	0	1	0	9	0.51
11	1	1	1	1	0	1	1	0	0	0	0	0	0	1	0	1	1	1	0	1	11	0.51
12	0	1	1	0	0	1	1	0	0	0	0	1	0	0	0	1	0	0	0	0	6	0.47
13	0	1	1	0	1	0	1	0	0	1	1	1	0	1	0	1	0	1	0	1	11	0.51
14	1	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	4	0.41
15	1	0	0	0	0	0	1	0	0	1	0	1	0	0	0	1	1	1	0	0	7	0.49
16	1	1	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	5	0.44
17	0	0	1	0	1	0	0	0	1	0	1	0	0	0	1	1	0	1	0	0	7	0.49
18	1	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	1	0	0	6	0.47
19	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0.31
20	1	1	0	1	1	0	1	0	1	1	1	1	1	1	1	1	1	0	1	0	15	0.44
21	0	1	0	0	0	0	0	1	1	1	0	0	0	0	1	1	0	0	1	0	7	0.49
22	0		0	1	0	1	0	1	1	1	1	1	1	0	1	1	1	0	0	1	12	0.50
23	0	1	0	1	0	1	1	1	0	0	0	0	0	0	1	0	0	0	1	1	8	0.50
24	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	4	0.41
25	0	0	1	0	1	0	1	1	1	1	1	1	0	0	1	1	0	1	1	1	13	0.49
26	1	1	1	1	1	1	1	1	0	1	0	1	1	1	0	1	0	1	1	0	15	0.44
27	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	2	0.31
28	1	0	1	0	1	0	1	0	1	1	0	0	0	0	0	1	1	0	0	0	8	0.50
29	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	5	0.44
30	1	0	1	0	1	0	1	0	1	0	0	0	0	0	0	1	1	0	1	0	8	0.50
31	0	0	1	0	1	0	1	0	1	0	1	0	0	1	0	1	0	0	0	0	7	0.49
32	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	1	0	0	1	1	15	0.44
33	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	0	1	1	7	0.49
34	0	1	1	1	1	0	1	1	0	1	1	0	0	0	1	0	0	1	0	1	11	0.51
35	0	1	1	1	1	0	1	0	1	1	0	1	0	0	1	1	1	1	0	1	13	0.49
36	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	0	1	0	1	15	0.44
37	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	1	0	0	5	0.44
38	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	5	0.44
39	0	0	1	0	0	1	1	1	1	0	0	0	0	1	0	1	0	0	0	1	8	0.50
40	0	1	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	4	0.41
41	0	0	0	1	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1	1	7	0.49
42	1	1	0	1	0	0	0	1	0	1	0	0	1	1	1	1	0	1	0	0	10	0.51
43	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	18	0.31
Total	21	21	20	21	18	20	25	17	20	21	17	14	9	19	18	32	13	17	15	15		

*Assessment Item

** Correct Score per Assessment Item

Physical Science Class - 2nd Hour - Posttest Assessment
Students 201 - 220

A*	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	C**	SD
1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	18	0.31
2	1	0	0	0	0	1	1	1	1	0	1	0	1	0	1	1	1	1	0	0	11	0.51
3	1	0	1	1	0	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	15	0.44
4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20	0.00
5	0	0	1	0	1	1	1	1	1	0	1	0	1	0	0	0	1	1	0	0	10	0.51
6	1	0	1	0	1	0	0	1	1	0	1	0	0	0	1	1	0	1	1	1	11	0.51
7	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	17	0.37
8	1	1	1	1	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	17	0.37
9	1	0	1	0	1	1	1	0	0	1	1	1	1	0	1	1	1	1	1	1	15	0.44
10	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	0	1	1	0	1	16	0.41
11	1	0	1	0	0	0	1	1	0	1	1	1	1	1	0	1	0	1	1	1	13	0.49
12	0	1	1	1	0	0	1	1	0	0	1	0	0	0	1	1	1	1	0	0	10	0.51
13	1	1	0	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	16	0.41
14	1	0	1	0	0	1	1	1	0	1	1	1	1	0	1	1	0	1	1	1	14	0.47
15	1	1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	16	0.41
16	0	0	1	0	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	14	0.47
17	0	1	1	1	1	1	0	0	1	0	1	0	1	1	1	1	0	1	0	0	12	0.50
18	1	1	1	1	1	1	0	1	0	0	0	0	1	1	1	1	1	0	0	1	13	0.49
19	0	1	0	0	0	0	1	1	0	1	1	1	0	0	1	1	0	1	1	1	11	0.51
20	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	18	0.31
21	0	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	0	15	0.44
22	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	18	0.31
23	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	19	0.22
24	0	1	0	0	0	0	1	1	1	0	1	0	1	1	1	1	1	1	1	1	13	0.49
25	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	17	0.37
26	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	19	0.22
27	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	17	0.37
28	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	0.31
29	1	0	1	0	1	1	1	1	0	0	1	0	1	0	1	1	1	1	1	0	13	0.49
30	0	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17	0.37
31	1	1	1	0	1	1	1	1	0	1	1	1	1	0	0	1	1	1	0	1	15	0.44
32	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	18	0.31
33	0	0	1	1	1	0	0	1	0	0	0	0	1	1	0	1	1	0	1	1	10	0.51
34	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17	0.37
35	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19	0.22
36	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	0	1	17	0.37
37	1	0	1	1	0	0	1	1	1	1	0	0	1	0	1	1	0	1	0	1	12	0.50
38	0	1	0	0	0	1	0	0	0	0	1	1	0	0	1	1	0	0	0	0	6	0.47
39	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	19	0.22
40	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	4	0.41
41	0	1	1	0	1	1	0	0	1	1	1	0	1	1	1	1	0	0	1	0	12	0.50
42	1	1	1	0	0	1	1	1	0	0	0	0	1	1	1	0	0	1	0	1	11	0.51
43	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	19	0.22
Total	28	31	34	20	24	34	34	37	31	31	38	25	33	28	38	40	29	37	32	28		

*Assessment Item

** Correct Score per Assessment Item

Physical Science Class - 3rd Hour - Pre-Test Assessment
Students 301-323

A*	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	C**	SD
1	0	0	0	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0	1	0	0	0	13	0.51
2	0	0	1	0	1	1	1	1	0	0	0	1	0	1	0	0	0	1	1	0	0	1	0	10	0.51
3	1	0	1	1	1	1	1	1	0	0	1	1	1	0	0	1	1	1	0	1	1	0	0	15	0.49
4	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	0	18	0.42
5	1	0	0	0	0	0	0	1	0	0	1	1	1	1	0	1	0	1	0	1	0	1	1	11	0.51
6	1	0	1	0	0	1	0	0	0	0	1	1	0	1	0	0	0	0	0	1	0	1	1	9	0.50
7	1	1	1	1	1	1	1	1	0	1	1	1	0	1	0	0	0	1	0	1	1	0	1	16	0.47
8	1	0	1	1	0	0	0	0	0	1	1	1	0	1	0	0	1	1	0	1	0	0	1	11	0.51
9	0	1	0	0	0	0	1	1	0	0	0	1	1	1	0	1	0	1	0	1	0	0	1	10	0.51
10	1	0	0	1	0	1	1	1	0	1	1	1	0	0	0	1	0	1	0	1	1	0	1	13	0.51
11	1	1	1	0	1	0	0	0	1	0	1	0	1	0	0	1	1	1	1	1	1	1	1	15	0.49
12	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0.29
13	1	1	1	1	0	1	1	1	0	0	0	1	1	0	0	1	0	1	1	1	1	0	1	15	0.49
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0.21
15	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	6	0.45
16	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	3	0.34
17	1	0	1	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	1	0	7	0.47
18	1	1	0	1	0	0	0	0	1	1	1	0	0	0	0	1	1	0	1	1	0	0	1	11	0.51
19	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	5	0.42
20	1	0	1	0	1	0	0	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1	16	0.47
21	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	7	0.47
22	1	0	0	0	0	1	0	0	1	0	1	0	0	1	0	1	1	1	0	1	1	1	1	12	0.51
23	1	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	6	0.45
24	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	5	0.42
25	0	1	0	1	1	0	0	0	0	1	1	1	1	1	0	1	0	1	0	1	1	1	0	13	0.51
26	0	1	0	1	0	0	0	0	1	1	0	1	1	0	0	0	0	1	0	1	0	0	1	9	0.50
27	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	5	0.42
28	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	5	0.42
29	0	0	1	0	1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	1	0	0	0	6	0.45
30	1	0	0	0	0	1	0	1	1	1	1	0	1	0	0	0	0	0	0	1	1	0	0	9	0.50
31	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	4	0.39
32	1	1	1	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1	14	0.50
33	1	1	1	0	0	0	0	0	0	1	1	0	0	1	0	0	1	1	1	0	0	0	0	9	0.50
34	1	0	1	0	0	1	0	1	0	0	1	1	0	0	0	0	1	1	0	0	0	0	1	9	0.50
35	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	1	8	0.49
36	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	1	1	1	1	1	1	1	16	0.47
37	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	3	0.34
38	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0.29
39	1	0	1	0	0	0	1	0	0	0	1	1	1	0	1	1	1	1	0	1	0	1	0	12	0.51
40	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	4	0.39
41	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	6	0.45
42	1	0	0	0	0	1	0	1	1	1	1	1	0	1	1	0	0	1	0	1	1	1	1	14	0.50
43	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	0	1	1	19	0.39
Total	24	19	17	18	13	15	13	17	11	15	25	27	17	18	7	17	20	23	14	26	13	16	19		

*Assessment Item

** Correct Score per Assessment Item

Physical Science Class -3rd Hour - Posttest Assessment
Students 301-323

A*	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	C**	SD
1	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	13	0.51
2	1	0	1	0	0	0	1	1	0	1	0	1	1	1	1	1	0	1	0	0	1	1	1	10	0.51
3	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15	0.49
4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	18	0.42
5	1	1	1	0	0	0	0	1	0	0	1	0	0	1	0	1	1	1	0	1	0	0	1	11	0.51
6	1	1	1	0	0	0	1	1	1	0	1	0	1	1	0	0	1	1	0	1	1	0	1	9	0.50
7	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	16	0.47
8	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	0	1	11	0.51
9	1	1	1	1	0	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	0	1	10	0.51
10	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	13	0.51
11	1	1	1	1	1	0	1	1	0	0	1	1	1	1	1	1	1	1	1	1	0	1	1	15	0.49
12	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	1	0	1	2	0.29
13	1	1	1	1	1	0	1	1	0	1	1	1	0	1	1	1	1	1	0	1	1	1	1	15	0.49
14	0	1	1	1	1	1	0	0	1	0	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0.21
15	1	0	1	0	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0	1	1	1	1	6	0.45
16	1	1	1	1	1	0	0	1	0	1	1	1	0	1	1	0	0	1	0	1	0	1	0	3	0.34
17	0	0	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	1	7	0.47
18	0	1	1	1	0	0	0	1	1	1	1	1	1	0	1	0	1	1	1	0	0	1	1	11	0.51
19	1	1	1	0	0	0	1	0	0	1	1	0	0	1	1	0	1	1	0	0	1	1	1	5	0.42
20	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	16	0.47
21	1	1	1	0	0	0	1	0	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	7	0.47
22	1	1	1	1	0	0	0	1	0	1	1	1	1	0	1	0	1	1	1	1	0	0	1	12	0.51
23	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	0	0	0	1	1	1	1	1	6	0.45
24	1	1	1	1	0	0	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	5	0.42
25	1	1	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	13	0.51
26	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	9	0.50
27	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	5	0.42
28	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	5	0.42
29	1	1	1	1	1	0	1	1	0	1	1	0	0	1	0	1	1	1	0	0	0	1	1	6	0.45
30	1	1	1	1	0	0	0	1	1	1	1	1	0	1	0	0	1	1	1	1	1	1	1	9	0.50
31	1	1	0	0	0	0	0	0	1	1	1	1	0	0	0	1	0	1	1	1	1	1	1	4	0.39
32	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	0	0	1	1	0	1	1	14	0.50
33	1	0	0	1	1	1	0	1	1	1	1	0	1	1	0	1	1	1	1	1	1	0	0	9	0.50
34	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	0	1	1	0	1	0	1	1	9	0.50
35	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	0	1	0	1	1	8	0.49
36	1	1	1	1	1	1	1	1	0	1	1	1	0	0	1	0	1	1	1	1	1	1	1	16	0.47
37	1	1	1	1	1	0	1	1	0	1	1	1	0	0	1	0	1	1	1	1	1	0	1	3	0.34
38	0	0	0	0	1	0	1	1	0	1	1	1	1	0	0	0	0	0	1	0	1	0	1	2	0.29
39	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	12	0.51
40	0	0	0	1	1	0	1	1	0	1	1	1	0	1	0	0	1	0	0	0	1	0	1	4	0.39
41	0	1	0	0	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	0	1	6	0.45
42	1	0	0	1	1	0	1	1	0	1	1	0	1	1	1	0	1	0	1	0	1	1	1	14	0.50
43	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	19	0.39
Total	36	35	35	31	26	13	29	37	19	35	41	35	31	33	32	22	31	37	28	34	28	30	41		

*Assessment Item

** Correct Score per Assessment Item

Physical Science Class - 4th Hour - Pre-Test Assessment
Students 401 - 419

A*	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	C**	SD
1	0	1	1	1	0	1	0	0	0	0	1	1	0	1	1	1	1	1	0	11	0.51
2	0	0	0	1	0	0	0	0	1	1	0	1	1	1	1	0	0	1	0	8	0.51
3	0	1	1	0	0	0	1	1	0	0	1	1	0	1	1	0	1	0	1	10	0.51
4	0	1	1	1	0	1	0	1	0	1	0	1	1	0	1	1	1	0	1	12	0.50
5	1	1	1	0	1	0	0	0	1	0	1	0	0	0	0	0	1	1	0	8	0.51
6	0	0	0	0	1	0	0	0	0	0	0	0	1	1	1	0	0	0	0	4	0.42
7	1	1	1	1	1	1	0	1	1	0	1	1	0	0	1	0	0	0	1	12	0.50
8	0	1	0	1	0	1	1	1	0	1	0	0	0	1	0	1	1	1	1	11	0.51
9	0	0	1	1	1	1	1	0	0	0	0	1	1	0	0	1	0	0	0	8	0.51
10	1	1	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	1	7	0.50
11	1	0	1	0	0	0	1	1	0	0	0	0	1	0	1	0	1	0	0	7	0.50
12	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0.37
13	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	4	0.42
14	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2	0.32
15	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	1	0	1	7	0.50
16	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0	0	0	6	0.48
17	0	1	0	0	0	0	1	0	1	1	1	0	1	1	0	1	0	0	0	8	0.51
18	0	0	0	0	0	1	0	1	0	0	1	1	0	0	1	0	1	1	0	7	0.50
19	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	3	0.37
20	1	0	1	0	1	0	1	1	0	1	1	0	0	0	1	0	1	0	1	10	0.51
21	0	1	0	0	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	6	0.48
22	0	0	1	0	1	1	0	0	0	0	1	1	0	0	1	0	1	0	0	7	0.50
23	0	1	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	1	5	0.45
24	1	0	1	0	1	0	0	0	0	0	0	0	0	1	1	0	1	1	1	8	0.51
25	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	0	1	0	1	7	0.50
26	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	1	0	1	1	9	0.51
27	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	2	0.32
28	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	4	0.42
29	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	4	0.42
30	0	1	0	0	0	0	1	0	0	1	0	1	0	0	1	0	1	1	0	7	0.50
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
32	0	0	0	0	1	1	1	1	0	0	1	1	1	0	1	1	1	0	1	11	0.51
33	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	4	0.42
34	0	0	1	1	0	1	1	0	0	0	0	1	1	1	0	0	1	1	0	9	0.51
35	0	0	1	1	0	1	1	0	0	0	1	0	1	0	0	0	1	0	0	7	0.50
36	1	0	1	1	1	1	1	0	0	0	0	1	1	0	1	1	1	0	0	11	0.51
37	0	0	0	0	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	5	0.45
38	1	0	1	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	6	0.48
39	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	1	5	0.45
40	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0.32
41	1	1	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0	1	1	8	0.51
42	0	1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	5	0.45
43	0	1	0	1	1	1	1	1	0	1	0	1	1	0	1	1	1	1	1	14	0.45
Total	10	16	14	14	15	19	22	16	10	14	17	19	17	12	18	12	19	12	18		

*Assessment Item

** Correct Score per Assessment Item

Physical Science Class - 4th Hour - Posttest Assessment
Students 401 - 419

A*	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	C**	SD
1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	18	0.32
2	0	0	1	1	0	1	0	1	0	1	1	1	1	1	1	1	1	1	1	14	0.45
3	0	1	0	0	1	1	1	1	0	1	1	1	1	1	1	1	0	0	1	13	0.48
4	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19	0.23
5	0	1	0	0	1	0	0	0	1	1	0	0	1	0	0	0	1	0	0	6	0.48
6	1	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	7	0.48
7	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	18	0.32
8	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	18	0.32
9	1	1	0	0	1	1	0	1	1	1	1	1	1	1	0	1	1	0	1	15	0.45
10	0	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	16	0.37
11	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	19	0.23
12	0	1	0	0	0	1	0	0	0	0	0	0	1	1	1	0	1	0	1	7	0.50
13	0	1	0	1	1	1	1	1	0	1	1	1	1	1	0	1	1	0	1	14	0.45
14	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	16	0.42
15	1	1	1	0	1	1	0	0	0	0	1	1	1	1	1	0	1	0	0	12	0.51
16	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	0	1	11	0.51
17	0	0	0	1	0	1	0	0	1	1	0	0	1	0	0	1	1	1	1	9	0.51
18	0	0	1	0	1	1	1	1	0	1	1	0	1	0	1	1	1	0	0	11	0.51
19	1	1	0	0	0	1	1	0	0	1	1	1	1	1	0	1	0	0	1	12	0.51
20	1	1	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	17	0.37
21	0	1	0	0	0	1	1	1	0	0	0	1	1	0	1	1	1	0	1	10	0.51
22	1	0	1	1	0	1	0	1	0	1	1	1	0	0	1	1	0	1	1	13	0.50
23	1	1	1	0	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	17	0.37
24	1	1	1	0	0	1	1	1	1	0	1	1	1	1	0	1	1	1	0	15	0.45
25	1	0	0	1	1	1	0	1	1	0	0	1	1	0	1	1	1	0	0	12	0.51
26	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	18	0.32
27	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20	0.00
28	1	1	1	0	1	0	1	1	0	1	1	1	1	0	1	1	1	1	1	16	0.42
29	1	1	1	0	1	1	0	0	0	1	1	1	1	0	1	1	1	1	1	15	0.45
30	1	1	1	0	0	0	1	1	0	1	0	1	1	1	1	1	1	0	0	13	0.50
31	1	1	1	1	0	0	0	0	1	0	0	0	1	1	1	0	1	0	0	10	0.51
32	1	1	0	0	0	1	1	1	1	0	1	1	1	1	0	1	1	0	1	14	0.48
33	0	0	0	1	0	1	1	1	1	1	1	1	1	0	1	0	1	0	0	11	0.51
34	0	1	1	0	1	1	1	1	0	0	0	1	1	1	1	1	1	0	1	13	0.48
35	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	16	0.37
36	1	1	1	1	0	1	1	0	0	1	0	1	1	1	1	1	1	1	1	16	0.42
37	0	1	1	0	1	1	0	1	1	1	1	1	1	0	1	1	1	1	0	14	0.45
38	0	0	0	0	1	1	1	0	1	0	0	1	1	0	1	1	1	0	1	10	0.51
39	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	18	0.32
40	0	0	0	0	1	1	1	0	0	0	0	0	1	1	1	0	1	1	1	9	0.51
41	0	0	0	0	1	0	1	1	0	0	0	1	1	0	1	1	1	0	0	8	0.51
42	0	1	0	0	0	1	1	0	0	0	0	1	0	1	0	1	0	0	1	7	0.50
43	1	1	1	1	1	1	1	1	0	1	0	1	1	1	0	1	1	0	1	16	0.42
Total		32	23	19	26	37	31	31	18	28	26	35	40	29	33	36	38	19	32		

*Assessment Item

** Correct Score per Assessment Item

Physical Science Class - 5th Hour - Pre-Test Assessment
Students 501 - 523

A*	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	C**	SD
1	0	1	1	1	0	1	1	1	1	1	0	1	1	1	1	0	0	1	1	0	1	1	1	17	0.45
2	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	5	0.42
3	1	0	0	1	0	1	1	0	0	1	1	1	0	0	1	0	1	0	1	0	0	1	0	11	0.51
4	1	0	0	1	1	1	1	0	0	1	0	1	1	0	1	1	1	0	1	0	1	0	1	14	0.50
5	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	1	0	1	1	1	8	0.49
6	0	1	0	0	1	1	1	0	1	1	1	0	1	0	0	0	0	0	0	0	1	0	1	10	0.51
7	0	1	1	0	1	1	1	0	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	18	0.42
8	0	0	0	0	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1	15	0.49
9	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	0	1	1	1	7	0.47
10	0	0	1	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	1	1	1	10	0.51
11	0	0	1	1	0	1	1	1	0	1	1	1	0	0	1	1	1	1	0	0	1	0	1	14	0.50
12	0	0	0	0	1	1	0	1	1	1	0	1	0	1	1	1	0	1	0	0	1	1	0	12	0.51
13	0	0	0	0	1	1	0	0	0	1	0	1	1	0	1	1	0	0	0	0	1	1	0	9	0.50
14	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	6	0.45
15	1	0	1	1	0	0	0	1	0	0	0	1	0	0	1	0	1	1	1	0	1	0	0	10	0.51
16	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.29
17	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	5	0.42
18	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1	1	0	1	0	0	1	0	7	0.47
19	0	0	1	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	0	0	0	1	7	0.47
20	1	1	0	0	1	1	0	0	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	17	0.45
21	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	3	0.34
22	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	1	0	1	0	0	0	1	15	0.49
23	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	1	1	7	0.47
24	0	0	0	1	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	1	0	0	8	0.49
25	1	0	0	1	0	0	1	1	0	1	0	0	0	0	1	0	1	0	0	0	1	1	0	9	0.50
26	0	1	0	0	1	1	1	0	0	1	1	0	1	1	1	1	1	0	1	0	1	1	1	15	0.49
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2	0.29
28	1	0	1	0	0	0	1	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	7	0.47
29	0	1	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	6	0.45
30	0	0	0	0	0	1	1	0	0	1	1	1	0	1	0	1	1	1	1	0	0	1	1	12	0.51
31	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	4	0.39
32	0	0	1	1	1	1	1	0	1	1	0	1	1	1	1	1	0	1	0	1	1	1	0	16	0.47
33	0	0	0	0	1	1	0	1	0	1	1	0	1	1	1	0	1	1	0	0	1	1	0	12	0.51
34	0	1	1	1	1	1	0	0	0	1	1	0	0	0	1	1	1	0	1	1	1	1	1	15	0.49
35	1	0	1	0	0	1	1	0	0	1	1	1	1	0	0	1	1	0	1	1	1	1	1	15	0.49
36	1	0	1	0	0	1	1	0	0	1	1	1	1	1	0	1	1	0	1	0	1	1	1	15	0.49
37	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	1	0	0	1	0	5	0.42
38	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	5	0.42
39	0	0	0	1	1	0	0	0	0	1	0	1	0	1	1	1	1	0	1	0	0	1	0	10	0.51
40	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	3	0.34
41	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	1	0	0	4	0.39
42	0	0	1	1	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	0	8	0.49
43	1	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	19	0.39
Total	11	9	17	14	16	23	23	10	16	32	21	18	16	15	23	19	22	9	25	11	22	25	22		

*Assessment Item

** Correct Score per Assessment Item

Physical Science Class - 5th Hour - PostTest Assessment
Students 501 - 523

A*	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	C**	SD
1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	0	20	0.34
2	1	0	1	1	1	1	0	0	1	1	1	0	1	0	1	1	1	1	1	1	0	1	1	17	0.45
3	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	0	1	1	19	0.39
4	1	1	1	1	1	1	0	1	0	1	1	1	0	1	1	1	1	1	1	0	1	1	1	19	0.39
5	1	0	1	0	1	0	1	0	1	1	1	1	0	1	1	1	0	0	1	1	1	1	1	16	0.47
6	1	1	0	0	1	0	0	1	1	1	1	0	1	0	1	1	0	1	0	1	1	0	1	14	0.50
7	1	1	1	1	0	1	0	0	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	18	0.42
8	1	1	0	1	1	1	1	0	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	19	0.39
9	0	0	0	1	1	0	0	1	0	1	1	1	0	1	1	1	1	0	1	1	1	1	1	15	0.49
10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23	0.00
11	1	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	19	0.39
12	0	0	0	0	1	1	1	1	0	1	0	1	0	0	0	1	0	0	0	0	1	1	0	9	0.50
13	1	1	1	1	1	1	1	0	0	1	0	1	1	1	1	1	1	0	1	1	1	1	1	19	0.39
14	1	0	1	0	1	1	1	0	1	1	1	1	0	1	1	0	1	0	1	1	1	1	1	17	0.45
15	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	21	0.29
16	1	0	0	1	1	1	0	0	0	1	1	0	1	1	1	1	0	0	1	0	1	1	0	13	0.51
17	1	0	1	1	1	0	0	1	0	1	1	1	1	1	1	1	1	0	1	0	1	1	1	17	0.45
18	1	1	1	1	1	1	0	1	0	1	1	0	0	0	1	1	1	1	1	1	0	1	1	17	0.45
19	1	0	1	0	1	1	1	1	0	1	0	0	1	1	1	1	1	1	1	0	1	1	1	17	0.45
20	1	1	1	1	0	1	0	0	1	1	1	1	0	1	1	1	0	0	1	0	1	1	11	26	2.20
21	1	0	1	1	0	0	0	1	0	1	1	0	0	1	1	0	1	1	1	0	0	1	1	13	0.51
22	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	0	0	1	1	1	1	19	0.39
23	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	21	0.29
24	1	0	1	1	1	1	0	0	1	1	1	0	1	1	1	0	1	0	1	1	1	1	1	17	0.45
25	1	1	0	0	1	0	1	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	17	0.45
26	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	22	0.21
27	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	1	0	1	1	1	19	0.39
28	1	1	0	1	0	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	19	0.39
29	1	1	1	0	1	1	0	0	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	18	0.42
30	1	1	1	1	1	0	0	1	0	1	1	1	1	1	1	1	0	0	1	1	1	1	1	18	0.42
31	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	1	1	0	19	0.39
32	1	0	0	1	1	0	1	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	16	0.47
33	0	0	1	1	0	1	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	0	0	9	0.50
34	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	20	0.34
35	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	21	0.29
36	1	1	1	0	1	1	1	0	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	18	0.42
37	0	1	0	1	0	1	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	0	15	0.49
38	0	1	0	1	1	0	0	0	0	1	1	0	0	1	1	1	1	1	1	0	1	1	0	13	0.51
39	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22	0.21
40	0	1	0	0	1	0	1	0	0	1	0	0	0	0	1	0	1	0	1	1	1	1	0	10	0.51
41	0	0	0	0	0	1	0	1	1	1	0	1	1	1	1	0	0	1	1	0	1	1	1	13	0.51
42	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	1	1	0	1	0	0	1	8	0.49
43	1	1	0	0	1	1	1	0	1	1	1	1	0	1	1	1	1	0	1	1	1	0	1	17	0.45
Total	35	28	28	30	35	32	24	21	20	42	34	30	27	33	40	36	33	22	38	30	38	39	44		

*Assessment Item

** Correct Score per Assessment Item

Demographics: Current Physical Science Class 2011-2012

Current Physical Science Class Compared to All High School Student Demographics

Students	N	Free and reduced lunch	Race (Non-White)	Special Needs	Gender Male	Female
2011-2012	108	52.3% Total	3	10	50	58
All CLK students	399	48.6% Total	6	28	193	206

Current Physical Science Class Demographics 2011-2012

Classes	N*	Gender Male	Gender Female	Special Needs**	Race (Non-white)	Special Needs Aid
2nd Period:	23	7	16	0	0	0
3rd Period:	26	14	12	2	2	1
4th Period:	25	13	12	10	1	1
5th Period:	25	11	14	1	0	0
TOTAL	99	45	54	13	3	

* 96 of 108 ninth grade and three sophomore students took physical science. Twelve ninth grade students took biology.
** There were 3 tenth grade students taking physical science. These students opted out of the study

Current Physical Science Class Status in MTU Research Study 2011-2012

Classes	N	Students In Study	Students in Study Opting out of Survey	Opted out Of Study	Did not Turn in Form
2ndPeriod:	23	20	1	1	2
3rdPeriod:	26	23	0	1	2
4thPeriod:	25	19	2	1	5
5thPeriod:	25	23	1	2	0
TOTAL	99	85	4	5	9

Demographics: Prior 2010-2011 Physical Science Class

Prior 2010-2011 Physical Science Class Compared to All High School Student Demographics

Students	N	Free and reduced lunch	Race (Non-White)	Special Needs	Gender Male	Female
2010-2011	121	54.5% Total	0	10	53	68
All CLK students	386	47.7% Total	5	23	205	181

Prior 2010-2011 Physical Science Class Demographics

Classes	N*	Gender Male	Gender Female	Special Needs	Race (Non-white)	Special Needs Aid
1st Period:	18	6	12	1	1	1
2nd Period:	24	12	12	3	0	1
6th Period:	23	13	10	5	0	1
7th Period:	21	12	9	1	0	0
TOTAL	86	43	43	10	1	

* 86 of 121 ninth grade students took physical science. Thirty-five ninth grade students took biology.

Demographics: Prior 2009-2010 Physical Science Class

Prior 2009-2010 Physical Science Class Compared to All High School Student Demographics

Students	N	Free and reduced lunch	Race (Non-White)	Special Needs	Gender Male	Female
2009-2010	96	59.4% Total	1	12	49	47
All CLK students	403	48.9% Total	4	25	197	206

Prior 2009-2010 Physical Science Class Demographics

Classes	N*	Gender Male	Gender Female	Special Needs**	Race (Non-white)	Special Needs Aid
1st Period:	21	10	11	6	0	1
5th Period:	23	15	8	4	1	1
6th Period:	25	14	11	4	1	1
TOTAL	69	39	30	14	2	

* 67 of 96 ninth grade and two tenth grade students took physical science. Twenty-seven ninth grade students took biology.
** There were 2 tenth grade students taking physical science.

Appendix E - Institutional Review Board Forms

This appendix includes the institutional review board letter of approval, letter sent to parents and guardians explaining the study and request for consent study, and the consent form for parents and students to sign.

Michigan Technological University

Office of Compliance, Integrity, and Safety

Lakeshore Center
1400 Townsend Drive
Houghton, MI 49931
906.487.2902

MEMO

TO: Dr. William Yarroch, CLS

CC: Joseph Heflin, CLS

FROM: Joanne Polzien, Executive Director, Compliance, Integrity, and Safety Joanne Polzien

DATE: January 31, 2012

SUBJECT: Approval M0862

Your application to use human subjects in research or classroom situations has been reviewed with the following determination:

Protocol #: M0862
Protocol Title: "The Effects of Web-Based Technological Resources in a Rural Upper Peninsula Science Classroom"
Approved Dates: January 31, 2012 through January 30, 2013

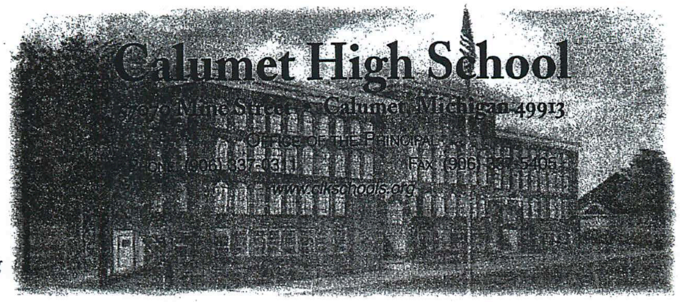
Approvals are granted for up to a one year period. You will need to request a continuation for each year of the project six weeks prior to the end date indicated above for each year of the project. The Office of Compliance, Integrity, and Safety will make every effort to send the Principal Investigator annual reminders. However, the Principal Investigator is responsible for submitting annual Continuation Forms in advance of the expiration date for the project. It is very important that these expiration dates are not missed. Failure to submit annual review materials on time will result in the termination of this protocol.

This approval applies only for this project, and only under the conditions and procedures described in the application; if any changes are made in the protocol or conditions set forth in the application, the principal investigator must obtain a separate approval before these changes take place. The approved project will be subject to surveillance procedures requiring periodic review. This review will consist of consulting with the principal investigator and examining the appropriate project records.

Individual identification of human subjects in any publication is an invasion of privacy. Before beginning a project involving human subjects, and only if required, the principal investigator must obtain a properly executed informed consent from each subject and/or the person legally responsible for the subject. **If a consent form has been reviewed and approved it has been attached with an official date stamp on it. Only copies of the official date stamped informed consent is to be distributed to participants relating to this project. If any changes or modifications are needed regarding this form, you must first submit the revised document for review and approval prior to use.** The principal investigator must retain informed consent forms on file for at least three years after the end of the project. If a project involves a high level of risk, copies of the signed informed consent forms must be filed with the Human Subjects Committee; if this is the case, you will be notified.

This document is on file in the Office of Compliance, Integrity, and Safety. If you have any questions, please contact me at 487-2902 or jpolzien@mtu.edu.

JP/cl



GEORGE F. TWARDZIK
Principal
E-mail: gtwardzik@clkschools.org

SEAN JACQUES
Asst. Principal/Athletic Directo
E-mail: sjacques@clkschools.org

Consent to Participate in Research

Technology Based Study

1. My name is Mr. Joseph Heflin. I am working on a Master's Degree in Applied Science from Michigan Technological University in Houghton, Michigan.
2. My advisor, Dr. William Yarroch, and I are asking you to take part in a research study because we are attempting to learn more about the affects of using technology in the science classroom. We will be providing students access to science resources that will be available on the Calumet High School webpage. These resources will be relevant to both science content in the classroom as well as in your own life.
3. If you agree to be in this study, you will participate in a unit where technology resources can assist you in comprehending the chemistry knowledge.
4. You will take a pre- and post-test that will contain some questions about your knowledge of the subject and I will use some of your assignments as part of the study. Your real name will never be used in publication – each of your assessments and assignments will be assigned a random number.
5. A short survey will be administered after the post-test to determine the basic demographics of the students. This survey will be used to assess how, when, where and to what extent students used the science resources via the webpage. This information will be compared with student test scores to see if there was a connection.
6. Only classroom knowledge relevant to Michigan's Grade Level Content Expectations (GLCE) and High School Content Expectations (HSCE) will be measured in the tests. We will be focusing on the Chemistry standards, specifically those about chemical bonding and the periodic table. The science standards can be found at the following website: http://www.michigan.gov/documents/CHEM_HSCE_168205_7.pdf
7. There are no known risks to participating. We will be using all the classroom resources and school district technology in a safe responsible manner.
8. Please talk this over with your parents/guardians before you decide whether or not to participate. Your parents/guardians will need to give their permission for you to take part in this study. They can give permission by reading, signing, and having you return the parent consent form to me. Even if your parents/guardians say "yes", you can still decline to participate.
9. There will be no negative action or consequence on your grade or status in the class for choosing to participate or not in this study. You can change your mind at any time after starting the study by verbally telling Mr. Heflin.
10. The Michigan Tech Institutional Review Board has reviewed my request to conduct this project. If you have any concerns about your rights in this study, please contact the Michigan Tech-IRB at 906-487-2902 or email irb@mtu.edu
11. At any time, you can ask any question of communicate any concerns that you have about the study, either in person or via email – jheflin@clkschools.org
12. Signing your name at the bottom and on the following page means that you agree to be in this study. You and your parents/guardians will keep this copy. You will also need to sign the bottom of the parent/student consent form (see next page).

DATE OF IRB APPROVAL: 01-31-12
IRB NUMBER: M0862
PROJECT EXPIRATION DATE: 01-30-13

Sign and keep this form for your records. Sign and return the second page to your science teacher.

Signature of Student	Signature of Parent/Guardian
Printed Name of Student	Printed name of Parent/Guardian
Date:	Date:

Parent Consent – The Effects of Web-Based Technological Resources in a Rural Upper Peninsula Science Classroom

Please indicate whether or not you wish to allow your child to participate in this project by checking one of the statements below, signing your name and having your child return this page to me, Mr. Joseph Heflin. Keep the first page for your records.

_______ I grant permission for my child to participate in Mr. Joseph Heflin's and Dr. William Yarroch's study of The Effects of Web-Based Technological Resources in a Rural Upper Peninsula Science Classroom.

_______ I **do not** grant permission for my child to participate in Mr. Joseph Heflin's and Dr. William Yarroch's study of The Effects of Web-Based Technological Resources in a Rural Upper Peninsula Science Classroom.

Signature of Parent/Guardian | Printed Name of Student

Printed name of Parent/Guardian

DATE OF IRB APPROVAL: 01-31-12
IRB NUMBER: M0862
PROJECT EXPIRATION DATE: 01-30-13

Date:

Student Consent – The Effects of Web-Based Technological Resources in a Rural Upper Peninsula Science Classroom

I have read and understand the Student Consent to Participate form for Mr. Joseph Heflin's and Dr. William Yarroch's study of The Effects of Web-Based Technological Resources in a Rural Upper Peninsula Science Classroom. If I have questions, I understand that I can ask Mr. Heflin at any time during the classroom unit or I can contact Mr. Heflin by emailing him at jheflin@clkschools.org.

Please check one of the statements below and return this page to Mr. Heflin. Keep the Student Consent to Participate form for your records.

_______ I **do agree** to participate in Mr. Heflin's and Dr. William Yarroch's study of The Effects of Web-Based Technological Resources in a Rural Upper Peninsula Science Classroom. I have read and understand the Student Consent to Participate form and agree to its terms.

_______ I **do not agree** to participate in Mr. Joseph Heflin's and Dr. William Yarroch's study of The Effects of Web-Based Technological Resources in a Rural Upper Peninsula Science Classroom. I have read and understand the Student Consent to Participate form and I do not wish for my class work or scores to be used for this study.

Signature of Student (subject)

Printed name of Student (subject)

DATE OF IRB APPROVAL: 01-31-12
IRB NUMBER: M0862
PROJECT EXPIRATION DATE: 01-30-13

Date:

Appendix F - Technology Survey

Before taking this survey, students were given their individual progress reports. The information supplied by these reports included students' current third marking period grade, chemistry test grade, and absences. The original technology survey questions and the student responses are included in this appendix.

Technology Survey Questions

1. Type in your first and last name?

2. What hour do you have Physical Science class?

a. 2nd Hour
b. 3rd Hour
c. 4th Hour
d. 5th Hour

3. What is your 3rd marking period grade (T3)?

a. A (93-100%)
b. A- (90-92.9%)
c. B+ (87-89.9%)
d. B (83-86.9%)
e. B- (80-82.9%)
f. C+ (77-79.9%)
g. C (73-76.9%)
h. C- (70-72.9%)
i. D+ (67-69.9%)
j. D (63-866.9%)
k. D- (60-62.9%)
l. E (0-59.9%)

4. What was your grade on the Chemistry Test (Chapter 19)?

a. A (93-100%)
b. A- (90-92.9%)
c. B+ (87-89.9%)
d. B (83-86.9%)
e. B- (80-82.9%)
f. C+ (77-79.9%)
g. C (73-76.9%)
h. C- (70-72.9%)
i. D+ (67-69.9%)
j. D (63-866.9%)
k. D- (60-62.9%)
l. E (0-59.9%)

5. During the Chemistry unit (March), how many days were you absent from Physical Science class (sick or other reasons)?

a. 0 Days (Never)
b. 1 Day
c. 2 Days
d. 3 Days
e. 4 Days
f. 5 Days or more

6. Do you have access to a computer at home?

a. Yes
b. No

7. Do you have internet access at home?

a. Yes
b. No

8. Do you have wireless internet to use your iPad at home?

a. Yes
b. No

9. Do you use your iPad before and/or after school in the library, study hall, or in the new commons area?

a. Yes
b. No

10. It is helpful to have Mr. Heflin's lesson plans (agenda) on the school webpage. I can see everything that we are doing for the week - when homework and labs are assigned and when they are due.

a. Agree **c. Somewhat disagree.**
b. Somewhat agree. **d. Disagree.**

Comments:

11. When I was absent from school (sick or other reasons), I used Mr. Heflin's webpage to check what I had missed.

a. Yes
b. No

Comments:

12. It is helpful when Mr. Heflin emailed me reminders about upcoming quizzes, assignments, or when he put new resources (PowerPoint presentations, videos, and/or podcasts) on his webpage.

a. Agree **c. Somewhat disagree.**
b. Somewhat agree. **d. Disagree.**

13. It is helpful that Mr. Heflin put **videos** covering the chemistry lessons and curriculum on his school webpage.

a. Agree **c. Somewhat disagree.**
b. Somewhat agree. **d. Disagree.**

Comments:

14. Mr. Heflin put eight (8) **videos** covering the chemistry lessons and curriculum on his school webpage – Basics of Chemistry, Properties of Matter (2), Atoms & Elements, Periodic Table, Chemical Reactions, & Chemical Bonding (2). How many did you watch?

a. 0 **f. 5**
b. 1 **g. 6**
c. 2 **h. 7**
d. 3 **i. 8**
e. 4

15. It is helpful that Mr. Heflin put **PowerPoint presentations** covering the chemistry lessons and curriculum on his school webpage.

a. Agree **c. Somewhat disagree.**
b. Somewhat agree. **d. Disagree.**

Comments:

16. Mr. Heflin put five (5) **PowerPoint presentations** covering the chemistry lessons and curriculum on his school webpage - Chapter 19 Reading Guides 1-3, Half-Life, & Chapter 19 Review). How many did you watch?

a. 0
b. 1
c. 2
d. 3
e. 4
f. 5

17. It is helpful that Mr. Heflin put **podcasts** (audio only) covering the chemistry lessons and curriculum on his school webpage.

a. Agree **c. Somewhat disagree.**
b. Somewhat agree. **d. Disagree.**

Comments:

18. Mr. Heflin's put two (2) **podcasts** (audio only) covering the chemistry lessons and curriculum on his school webpage - General Chemistry (2). How many did you watch?

a. 0
b. 1
c. 2

19. It is helpful that Mr. Heflin put **practice questions (quizzes)** covering the chemistry lessons and curriculum on his school webpage.

a. Agree **c. Somewhat disagree.**
b. Somewhat agree. **d. Disagree.**

20. Mr. Heflin's internet resources (PowerPoint presentations, videos, and/or podcasts) were **helpful in strengthening my understanding** of the chemistry information.

a. Agree **c. Somewhat disagree.**
b. Somewhat agree. **d. Disagree.**

Comments:

21. Mr. Heflin's internet resources (PowerPoint presentations, videos, and/or podcasts) were helpful in **clarifying misconceptions** or things that I was confused about in the chemistry unit.

a. Agree **c. Somewhat disagree.**
b. Somewhat agree. **d. Disagree.**

Comments:

22. Mr. Heflin's internet resources (PowerPoint presentations, videos, and/or podcasts) focusing on historical figures and modern scientists **helped me to see that science is an active process with many goals and differing paths**.

a. Agree **c. Somewhat disagree.**
b. Somewhat agree. **d. Disagree.**

Comments:

23. What I am learning in Mr. Heflin's science class <u>may</u> be helpful in my future career.

a. Agree **c. Somewhat disagree.**
b. Somewhat agree. **d. Disagree.**

Comments:

24. On average, how often does your parent or guardian look at Mr. Heflin's webpage?

a. Never
b. Very Infrequently – once or twice a marking period
c. Infrequently – once or twice a month
d. Frequently – once or twice a week
e. Very Frequently – more than twice a week
f. I don't know how often, but they do check it

Technology Survey Results

1. Type in your name (first and last)

	Response Count	Response Percent
Total	81	100
Skipped question	0	0.0

2.What hour do you have Physical Science class?

Answer Options	Response Count	Response Percent
2nd Period	19	23.5
3rd Period	23	28.4
4th Period	17	21.0
5th Period	22	27.2
Total	81	100
Skipped question	0	0.0

3.What is your 3rd marking period grade (T3)?

Answer Options	Response Count	Response Percent
A (93-100%)	2	2.5
A- (90-92.9%)	3	3.7
B+ (87-89.9%)	6	7.4
B (83-86.9%)	2	2.5
B- (80-82.9%)	15	18.5
C+ (77-79.9%)	4	4.9
C (73-76.9%)	6	7.4
C- (70-72.9%)	10	12.3
D+ (67-69.9%)	7	8.6
D (63-866.9%)	6	7.4
D- (60-62.9%)	4	4.9
E (0-59.9%)	16	19.8
Total	81	100
Skipped question	0	0.0

4.What was your grade on the Chemistry Test (Chapter 19)?

Answer Options	Response Count	Response Percent
A (93-100%)	2	2.5
A- (90-92.9%)	3	3.7
B+ (87-89.9%)	6	7.4
B (83-86.9%)	2	2.5
B- (80-82.9%)	15	18.5
C+ (77-79.9%)	4	4.9
C (73-76.9%)	6	7.4
C- (70-72.9%)	10	12.3
D+ (67-69.9%)	7	8.6
D (63-866.9%)	6	7.4
D- (60-62.9%)	4	4.9
E (0-59.9%)	16	19.8
Total	81	100
Skipped question	0	0.0

5. During the Chemistry unit (March), how many days were you absent from Physical Science class (sick or other reasons)?

Answer Options	Response Count	Response Percent
0 Days (Never)	21	25.9
1 Day	13	16.0
2 Days	18	22.2
3 Days	10	12.3
4 Days	10	12.3
5 Days or more	9	11.1
Total	81	100
Skipped question	0	0.0

6. Do you have access to a computer at home?

Answer Options	Response Count	Response Percent
Yes	74	91.4
No	7	8.6
Total	81	100
Skipped question	0	0.0

7. Do you have internet access at home?

Answer Options	Response Count	Response Percent
Yes	76	93.8
No	5	6.2
Total	81	100
Skipped question	0	0.0

8. Do you have wireless internet to use your iPad at home?

Answer Options	Response Count	Response Percent
Yes	69	85.2
No	12	14.8
Total	81	100
Skipped question	0	0.0

9. Do you use your iPad before and/or after school in the library, study hall, or in the new commons area?

Answer Options	Response Count	Response Percent
Yes	57	70.4
No	24	29.6
Total	81	100
Skipped question	0	0.0
Student Comments	24	29.6
Student Not Commenting	57	70.4

	Student Free Response Comments	Classification
1	I'm rarely here early or late.	Neutral
2	Only when I stay after (rarely)	Neutral
3	I no longer own an iPad.	Neutral
4	Works great! Wish I had a bit more freedom, or you had a page with recommended info sites that are not blocked.	Positive
5	I go home right after school cuz my only ride home is the bus	Neutral
6	Study hall, actually.	Neutral
7	Sometimes in the commons	Neutral
8	Mostly for random stuff.... I usually do my homework up home.	Neutral
9	Not a lot	Neutral
10	Have computer connection only at m mothers place	Not Interpret
11	I like to use my iPad in the commons area because it's normally quiet	Positive
12	No need	Neutral
13	Sometimes.	Neutral
14	Sometimes	Neutral
15	Not recently though because it smells funny in the commons..:(	Negative
16	Don't have an iPad	Neutral
17	Sometimes in the morning to look over things before class.	Neutral
18	Look at scores on the internet	Neutral
19	How’s your day	Not Interpret
20	Sometimes	Neutral
21	I hate [other teacher]*	Not Interpret
22	Yea dawg	Not Interpret
23	I love the Ipads!!!!!!	Not Interpret
24	I love the Commons area	Not Interpret

10. It is helpful to have Mr. Heflin's lesson plans (agenda) on the school webpage. I can see everything that we are doing for the week - when homework and labs are assigned and when they are due.

Answer Options	Response Count	Response Percent
Agree	55	67.9
Somewhat agree.	23	28.4
Somewhat disagree.	2	2.5
Disagree.	1	1.2
Total	81	100
Skipped question	0	0.0
Student Comments	16	19.8
Students Not Commenting	65	80.2

	Student Free Response Comments	Classification
1	If I'm absent I can check on what I missed.	Neutral
2	This is very helpful!	Positive
3	I think study guides and reviews should have an answer key so we are sure to study the right thing. It really bothers me that you don't have that.	Not Interpret
4	But I don't always go on them	Neutral
5	I always check.	Neutral
6	I never really look	Neutral
7	I like it but for some reason it doesn't show up for me.	Neutral
8	Because if we have a test I can try to study for that week.	Neutral
9	It's more helpful when he e-mails them or puts them on My Big Campus.	Neutral
10	It's a good thing he has it. But I don't use it.	Neutral
11	If I miss class I know what to do, or I can know when an assignment is due.	Positive
12	It would be very helpful if I actually looked at them	Neutral
13	I don't use it but it could be good for when you are gone...	Neutral
14	I'm bored	Not Interpret
15	I hate [other teacher]*	Not Interpret
16	Mr. Heflin you are awesome	Not Interpret

* The name of the teacher has been removed for confidentiality.

11. When I was absent from school (sick or other reasons), I used Mr. Heflin's webpage to check what I had missed.

Answer Options	Response Count	Response Percent
Yes	20	24.7
No	61	75.3
Total	81	100
Skipped question	0	0.0
Student Comments	18	22.2
Student Not Commenting	63	77.8

	Student Free Response Comments	Classification
1	Some days I knew what we were doing and other days I had to check.	Neutral
2	I check my schedule that I got every Monday	Neutral
3	I was never absent	Neutral
4	I honestly can't remember if I did the one day I was absent, so just going with no.	Neutral
5	But I did use the blue sheet for the week	Neutral
6	I have it written down	Neutral
7	I also look at the board or as Mr. Heflin	Neutral
8	But I was kind of confusing.	Not Interpret
9	Sometimes I do and don't.	Neutral
10	Was not sick	Neutral
11	I figured I could just ask the next day, didn't think about it.	Neutral
12	I got my work and talked to Mr. Heflin before I was absent.	Neutral
13	I wasn't absent	Neutral
14	Forgot	Neutral
15	Yay	Not Interpret
16	I'm sick, I'm not going to do school work...	Negative
17	I didn't need to because I got it before I was absent.	Neutral
18	I hate [other teacher]*	Not Interpret

* The name of the teacher has been removed for confidentiality.

12. It is helpful when Mr. Heflin emailed me reminders about upcoming quizzes, assignments, or when he put new resources (videos, PowerPoint presentations, and audio podcasts) on his webpage.

Answer Options	Response Count	Response Percent
Agree	61	75.3
Somewhat agree.	16	19.8
Somewhat disagree.	2	2.5
Disagree.	2	2.5
Total	81	100
Skipped question	0	0.0
Student Comments	14	17.3
Students Not Commenting	67	82.7

	Student Free Response Comments	Classification
1	When he emails me (us) I usually go to the web page within the five-ten minutes following and go over the quizzes/presentations again.	Positive
2	Helps me study for tests and view what we have learned	Positive
3	I don't use them though	Neutral
4	I love that I'm reminded about tests and quizzes over the weekends and weekdays.	Positive
5	Email is not working	Neutral
6	So then I can study for them in advance.	Neutral
7	It got me more motivated to study/finish my work.	Positive
8	If I actually got the emails at my home ahead of time it would be a great deal of help to me, but because I don't have access to Wi-Fi where I live I don't receive these at home, I instead get them all when I come to school.	Positive
9	Otherwise I forget to study.	Positive
10	Helpful!	Positive
11	Forget to check emails sometimes	Neutral
12	Go calumet	Not Interpret
13	I never check my email	Neutral
14	I hate [other teacher]*	Not Interpret

* The name of the teacher has been removed for confidentiality.

13. It was helpful that Mr. Heflin put videos covering the chemistry lessons and curriculum on his school webpage.

Answer Options	Response Count	Response Percent
Agree	53	65.4
Somewhat agree.	23	28.4
Somewhat disagree.	3	3.7
Disagree.	2	2.5
Total	81	100
Skipped question	0	0.0
Student Comments	19	23.5
Students Not Commenting	62	76.5

	Student Free Response Comments	Classification
1	I did not review all of them only a few.	Neutral
2	I didn't exactly have access to them but they helped other kids	Positive
3	I agree, but I didn't watch any	Neutral
4	But did not look at it	Not Interpret
5	Chemistry was difficult, the Power Points helped.	Not Interpret
6	They help when I think I need them	Positive
7	They helped me study for tests and quizzes.	Positive
8	Some were a little long but they definitely helped me learn better.	Positive
9	When I saw the link to the physical changes song, I saw a video of Daniel Radcliffe singing all of the elements super-fast and I'm going to learn it!! >:D	Not Interpret
10	It would've been if I watched them.	Neutral
11	It’s helpful. But I don't use them.	Positive
12	I only watched 1, but even that worked.	Positive
13	They were boring, didn't watch all of them.	Negative
14	I never got to look at any of em'	Neutral
15	I didn't watch them...	Neutral
16	Didn't watch em	Neutral
17	I don’t watch the videos, i look over the Power Points	Positive
18	Gives a lot of information that is on the tests.	Positive
19	I hate [other teacher]*	Not Interpret

* The name of the teacher has been removed for confidentiality.

14. Mr. Heflin put eight (8) videos covering the chemistry lessons and curriculum on his school webpage – Basics of Chemistry, Properties of Matter (2), Atoms & Elements, Periodic Table, Chemical Reactions, & Chemical Bonding (2). How many did you watch?

Answer Options	Response Count	Response Percent
0	28	34.6
1	8	9.9
2	10	12.3
3	11	13.6
4	6	7.4
5	7	8.6
6	2	2.5
7	3	3.7
8	6	7.4
Total	81	100
Skipped question	0	0.0

15. It was helpful that Mr. Heflin put Power Point presentations covering the chemistry lessons and curriculum on his school webpage.

Answer Options	Response Count	Response Percent
Agree	61	75.3
Somewhat agree.	15	18.5
Somewhat disagree.	4	4.9
Disagree.	1	1.2
Total	81	100
Skipped question	0	0.0
Student Comments	15	18.5
Students Not Commenting	66	81.5

	Student Free Response Comments	Classification
1	Every once in a while I will go through all of them again for a review.	Neutral
2	Easier to look back on instead of books	Positive
3	I watched these	Neutral
4	I wish we would go over them in class more.	Neutral
5	I really like these! They're very helpful.	Positive
6	It's good but bad it's bad because all the answers are there in order and u don't have to search for them.	Neutral
7	It would've been if I watched them.	Neutral
8	Very nice for studying and making flash cards based off them....	Positive
9	The first time I looked at them, I got my worst test score for this year. Just Sayin'	Negative
10	Science is the best	Not Interpret
11	They help me before tests, except for this one cause i forgot about it....	Positive
12	I didn't watch them	Neutral
13	I hate [other teacher]*	Not Interpret
14	Use them before test!	Positive
15	I used it for the tests even though I still suck	Not Interpret

* The name of the teacher has been removed for confidentiality.

16. Mr. Heflin put five (5) Power Point presentations covering the chemistry lessons and curriculum on his school webpage - Chapter 19 Reading Guides 1-3, Half-Life, & Chapter 19 Review). How many did you watch?

Answer Options	Response Count	Response Percent
0	23	28.4
1	5	6.2
2	16	19.8
3	20	24.7
4	7	8.6
5	10	12.3
Total	81	100
Skipped question	0	0.0

17. It was helpful that Mr. Heflin put podcasts (audio only) covering the chemistry lessons and curriculum on his school webpage.

Answer Options	Response Count	Response Percent
Agree	26	32.1
Somewhat agree.	32	39.5
Somewhat disagree.	15	18.5
Disagree.	8	9.9
Total	81	100
Skipped question	0	0.0
Student Comments	22	27.2
Students Not Commenting	59	72.8

	Student Free Response Comments	Classification
1	I didn't listen to any of them.	Neutral
2	Did to know about these	Neutral
3	I didn't know we had those	Neutral
4	Didn't know there where podcasts	Neutral
5	I didn't listen to them tho...	Neutral
6	Didn't even know you had podcasts.....	Neutral
7	I didn't see those, but I definitely would be helpful.	Neutral
8	It was good because I learned the curriculum but in a funny way.	Positive
9	Did not know he had them	Neutral
10	I didn't know there was any though...	Neutral
11	It would've been if I watched them.	Neutral
12	I think if you're one of them people that learn from listening it is good. For them......	Neutral
13	I think the videos or power points would be better than pod cast	Neutral
14	Weird	Not Interpret
15	I dont think people want to listen to podcasts.	Negative
16	Easier to watch or else read.	Negative
17	I didn't listen to any of them	Neutral
18	I didn't know there were any	Neutral
19	Didnt listen to em	Neutral
20	No	Negative
21	Never watched it	Neutral
22	I hate [other teacher]*	Not Interpret

* The name of the teacher has been removed for confidentiality.

18. Mr. Heflin put two (2) podcasts (audio only) covering the chemistry lessons and curriculum on his school webpage - General Chemistry (2). How many did you watch?

Answer Options	Response Count	Response Percent
0	70	86.4
1	8	9.9
2	3	3.7
Total	81	100
Skipped question	0	0.0

19. It is helpful that Mr. Heflin put practice questions (quizzes) covering the chemistry lessons and curriculum on his school webpage.

Answer Options	Response Count	Response Percent
Agree	60	74.1
Somewhat agree.	18	22.2
Somewhat disagree.	1	1.2
Disagree.	2	2.5
Total	81	100
Skipped question	0	0.0
Student Comments	17	21.0
Students Not Commenting	64	79.0

	Student Free Response Comments	Classification
1	I usually review all of the practice quizzes that are available.	Positive
2	Helped me study greatly	Positive
3	It would be more helpful if we had the answers to check our work	Neutral
4	I would all ways take pictures of them to use at home.	Neutral
5	I never have the time to use these and I don't have Internet at home	Negative
6	They helped	Positive
7	Never took one from the webpage.	Neutral
8	You might want to try to set them up like the test questions more.	Neutral
9	Definitely helpful to me.	Positive
10	Didn't listen to the audio	Not Interpret
11	It helps me get a better understanding of what kind of topics will be on the quiz/test	Positive
12	Strongly Agree	Positive
13	It would've been if I did them.	Neutral
14	Keep the practice quiz it helps a lot	Positive
15	My brother likes chocolate	Not Interpret
16	I hate [other teacher]*	Not Interpret
17	Yea Dawg	Not Interpret

* The name of the teacher has been removed for confidentiality.

20. Mr. Heflin's internet resources (Power Point presentations, videos, and/or podcasts) were helpful in strengthening my understanding of the chemistry information.

Answer Options	Response Count	Response Percent
Agree	37	45.7
Somewhat agree.	36	44.4
Somewhat disagree.	4	4.9
Disagree.	4	4.9
Total	81	100
Skipped question	0	0.0
Student Comments	12	14.8
Students Not Commenting	69	85.2

	Student Free Response Comments	Classification
1	Sometimes I can't remember what I review but most of the time it helps to look at the presentations, quizzes, etc.	Positive
2	I didn't watch all of them.	Neutral
3	I had to look at them a couple times to understand something	Positive
4	I never actually used them, but they would be helpful if I did.	Neutral
5	Still manage to fail	Negative
6	They were kind of boring.	Negative
7	I understood it more than I thought I would with these videos	Positive
8	It would've been if I watched them.	Neutral
9	I never looked at the stuff	Neutral
10	Never ever watched a video	Neutral
11	My sister likes chocolate	Not Interpret
12	I hate [other teacher]*	Not Interpret

* The name of the teacher has been removed for confidentiality.

21. Mr. Heflin’s internet resources (Power Point presentations, videos, and/or podcasts) were helpful in clarifying misconceptions or things that I was confused about in the chemistry unit.

Answer Options	Response Count	Response Percent
Agree	31	38.3
Somewhat agree.	44	54.3
Somewhat disagree.	2	2.5
Disagree.	4	4.9
Total	81	100
Skipped question	0	0.0
Student Comments	10	12.3
Students Not Commenting	71	87.7

	Student Free Response Comments	Classification
1	I remember one specific time when I had to look up a problem on the Power Points and it helped me.	Positive
2	I had a hard time trying to access videos and i didn't know about podcasts but pwrpnts helped	Positive
3	Especially on the half-life power pt.	Positive
4	The info needs to be condensed	Negative
5	Again, they would be helpful if I was confused.	Neutral
6	The ones he made weren't fun I like things that interest me.	Negative
7	It would've been if I watched them.	Neutral
8	Helped me with tests.	Positive
9	I like chocolate	Not Interpret
10	I hate [other teacher]*	Not Interpret

* The name of the teacher has been removed for confidentiality.

22. Mr. Heflin's internet resources (Power Point presentations, videos, and/or podcasts) focusing on historical figures and modern scientists helped me to see that science is an active process with many goals and differing paths.

Answer Options	Response Count	Response Percent
Agree	20	24.7
Somewhat agree.	45	55.6
Somewhat disagree.	10	12.3
Disagree.	6	7.4
Total	81	100
Skipped question	0	0.0
Student Comments	6	7.4
Students Not Commenting	75	92.6

	Student Free Response Comments	Classification
1	I didn't review any of this.	Neutral
2	Kinda knew that anyway. Would probably be helpful to others, though.	Neutral
3	I agree they'd help me see that, I've never viewed them.	Neutral
4	I agree with most of these, yet I rarely used the resources. Still helpful though.	Neutral
5	My dad likes chocolate	Not Interpret
6	I hate [other teacher]*	Not Interpret

* The name of the teacher has been removed for confidentiality.

23. What I am learning in Mr. Heflin's science class may be helpful in my future career.

Answer Options	Response Count	Response Percent
Agree	34	42.0
Somewhat agree.	30	37.0
Somewhat disagree.	9	11.1
Disagree.	8	9.9
Total	81	100
Skipped question	0	0.0
Student Comments	11	13.6
Students Not Commenting	70	86.4

	Student Free Response Comments	Classification
1	I have been considering something in the medical field lately so I might be learning something useful.	Neutral
2	I mean, unless I end up writing hard Science Fiction...	Neutral
3	No doubt in my mind.	Positive
4	Might go into something science related.	Neutral
5	I learned more in this class than any other science class I had yet.	Positive
6	If I go into architecture or anything like that it would be good to know.	Neutral
7	Not really sure what I'm planning to be when I get older so I'm not really sure.	Neutral
8	Haha, I don't think I'm going to be a scientist	Neutral
9	My mom likes chocolate	Not Interpret
10	Not really sure what my career should be yet.	Neutral
11	I hate [other teacher]*	Not Interpret

* The name of the teacher has been removed for confidentiality.

24. On average, how often does your parent or guardian look at Mr. Heflin's webpage?

Answer Options	Response Count	Response Percent
Never	60	74.1
Very Infrequently – once or twice a marking period	10	12.3
Infrequently – once or twice a month	2	2.5
Frequently – once or twice a week	2	2.5
Very Frequently – more than twice a week	0	0.0
I don't know how often, but they do check it	7	8.6
Total	81	100
Skipped question	0	0.0
Student Comments	19	23.5
Students Not Commenting	62	76.5

	Student Free Response Comments	Classification
1	I don't think they have ever looked at it.	Neutral
2	My mother should.	Neutral
3	I've never told my parents about your website.	Neutral
4	They don't even know you have web page	Negative
5	I keep track of my schoolwork	Neutral
6	They do not know it's there	Negative
7	I don't think they know about it...	Negative
8	I know that whenever I check it, my mother checks it with me to see what's going on in class and if she can help me with the topic we're learning.	Positive
9	When I need something explained to me my dad or sister looks at it to get ideas how to explain it to me........	Positive
10	No idea	Neutral
11	Not sure	Neutral
12	She doesn't know about the teacher web pages	Negative
13	My parents never do	Neutral
14	Parents never seen the site, I do most of this stuff on my own.	Neutral
15	Hi Mr. Heflin!!	Not Interpret
16	My mom is too lazy and she's too obsessed with Zumba to do that....	Not Interpret
17	She's way clueless about that stuff	Not Interpret
18	I still hate [other teacher]*	Not Interpret
19	Yea Dawg	Not Interpret

* The name of the teacher has been removed for confidentiality.

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Appendix G - Teacher Webpage Activity Information

The software program Google Analytics® was utilized to quantify the number of times the teacher's webpage was accessed during the last 18 days (March 12 – March 30) of the research study. The software program was also able to calculate the average time spent on the webpage for all the internet users during the specific time frame. Google Analytics® summarized the origins of the internet users accessing the teacher's webpage by city (in the United States) and the country (if not from the United States). All the information was recorded and is displayed in Appendix F. (Note: the teacher was not familiar with Google Analytics® until March12, which was the first day Google Analytics® was implemented).

Google Analytics

jheflin - https://sites.google.com/a/ol...
jheflin [DEFAULT]

Visitors Overview

Mar 12, 2012 - Mar 30, 2012

% of visits: 100.00%

Overview

146 people visited this site

Visits: **443**

Unique Visitors: **146**

Pageviews: **1,239**

Pages / Visit: **2.80**

Avg. Visit Duration: **00:03:06**

Bounce Rate: **16.93%**

% New Visits: **32.96%**

67.04% Returning Visitor
297 Visits

32.96% New Visitor
146 Visits

	Language	Visits	% Visits
1.	en-us	430	97.07%
2.	(not set)	13	2.93%

view full report

Google Analytics

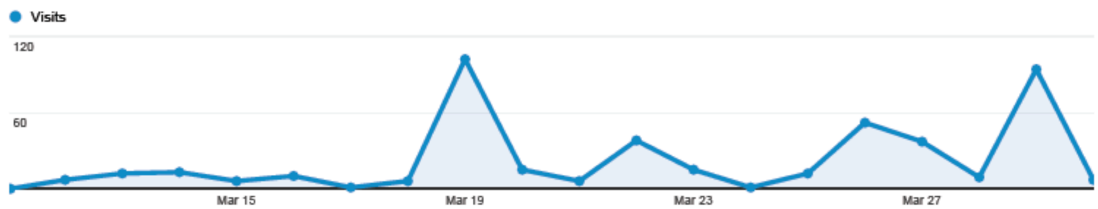
jheflin - https://sites.google.com/a/clkschools.org/mr-heflin/
jheflin [DEFAULT]

Audience Overview

Mar 11, 2012 - Mar 30, 2012

% of visits: 100.00%

Overview



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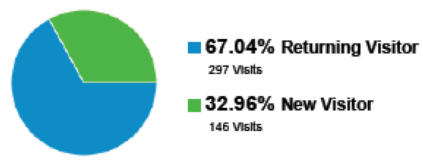

	Country / Territory	Visits	% Visits
1.	United States	440	99.32%
2.	Canada	1	0.23%
3.	Germany	1	0.23%
4.	Malaysia	1	0.23%

view full report

Google Analytics

jheflin - https://sites.google.com/a/clkschools.org/mr-heflin/
jheflin [DEFAULT]

Audience Overview

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% of visits: 100.00%

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67.04% Returning Visitor
297 Visits

32.96% New Visitor
146 Visits

	City	Visits	% Visits
1.	Calumet	354	79.91%
2.	Houghton	49	11.06%
3.	Green Bay	10	2.26%
4.	Appleton	9	2.03%
5.	Traverse City	6	1.35%
6.	Marquette	3	0.68%
7.	Chicago	2	0.45%
8.	Rexdale	1	0.23%
9.	Stuttgart	1	0.23%
10.	Johor Bahru	1	0.23%

view full report