

HYBRID LEARNING: A STUDY OF THE IMPACTS FELT BY STUDENTS AND
VETERAN TEACHER ALIKE DURING THE COMPLETION OF A HYBRID
ONLINE MODULE RICH IN 21ST CENTURY SKILLS

by

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A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2012

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July 2012

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ABSTRACT

A hybrid online unit was built by the researcher and implemented by a host teacher with the purpose of identifying the impacts hybrid methodology has on students and veteran teacher alike. The hybrid unit, which combines traditional classroom instruction with the best-of online course tools and activities, was implemented into a 7th grade science elective classroom located in rural Montana over the course of 16 weeks. The host teacher possessed a doctorate in education and concurrently instructed online graduate courses in Action Research. Neither the host nor students had prior experience with hybrid instruction. The hybrid course topic focused on climate science and was designed congruent to 21st century technology standards. The unit included a wide variety of vibrant online activities coupled with face-to-face classroom interactions and hands-on science labs. All student work, whether online or face-to-face, was completed digitally and uploaded within the online course. Data was collected from a variety classroom assessment techniques including student performance on summative assessments, frequent student surveys, host teacher journaling, host teacher interviews and surveys, researcher observations, and researcher journaling. Partial member checking was utilized for verification of data collection and analysis. In the end, an overwhelming majority of students preferred hybrid instruction to traditional classroom instruction. A majority of students found the course to be fun, easy to navigate, and they felt they remembered more from hybrid than traditional lecture or bookwork. Students showed strong academic gains in climate science topics, especially historically low performing students. The host teacher enjoyed the diverse curricular activities and approved using the unit again in future elective classes. The host also indicated interest in experimenting with creating his own hybrid course in future academic years once technology resources became more readily available. As a result of the hybrid unit implementation, the host teacher also noted secondary observations in students' improved computer literacy, problem solving, and expository writing skills. At the outcome of this study, it was evident that hybrid instruction benefits students in a variety of manors thus instructors should consider this methodology as technology becomes increasingly available within classrooms.

INTRODUCTION AND BACKGROUND

Project Background

Online learning is sweeping across America. In the year 2000, roughly 45,000 K-12 students took an online course. In 2009, more than 3 million K-12 students did. What was originally a distance-learning phenomenon no longer is. Most of the growth is occurring in blended-learning environments, in which students learn online in an adult-supervised environment at least part of the time. As this happens, online learning has the potential to transform America's education system by serving as the backbone of a system that offers more personalized learning approaches for all students. (Horn & Staker, 2011, p. 1)

Blended education is a relatively new concept, which emerged from the inclusion of online coursework in traditional brick-and-mortar schools. The term is utilized loosely by school administrators and policy makers to describe a wide spectrum of potential uses; such as to augment course offerings with online classes in small rural schools; to provide heightened temporal flexibility for large open-campus style high schools; to provide greater differentiation possibilities within individual classrooms; or to create hybrid learning environments where the teacher carefully designs curriculum by meshing a variety of online tools within the traditional class pedagogy. In the book *Disruptive Class*, the authors Christensen and Horn (graduates of Harvard's Business School) utilize mathematical algorithms to project that by 2019, 50 percent of all high school courses will be delivered online (Christensen, Horn & Johnson, 2011). Christensen likens the online phenomenon occurring in K-12 education to a disruptive technology, which is a

market changing advancement similar to the emergence of mp3 player technologies such as the iPod. Horn and Staker (2011) have tracked similar effects of the online disruption in home schooling, “A simultaneous explosion in home schooling – from roughly 800,000 students in 1999 to roughly 2 million today – was fueled by the rise of online and full-time virtual schools,” (Horn & Staker, 2011, p.1).

However popular, online classes do not necessarily provide the “silver bullet” to educational reform. “Full-time online schools also present certain challenges. A significant problem in Colorado is the academic performance of students in online schools relative to their peers in brick-and-mortar schools,” (Anderson & Skrzypchak, 2011, p.5).

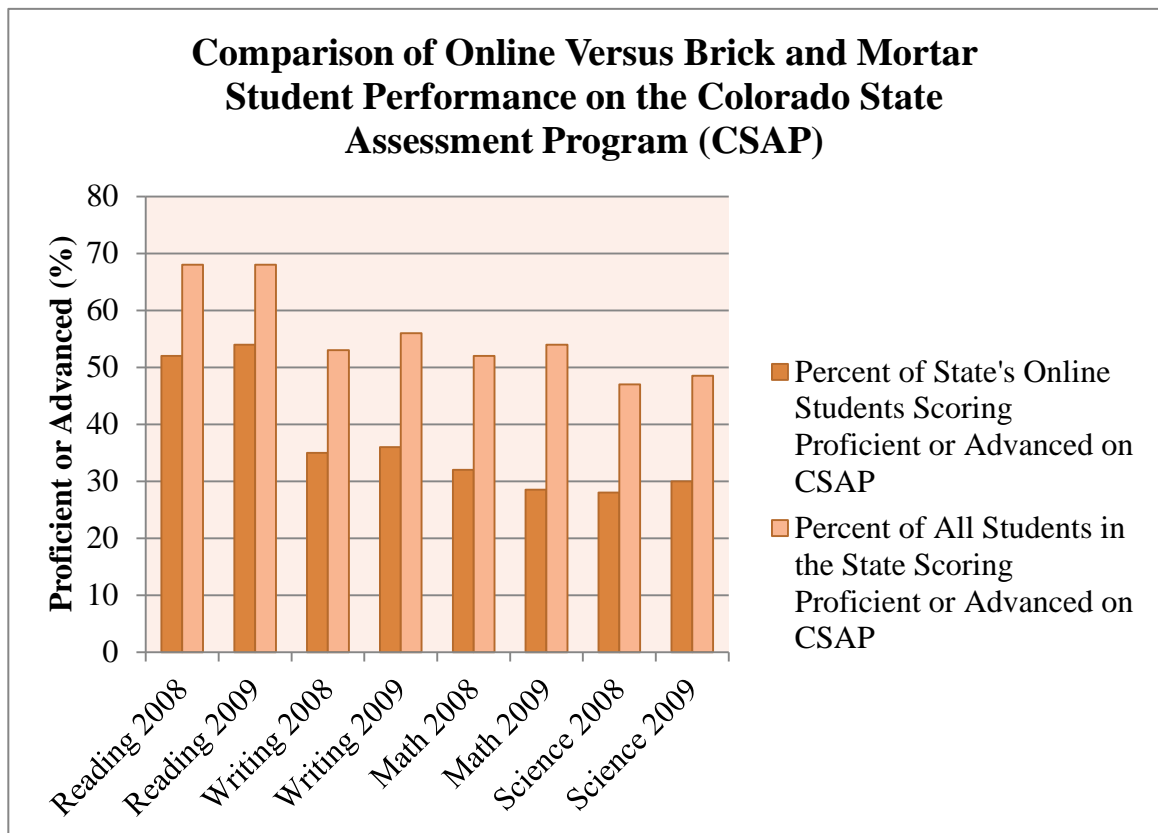


Figure 1. Percent of students scoring proficient or advanced in 2008 and 2009.

Statewide Colorado CSAP Exams in Full-Time Online Schools Relative to All CO Public Schools, (statewide averages; full time online 2008 $N = 10,290$; 2009 $N = 13,097$)

(adapted from Anderson & Skrzypchak, 2011, p. 5).

According to Figure 1, it is evident that online courses offered in Colorado fail to demonstrate proficient achievement levels on par with brick-and-mortar classrooms in all common core subjects tested by CSAP. Over 10,000 students were measured in each year, thus the researcher assumes that this sufficiently represents a diversified cross section of student demographics for valid comparison.

A recent study titled, *Evaluation of Evidence-based Practices in Online Learning: A Meta-analysis and Review of Online Learning Studies*, which was conducted by the U.S. Department of Education, compared 50 research findings regarding the success of online, face-to-face (f2f), and hybrid educational approaches. Their report suggests relative equality exists between the achievement fostered by online and f2f strategies, however blending online tools within f2f classrooms (hybrid) demonstrated significantly greater levels of achievement (Means, Toyama, Murphy, Bakia & Jones, 2010). “The mean effect size in studies comparing blended with face-to-face instruction was $+0.35$, $p < .001$. This effect size is larger than that for studies comparing purely online and purely face-to-face conditions, which had an average effect size of $+0.05$, $p = .46$ ” (Means et al., 2010, p. 17). The authors do point out that these findings are based on a limited number of studies, many of which were generated outside of K-12 settings such as in collegiate or medical training courses. The authors also noted that many of the current published findings regarding online success in K-12 are frequently biased because students self-selected themselves into the online course realm. When students are *required* to

complete an online course, regardless of their learning preference, student success often becomes feast or famine. Anywhere from 20 to 50% of first-time online students fail or withdraw from the course (Barbour & Reeves, 2009), while others who do complete their coursework may do so rather successfully.

The inclusion of online classes into the blended public school certainly has its history of success within unique niche populations. The content and experience delivered by online providers is also expected to continue to enhance with time. However, the seeming race for school districts and state programs across the country to introduce online course content provided by the flurry of new online companies demonstrates the decision by many to choose the lowest hanging fruit offered. Take for example Idaho, who recently introduced a statewide online program that offers to publicly fund the completion of all K-12 education delivered online through content provided by the company K¹². K¹² is a corporation which recently completed acquisitions of other major competitors and has quickly risen to become the largest provider of online content in the nation. K¹² also has a history of providing significant campaign contributions to state-level education directors in a variety of states it services. Idaho's board of education recently introduced a highly controversial mandate requiring all students to complete two online courses before graduation (Bonner, 2011, p. 1). "Proponents state that the new legislation will allow the state to save money and better prepare students for college and 21st century skills. But opponents claim they'll replace teachers with computers and shift state taxpayer money to the out-of-state companies that will be tapped to provide the online curriculum and laptops" (Bonner, 2011, p. 1). Public schools will ultimately feel

more stress to maintain seat numbers from the development and increased choice associated with home school options and online content providers.

Conversely, hybrid classrooms created and deployed by actual teachers have demonstrated the opportunity for superior performance over both traditional and online school options. They also provide similar or enhanced benefits regarding the preparation of 21st century thinking, problem solving skills, and computer literacy. It seems that these options have been overlooked by many, but not all. The Jefferson County School District near Denver, Colorado has created a unique opportunity for its staff to answer the call for digital classroom experiences.

The Jefferson County School District (Jeffco) has made professional development in online and hybrid instruction a priority. Jeffco has created a unique system of preparing current teachers for hybrid and online course instruction. By the end of 2010, 408 teachers had been trained in-house to teach online courses, through a six-week professional development program. Eventually, all Jeffco teachers will be trained in basic online instruction. During this professional development, teachers can elect to earn 2-3 graduate level credits for completing the online course training. The training mirrors online learning by being taught as a hybrid course, where teachers take weekly lessons online, and meet in person three times over the six-week course. Teachers are taught how to navigate the Blackboard online learning system and given deep instruction on developing the student-user experience. Teachers are able to view the portals and online platforms as their students would, to gain a clearer understanding of how their students will navigate their course. After initial professional development in online learning, teachers

can self-identify to become full-time online teachers. They are then mentored through a series of virtual and face-to-face development sessions. Teachers are given instruction and support on how to utilize programs like Response to Intervention from a virtual platform, as well as identify challenges, such as when it appears that students aren't being engaged or successful online. The professional development continues on a monthly basis, and teachers are given the opportunity to work with other instructors in their specific content areas. (Anderson & Skrzypchak, 2011, p. 15)

The following is a personal memoir of events describing the successes, challenges, and ongoing development of a recent start-up alternative school utilizing a variety of blended education approaches. This school's evolution with blended strategies epitomizes what current researchers predict a majority of larger mainstream schools will progress through over the course of the next decade. Between 2007 and 2011, I was recruited and employed as the master teacher to assist in creating, designing, and instructing in the nation's first public ski academy titled the Vail Ski & Snowboard Academy (VSSA) located within the Eagle County School District near Vail, Colorado. Starting the secondary school with 2.5 teachers and 38 students presented plenty of growing pains. In the first two years, the school relied heavily on outsourcing students to online courses due to our limited staffing. There would have been no possible way to initiate this public sport-specific school experiment based on public funding without the flexible advantages offered by online coursework due to the school's relatively small initial student interest (many families hesitated to enroll students until they witnessed a year or more of success from the newly created school). Students who weren't in an f2f

class offered during a specific period, such as science, English, or math, sat in the back of the classrooms completing online elective courses using their laptops. Students had no choice but to complete one to three online courses each semester to fulfill their elective requirements for graduation. Online course topics commonly included web design, art, photography, health, history, and a few students were forced to complete algebra II or pre-calculus. An outside charter school titled Colorado Online Learning (COL) initially facilitated these courses. Later corporate providers titled Aventa and K¹² provided the coursework. Many students struggled immensely with completing online content, especially if it was their first-ever online course. VSSA experienced an approximate 20% attrition rate for newly enrolled students in the first two years due to expressed disinterest or incapability with the online classes provided. This attrition rate is congruent with other K-12 schools and universities. Barbour and Reeves cite attrition rates of 25 – 50% in the first two years of Florida’s Virtual K-12 online offering (Barbour & Reeves, 2009). Another study points out that less than 4% of degree-seeking adults complete their degree from the University of Phoenix within 6 years (Haigh, 2007).

Meanwhile, a unique opportunity existed at VSSA since students were required to bring their personal laptop computers to class each day. Several of VSSA’s teachers (myself included) became well versed at creating our own hybrid forms of blended classrooms, seamlessly meshing the “best of” online tools and strategies into the “best of” brick-and-mortar classroom pedagogy. Students benefitted from a knowledgeable “live” instructor guiding them through the use of computer technologies, answering questions, forming unique class discussions, and facilitating appropriate real-time modifications if necessary. Creating a hybrid environment effectively provided creative control of the

curriculum while allowing students to continue to participate asynchronously during their travels abroad for athletic competitions.

Hybrid classrooms also benefit instructors by creating opportunity to design more critical questions, students have more time to formulate thoughts and opinions, and since nobody can hide in an online environment – everyone must participate (Heubeck, 2008). Other advantages include developing 21st century problem solving skills, computer literacy, dynamic digital grouping options, rich student-student collaborations, collaborations with real-world professionals, the flexibility for teachers to author media-rich course content specific to the needs and interests of the students, immediate feedback and support following assessments, heightened differentiation opportunities, and creative temporal flexibility wherein students analyze, critique and improve upon prior year's student work and discussion responses.

Below are results of a voluntary survey deployed in 2010 to compare student attitudes and perceptions regarding online and f2f hybrid courses (original survey located in Appendix A). Seventeen students were surveyed, all of which had successfully completed online courses in previous semesters.

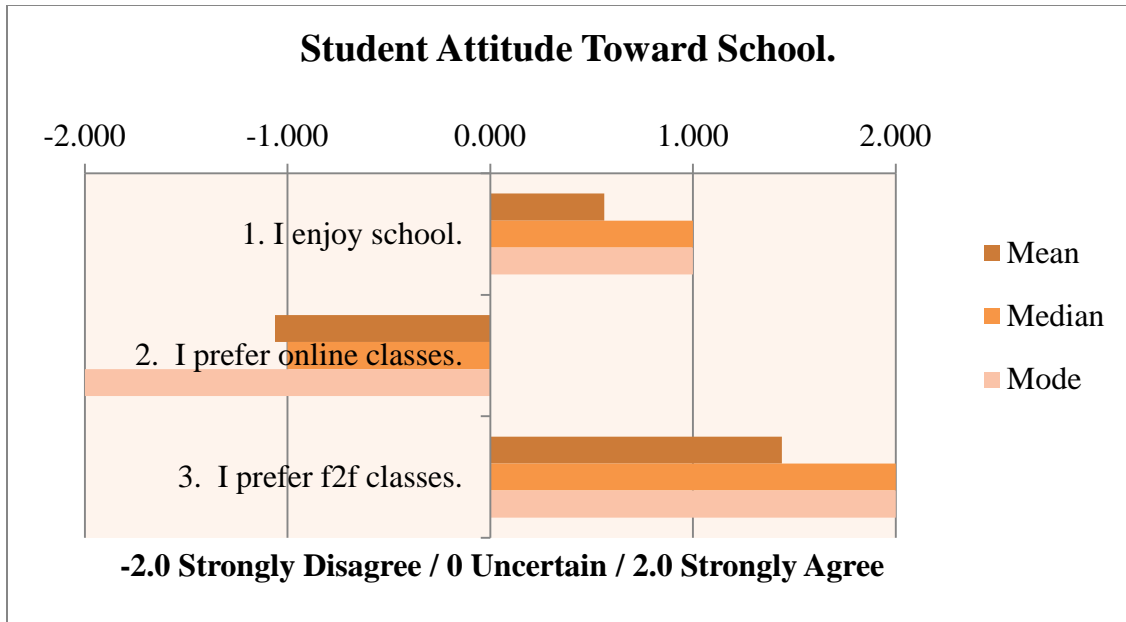


Figure 2. VSSA student attitudes regarding f2f hybrid and online classes, (N = 17).

Figure 2 demonstrates students’ dislike for classes offered online and appreciation for f2f classes utilizing hybrid approaches.

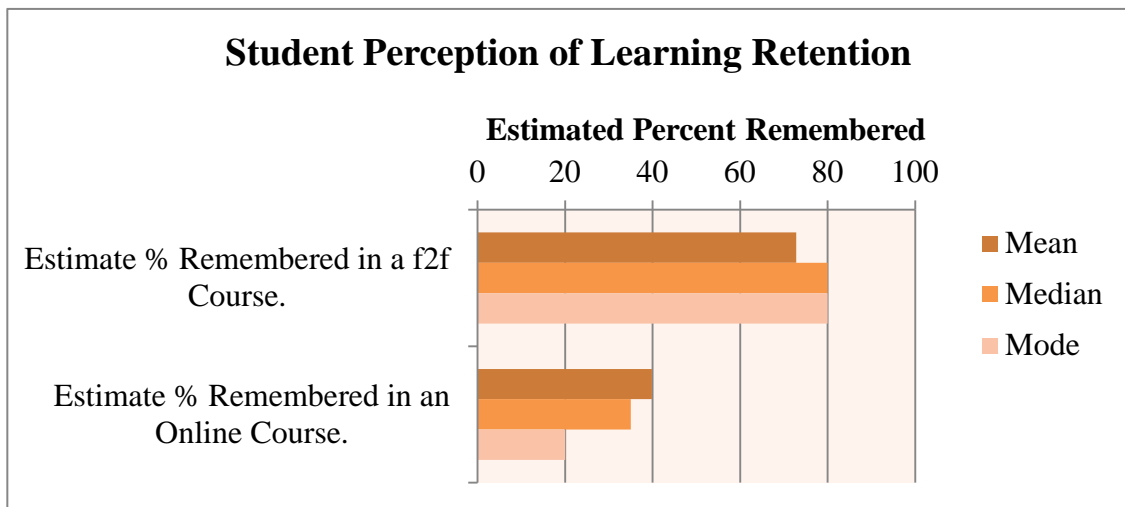


Figure 3. VSSA student perception of learning retention in f2f hybrid and online classes, (N = 17).

Figure 3 demonstrates students’ meta-cognitive evaluation for their learning. Actual percentages of information learned, in reality, are likely different than students’ perceived value, however it is important to note the pessimistic attitude that these

students maintain toward early versions of online course products provided by COL, Aventa, and K¹².

As the school evolved, it rapidly grew to 150 students and 11 staff members by year five (interestingly, this rapid growth came simultaneously during massive state and local education cut backs during the 2008 financial crisis). With additional staffing, the number of online offerings became intentionally limited to foreign language topics; these students completed online French or Spanish in a room with a certified foreign language teacher whose job description was to merely provide basic question-and-answer support. The school attracted 50% of its athletic population from out-of-county or out-of-state locations. These relatively privileged students typically moved from three types of environments; private ski academies who charged upwards of \$50,000 for tuition; students from home school backgrounds; or students transferred from expensive tutorial programs that assisted with school work provided by their parent school. The other 50% of VSSA's population were students originating locally from the Vail Valley who chose VSSA as a "school of choice" offered by the public school system. Regardless of their background, a majority of these kids entered VSSA with test scores typically ranging at or just above state and nationwide averages. Since its creation, VSSA successfully matriculated 100% of its students to universities including Harvard, Dartmouth, Middlebury, Denver University, and a variety of state universities throughout the nation. Meanwhile, over 40% of the students graduating in 2011 (the original freshmen class upon creation) successfully advanced to the next level of athletic competition either for the US Ski and Snowboard team or for Division I collegiate ski teams, including a 12th place finisher at the 2009 Vancouver Olympics. Big-ticket test scores, such as

Colorado's CSAP and ACTs, were closely aligned with state averages in year one. By year four, the school placed amid the top 2% of ACT scores amongst all secondary schools in the state of Colorado (test results were gathered from 17 students who were all enrolled in the program for 3 or more years) (Grimmer, 2011). All this from a *public* school utilizing a variety of blended and hybrid practices to flexibly meet the demanding needs of competitive ski and snowboard athletes who spent weeks (and even months) traveling the world for competitions during the academic school year.

In retrospect, VSSA followed a pathway recently predicted to occur over the next decade within the broader context of the nation's educational landscape by Christensen, Horn, and Johnson, authors of *Disrupting Class*. They predict that *phase one* for the adoption of online content will occur in the mainstream for lesser-valued courses, such as health or elective classes due to a variety of reasons including the tightening of school budgets, etc. (Christensen et al., 2011). However, online providers will only be able to rapidly fulfill a niche market demographic. Christensen et al. (2011), maintain that online providers will struggle to replace core courses that society values, such as math, English, science, and social studies because of pressures from teachers unions and the monolithic pipeline for which curriculum adoption occurs starting at each state's panel of curriculum experts. Ultimately, online providers will be forced to join the structures currently in place, resembling large textbook manufacturers creating content for the masses and losing the ability to specialize courses for individual learning styles due to the expensive nature. Oddly enough, the renaissance associated with Christensen's *phase two* will prosper from individual teachers within the schools and ultimately allow online education to continue to blossom changing education as we know it. Christensen et al.

(2011), predict that teachers will individually begin building unique course modules that will be available to other teachers through online networks similar to the iTunes online store. Other teachers will be able to rate and comment regarding the practicality and efficacy of the module much like current consumers comment in online shopping web sites. Teachers will then be able to select curriculum modules a la carte and deliver content specific for individual student learning styles (Christensen et al., 2011). Face-to-face teachers will not go by the wayside in Christensen's early to mid-21st century model, rather instructor roles will resemble facilitators as the "guide-on-the-side" rather than the "sage-on-the-stage" paradigm of the 20th century.

Since so many definitions are currently floating around in the educational realm regarding the use of online tools, let's take a minute to clarify the latter practice as Hybrid. From this point further, Hybrid Online defines teachers using online tools and activities between 30% and 70% of the time in the face-to-face classroom. Hybrid teachers fluently transfer between traditional pedagogical practices and the use of online content or activities within the same week or even the same day (similar to how a hybrid vehicle transitions between a gasoline engine or electric motor depending on conditions).

As the master teacher at VSSA, I regularly created weekly staff development opportunities highlighting and emphasizing research-based hybrid classroom strategies. I also completed routine weekly classroom observations and provided teachers with coaching feedback. I witnessed first-hand the ad hoc challenges, frustrations, successes, and inspirations experienced by colleagues coming from a myriad of technology backgrounds (or lack thereof). Teachers with rich background experiences in online technologies, typically arising from the successful prior completion of online undergrad

or graduate courses, were commonly quick to adopt and experiment with more complex hybrid practices in their own classrooms. These teachers maintained a positive outlook and strived to create complex digital grouping activities, media-rich student generated blogs and discussion boards targeting higher order thinking skills, and even experimented with weekly remediation or challenge activities to heighten differentiation opportunities for individual students, to name but a few. Meanwhile, colleagues with limited previous immersion in online educational technologies struggled to grasp the full potential of online tools available in their classroom. Many of these teachers were recognized and decorated by administration as “Outstanding Educators” within the traditional classroom realm, however they resisted and even derailed opportunities provided by the digital age. These teachers typically maintained a negative outlook and limited their experimentation with simple forms of student interaction through the use of basic web 2.0 sites, simple discussion board scenarios that generated little student discourse, or to simply warehouse and archived assignments online.

From these experiences, I am confident that hybrid education strategies, in the hands of prepared and willing educators, can successfully educate students with core knowledge requirements while simultaneously meshing necessary 21st century technology problem-solving and communication skill sets. However, without buy-in and exposure to high quality pedagogical practices, talented teachers potentially will misunderstand or fail to recognize the true potential that exists in today’s digital classroom.

Developing a hybrid curriculum does requires significant effort and sweat equity from the teaching staff and administration, but momentous advantages do exist due the

fact that teachers witness student success and frustrations real time providing the opportunity to modify on the fly, which characterizes one of the true arts of the teaching profession. In my personal extensive experience observing and assisting adolescent students completing courses delivered online by charters or companies such as Aventa and K¹², the lag and/or lack of response by the outside online instructor to adjust and improve educational content is stifling at best to the student's ability to progress at their full potential. With many teacher induction programs beginning to include specialized training in online content and pedagogy producing a talented new workforce, combined with the increased access to pads and laptops within schools, the time is ripe for teachers and school districts to explore creating personalized hybrid course content. Online learning management systems such as Blackboard's Coursesites provide teachers free opportunities to design online curriculum specific to the needs of the community served. Groups of teachers within the school have the option to divide the labor associated with developing hybrid curriculum then sharing freely amongst each other or with other schools. Meanwhile, teachers possess the ability to continue further personalizing the content specific to each teaching style as well as to the individual classroom population's needs. Currently, mainstream online providers do not freely allow their content to be personalized by teachers, which is a significant drawback.

My research purpose is to study the impact of an outside online consultant delivering a 16-week hybrid online module rich in 21st century skills into a decorated veteran host teacher's 7th grade science class located in rural Montana. The impact felt by both the teacher and students during the first-time inclusion of hybrid classroom activities will be analyzed. This experience will provide deeper personal insight into

prospective careers in the professional development of hybrid online modules and or options in digital education consulting services. Furthermore, significant trends uncovered in this study may assist school administrators and teachers choosing to experiment with hybrid learning strategies.

Research Question

What are the impacts of an outside online consultant delivering a hybrid online unit to a veteran science teacher for daily class implementation?

Research Sub Questions

- How are student engagement, attitude, and achievement levels characterized while participating in their first hybrid online module?
- What are the challenges and successes experienced by the host face-to-face teacher?
- What are the challenges and success experienced by the online consultant?

CONCEPTUAL FRAMEWORK

Overview

Schools across the country are being influenced to reform current practices by implementing 21st century technology and information literacy skills into the daily interactions with kids. The design philosophy for the hybrid online module used in this action research project will include activities consistent with several 21st century technology standards including literacy in computers, information, environment, and civics along with critical thinking and problem solving, digital age communication, and

collaboration opportunities. The following sections discuss: the basis for the 21st century reform, the challenges education in the 21st century presents to teachers, a breakdown of the skills students need for tomorrow's workforce, best practices and tools for online learning, and a general summary of content and classroom activities that will be used to emulate these standards within the hybrid module implemented in the research study.

21st Century School Reform

A plethora of responsibilities are placed on educators, including but not limited to: curriculum design and instruction, grading, athletic coaching, continual parent communications, serving as role models, mentoring and counseling roles, preparing students to fill in bubbles for federally mandated tests, and arguably one of the most important - preparing students with workplace skills. Due to exponential cultural changes associated with the Information Age that have occurred almost overnight, preparing students for success in the 21st century has taken a dramatic turn. A quote taken from a popular YouTube video titled "Did You Know / Shift Happens" characterizes the new charge to educators. "We are currently preparing students for jobs that don't yet exist, using technologies that haven't been invented, in order to solve problems we don't even know are problems yet" (Fisch, 2006). Fisch, a high school teacher in Denver, Colorado, created the "Did You Know?" video in 2006 to welcome an auditorium full of teachers back to the new school year. Fisch's popular quote characterizes the uneasy mood spreading throughout the K-12 educational landscape. Realizations in the last five years suggest that America's schools and educational practices prepare students for antiquated workplace skills. In addition, federal mandates

such as No Child Left Behind successfully narrowed the scope of education but have done little to prepare or lead students into the 21st century. Bill Gates, founder of the Microsoft Corporation, delivered a blow to the American educational system in his speech at the National Summit on High Schools in 2005.

America's high schools are obsolete... by obsolete, I mean that our high schools, even when they're working exactly as designed, cannot teach our kids what they need to know today. Training the workforce of tomorrow with the high schools of today is like trying to teach kids about today's computers on a 50-year-old-mainframe. It's the wrong tool for the times. Our high schools were designed fifty years ago to meet the needs of another age. Until we design them to meet the needs of the 21st century, we will keep limiting, even ruining the lives of millions of Americans every year. (Gates, 2005, para. 10)

The educational reforms called for in the 21st century are a result to the dramatic changing landscape of business and social culture brought on by advancements in the Information Age. Today's youth probably never listened to a cassette tape or watched a movie on VHS. Today's youth carry phones with more processing power than all the computers used to plan and run the early space missions. Information is literally at their fingertips - the 140 million books, photographs, movies, and other documents of the U.S. Library of Congress can now fit on a digital tape cassette. Information throughout the world is currently *doubling* every 72 hours! And information can be accessed with blazing fast speed - all the books ever written can be transmitted over an optical fiber the width of your hair in just a couple of seconds (Trilling & Fadel, 2009).

Many educators, parents, and politicians have a great deal of difficulty understanding that the world is different than the world they experienced when they grew up. ... It's easy to understand why so many older people have missed the significance of what has happened. This major shift to the online Information Age happened suddenly. In the early 1990's, a number of exponential trends came together with remarkable rapidity to provide us with the amazing online world and relatively inexpensive digital tools to access it. In the few short years since then, the ways people communicate, do business, get information, and entertain themselves have all been radically transformed by this online digital revolution. (Kelly, McCain & Jukes, 2009, p. 17)

21st century educational reform is needed to better prepare our students for the challenges they face in a workforce that is rapidly changing. Basic knowledge and fundamental skills in each discipline (science, math, English, social studies, etc.) will remain an important facet in the 21st century, however teachers will need to weave foundational content knowledge together with hands-on opportunities using new technologies in order to better prepare today's youth. The following describes the challenging landscape our youth faces.

The fundamental unit of the new economy is not the corporation, but the individual. Tasks aren't assigned and controlled through a stable chain of management, but rather are carried out autonomously by independent contractor, e-lancers, who join together into fluid and temporary networks to produce and sell goods and service. When the job is done... the network dissolves, and its

members become independent agents again, circulating through the economy, seeking the next assignment. (Peters, 2001, p. 11)

State and federal initiatives, along with non-profit and private organizations are beginning to lead. President Obama recently made this charge:

I'm calling on our nation's governors and state education chiefs to develop standards and assessments that don't simply measure whether students can fill in a bubble on a test, but whether they possess 21st century skills like problem-solving and critical thinking and entrepreneurship and creativity. (President Obama, 2009, para. 20)

Several organizations answering the call include the Partnership For 21st Century Skills (P21) and the International Society of Technology in Education (ISTE). Both P21 and ISTE provide excellent frameworks, standards, and resources for school district administration and teachers choosing to enhance and correlate with 21st century skill sets. These frameworks served as the basis for the design of the hybrid 'climate change' module content and activities and will be introduced in a later section.

Challenges of 21st Century Education

The following is a common adage heard in the educational setting: "Teachers teach in the manner they are accustomed to learning." It turns out that this "belief" is more closely related to the truth than we may have ever previously held. Relatively new discoveries in how brain synapses are networked, called neuroplasticity, demonstrates the brain's amazing ability to reorganize how it processes information based on new input.

If the brain encounters a new kind of input for sustained periods of time on a daily basis for an extended period of time, it will reorganize neural pathways to handle the new input more effectively. This is what happens when a child learns to read. With sustained exposure to textual input on a daily basis, the child's brain reorganizes how the brain processes this new input so the brain can make sense of it. In the same way, kids growing up in a digital world are being exposed to new kinds of input from digital experiences for sustained periods of time on a daily basis. Consequently, their brains are reorganizing to handle the digital environment more effectively. This is creating a huge problem in our schools. Kids are quite literally thinking differently than those who teach them. (Kelly et al., 2009, p. 23)

Will Richardson, author of "Blogs, Wikis, Podcasts" characterizes today's learners as *parallel thinkers* due to their ability to leap around and process information nearly simultaneously from a variety of sources. Meanwhile, non-digital adult educators are more sequential or *linear thinkers* (Richardson, 2009). Table one highlights some of the key differences that exist between the way digital kids process information and learn and the way non-digital adults teach.

Table 1
Comparison of the Learning Styles of Digital Learners and Nondigital Adults (Adapted from Kelly et al., 2009, p. 23)

Digital Learners	Nondigital Adult Teachers
Digital learners prefer receiving information quickly from multiple multimedia sources.	Many nondigital adults prefer slow and controlled release of information at conventional speed and from limited sources.
Prefer parallel processing and multitasking.	Many prefer singular processing and single or limited tasking.
Prefer active, engaged learning.	Many nondigital teachers have more experience with passive learning such as lectures.
Prefer processing pictures, sounds, and video before text.	Many prefer to provide text before pictures, sounds, and video.
Digital learners prefer random access to hyperlinked multimedia information.	Many nondigital teachers prefer to provide new info linearly, logically, and sequentially.
Prefer to network simultaneously with many others.	Many nondigital teachers prefer students to work independently before they network or interact.

Widespread adjustments need to take hold throughout all levels of our educational system to meet the needs of tomorrow's youth. Teacher induction programs, staff development, and school administration need to adjust to the new pedagogical theory and practice of hybrid learning strategies and 21st century skills. P21 calls for the following tenants displayed in Figure 4 to be adopted by educators.

Use technology comprehensively to develop proficiency in 21st century skills.

- Knowledge of core content is necessary, but no longer sufficient, for success in a competitive world. Even if all students mastered core academic subjects, they still would be woefully underprepared to succeed in postsecondary institutions and workplaces, which increasingly value people who can use their knowledge to communicate, collaborate, analyze, create, innovate and solve problems. Used comprehensively, technology helps students develop 21st century skills.

Use technology comprehensively to support innovative teaching and learning.

- To keep pace with a changing world, schools need to offer more rigorous, relevant and engaging opportunities for students to learn - and to apply their knowledge and skills in meaningful ways. Used comprehensively, technology supports new, research-based approaches and promising practices in teaching and learning.

Use technology comprehensively to create robust education support systems.

- To be effective in schools and classrooms, teachers and administrators need training, tools and proficiency in 21st century skills themselves. Used comprehensively, technology transforms standards and assessments, curriculum and instruction, professional development, learning environments, and administrations.

Figure 4. P21 technology implementation recommendations, (Adapted from Partnership for 21st Century Skills, 2011, p. 3).

On average, teachers born after 1990 (digital natives) will likely adapt the easiest to new tech-based pedagogical opportunities; meanwhile teachers born prior to 1980 (technology immigrants) will likely find that shifting their pedagogical approach is more daunting.

If the adults involved in education are willing to do this (embrace the new digital reality), it will have three enormous benefits. First, instruction in the classroom will become more relevant to students because it will be linked to their world. It's very simple-if we can't relate to the digital world of our students, then we can't make schools relevant. Second, by exploring the digital world, teachers will be able to discover powerful new electronic tools that will enhance the learning experience for their kids. These include games, simulations, new ways for

students to publish their work, entirely new ways to access and process information, and new ways for students to communicate and collaborate. Some of these tools exist today, and more will certainly appear in the near future. Third, teachers will be able to bring the wisdom of their experiences to guide students in using the new digital tools that are cascading onto the market. Right now, the kids are way ahead of adults, in the use of digital tools, so they are defining the parameters of the how, when, where, what, and why these tools are used. (Kelly et al., 2009, p. 22)

These adjustments are likely to be an uphill battle especially for non-digital adults. I mentioned earlier in my personal memoir regarding working at VSSA that frustrations were common among several non-digital teachers. They were likely resistant and prepared to sabotage digital tools due to feeling overwhelmed by the need to reinvent their traditional curriculum using 21st century skills and technologies. However, many educators that successfully make it over the hump with 21st century activities find that they'll "never go back" (Boss & Krauss, 2007, p. 3). While attending the Computer Using Educator Conference in 2011, I shared VSSA's frustrations with Michael Horn (coauthor of *Disrupting Class*) in a personal conversation. His advice was simply to provide emerging hybrid online teachers with premade online content so that they aren't initially beleaguered. An emerging hybrid teacher can utilize premade content to get right to business experimenting with these new tools and strategies in their classroom (M.B. Horn, personal communication, March 18, 2011). This brings us back to the focus of this action research project: studying the impacts of an outside consultant delivering a hybrid online module rich in 21st century skills to a host teacher's classroom.

21st Century Workforce Skills

In order to help guide non-digital and digital educators alike, ISTE worked in conjunction with businesses to develop National Education Technology Standards (NETS) for students in 2007. The editor granted permission to reproduce these standards (Appendix B). The curricular activities contained in the climate change module will emphasize skills described by NETS for students and will be referenced in a later section.

When it comes to embracing new technology standards, teachers don't need to throw the baby out with the bathwater. Many of the curricular activities they already possess in their file cabinets can be easily and effectively transposed into the digital realm. Teachers may be surprised to discover new life breathed into their old assignments based on increased student motivation and engagement when using digital tools. Meanwhile, teachers can provide routine mentorship guiding students in the online realm while also introducing skills for appropriate usage of technology. We should be cautious to point out that classrooms still need to evoke interpersonal interactions, hands-on activities, and meaningful classroom discussions among students and teacher; however non-digital educators will be surprised to find that these interactions tend to be richer once students have time to process the information introduced through daily digital activities. Teachers will also encounter limitless new possibilities with tech tools providing increased differentiation, collaboration, communication, information access, creativity, and accountability in the classroom.

Best Practices and Tools Common in Hybrid Online Courses

While developed standards exist regarding the necessary skills associated with the use of technology in education, there is an unfortunate void with regards to “best practice” guidelines for teachers in the online realm. A comprehensive meta-analysis reviewing open access literature completed by Cavanaugh, Barbour & Clark in their report titled: *Research and Practice in K-12 Online Learning*, found little with respect to best practice techniques. In fact they called for the need for pedagogical research to be completed in the K-12 realm due to its rapid industry growth (Cavanaugh, Barbour & Clark, 2009). Meredith DiPietro, who was a doctoral candidate in Educational Technology at the University of Florida, completed the closest report associated with pedagogy in online K-12 settings. Her report published in 2008 titled *Best practices in teaching K-12 online: Lessons learned from Michigan Virtual School teachers*, summarizes important online teacher behaviors and characteristics collected from 16 high quality virtual-school teachers. Several of her key findings applicable to hybrid teachers are listed in Figure 5 below.

Instructional Topic	Educator Behavior or Characteristics
General Characteristics of Teachers	Teachers go the extra mile to support learning.
	Skilled in the basic use of technology.
	Interested and enjoy experimenting with new technologies.
	Flexible with their time.
	Have extensive knowledge of the content area they teach.
Virtual Classroom Management Skills	Use appropriate strategies to manage abusive student behavior in public forums of the course.
	Monitor forums in the course to identify students in personal crisis.
Pedagogical Strategies: Assessment	Use multiple strategies to assess student learning.
	Use alternative assessment strategies to accommodate various learning styles.
Pedagogical Strategies: Engage Students in Content	Build in course components to reflect the interests of students enrolled in the course.
	Motivate students by clearly organizing and structuring content.
	Embed deadlines within the content structure to motivate students in self-paced courses.
	Provide students with multiple opportunities to engage content in ways that suit varying learning style.
Pedagogical Strategies: Making Course Meaningful for Students	Encourage and support communication between students.
	Seek out and make available a variety of supplemental support tools to meet the diverse needs of students.
Pedagogical Strategies: Communication and Community	Teachers model what ‘formal’ online communication looks like in discussion boards and emails.
	Effectively monitor the tone and emotion of their communication with students.
Technology	Purposefully tie the use of tools built into the course environment to state benchmarks to support student learning of content.
	Use content knowledge and knowledge of students to drive the integration of technology.

Figure 5. Key findings regarding behavior and characteristics of successful online teachers (DiPietro, Ferdig, Black & Preston, 2008, pp. 16-27).

Although DiPietro highlights important educator qualities necessary for successful online facilitation, her findings fall short regarding *specific* research based pedagogical strategies. Upon the outset of her study, DiPietro suggests the following: “A tremendous amount of exploration into technological pedagogical content knowledge was not fully explored. ... Namely, more research needs to be done that explores best practices within the context of specific content areas. This research would then help set the stage for exemplary practice or ‘best practices’ within virtual schooling” (DiPietro et al., 2008, p. 28). Although online education has been in place for more than a decade, there is simply a lack of extensive formal research conducted on large sample sizes regarding best practice in the K-12 setting, however this is expected to change quickly.

Two K-12 teachers utilizing Action Research methodologies for a Master’s capstone for Montana State University recently converged on congruent statements regarding the benefits of a hybrid approaches. Megan Hopkins compared the use of information dissemination through lecture in one unit with textual content and guided questions delivered via Internet in another. Hopkins compared student notes, assessment performance, and behavioral implications throughout her study and found possible differences in learning associated by gender. Girls performed better in the lecture model and boys best during the computer delivery. Hopkins also realized that different forms of classroom management are needed for students when working independently from a computer. Ultimately, Hopkins found that students did best with hybrid instructional formats combining traditional lecture opportunities and online content. She attested that she plans to adapt these findings for her future teaching philosophy. Another Montana State University capstone authored by Christian Mills compared math scores from

traditional classrooms to fully online offerings in the school he worked at in Wyoming. Mills (2011) found satisfactory levels of student growth using the online option, but student feedback reported through questionnaires indicated that students would prefer a hybrid offering combining online content with a live instructor. Both of these studies indicated shifts by the instructor regarding the inclusion of online options in the traditional classroom. As more teachers begin to experiment with new delivery methods, we will certainly hear more success stories and ultimately increased understanding for pedagogical success.

In the last decade, there have been a few publications regarding creative uses and ideas for the implementation of new tech tools such as wikis, blogs, and discussion boards, however these resources commonly fail to provide specific best practice strategies or caveats. Another interesting resource was created by Blackboard, a company that provides online platforms for educators. The company created a unique rubric to judge exemplar online courses for its annual Catalyst Award. This rubric contains some excellent goals for online course design worth mentioning. A list of technology tools and strategies adopted from a variety of sources appears in Table 2. I felt it important to impart my personal knowledge regarding the use of tech tools as well, which are based on four years of extensive daily use in middle school and high school settings. I instructed a wide variety of 8th to 12th grade science and math courses utilizing one-to-one computing ratios using innovative techniques. In that time I was selected as a National Finalist for the Presidential Award for Excellence in Math and Science Teaching, demonstrated momentous growth in student ACT science scores that significantly exceeded the national average, instructed a number of students for several

years who matriculated to Harvard, Dartmouth, Middlebury, Denver University, along with variety of state universities, published in Vernier Technology's Innovative Lessons, served a year as a beta-tester for Blackboards' new Coursesites, and spoke on behalf of Blackboard at the 2011 Computer Using Educators Conference in Palm Springs, CA. I authored a majority of the content contained in Table 2 based on these extensive classroom instructional experiences; however, other work is cited within the table when appropriate.

Table 2

Hybrid Technology Tool Uses, Strengths, Caveats, and Suggestions

Blackboard Coursesites Learning Management System (LMS)

Uses:

- Houses a variety of native tech tools and collaboration devices.
- Ability to include mash-ups using an instructor's favorite web content.
- Serves as a repository for instructor made content.
- Students can download and upload work.
- Teachers can provide digital feedback within the Learning Management System (LMS).
- Includes plagiarism detection tools.

Strengths:

- Blackboard Coursesites is a free LMS that serves as a "one-stop shop" for educators. Educators can house anything and everything within the course portal.
- Teachers can reuse the course each year and share with colleagues.
- Prepares students for navigating in online platforms used commonly in higher education.

Caveats:

- Architecting an LMS requires significant time and work with the initial course building process.
 - Not necessary for teachers who simply dabble with the use of technology in the classroom.
 - Be prepared for 21st century excuses from students akin to "the cyber-dog ate my homework".
-

Table 2 Continued
Hybrid Technology Tool Uses, Strengths, Caveats, and Suggestions

Suggestions for classroom use:

- Frequently model blackboard navigation within the classroom.
- Introduce each semester with course navigation activities such as treasure hunts that require students to access all course areas. Have students practice uploading the treasure hunt assignment.
- Demonstrate course navigation and tool usage with screen movies that can be archived for later student review.
- Include dates in activity titles, e.g., [Course Treasure Hunt \[1/6/2012\]](#).
- Provide embedded navigation links in assignment descriptions when a student needs to move between areas of the course.
- Frequently and reliably update the course calendar to instill student trust with its accuracy.

Suggestions by Blackboard for Course Design:

The Blackboard company hosts an annual contest for exemplar online course design. The following suggestions were taken from the rubric Blackboard uses to evaluate exemplar courses ("Blackboard exemplary," 2012).

- Include objectives that are clearly written at the appropriate level.
 - Present content logically in manageable chunks or segments.
 - Include guided activities for learners to work in meaningful ways. Higher order thinking is explained with examples and or models. Individualized instruction, remedial activities, and resources for advanced learning are included.
 - Include plenty of opportunities for synchronous and asynchronous course communication. Synchronous communications benefit from real-time communication and should rapid-fire type responses. Asynchronous activities promote critical reflection or other high-level critical thinking opportunities.
 - Collaboration activities build a sense of community while building workplace-useful skills such as teamwork, cooperation, negotiation, and consensus building.
 - Assessments match the student objectives; rubrics or descriptive criteria for desired outcomes are provided (e.g., models of good work may be shown).
 - Many opportunities for self-assessment are provided; self-assessments provide constructive meaningful feedback.
-

Table 2 Continued
Hybrid Technology Tool Uses, Strengths, Caveats, and Suggestions

Discussion Boards

Uses:

- Students answer a prompt in a discussion board.
- Students read and reply to other student responses.
- Teachers can participate in the read-write activity too.

Strengths:

- Provides opportunity for all students to participate.
- Provides students with ample time to think, research, and reply to prompts.
- Provides teachers with deeper insight into the thinking of all members of the class (important formative assessment tool).

Caveats:

- Students need training regarding how to maintain a thread with their replies.
- Students may initially respond too informally using texting abbreviations e.g., : -) lol.
- Students may respond with improper emotion or harsh voice creating possible misinterpretations.
- Students may respond too briefly if the topic question is too factual in nature.

Suggestions for classroom use:

- Use synchronous discussion prompts for rapid-fire responses valuable for formative assessment and feedback ("Blackboard exemplary," 2012).
 - Utilize asynchronous discussion prompts for critical thinking challenges ("Blackboard exemplary," 2012).
 - KISS – Keep it short and simple. Long messages discourage interaction (Shank, 2007, p. 79).
 - Have students reply with “quote” in order to conserve the parent thread information (Shank, 2007, p. 79).
 - Ask students to create specific text-to-text references using other students’ comments (Shank, 2007, p. 79).
 - Think “value added”. Assist students in adding value to a discussion and avoiding short person-person replies such as “Thanks”, etc., (Shank, 2007, p. 80).
 - Ask students to include hyperlinks in order to reference their research much like they would in a written paper (Shank, 2007, p. 80).
 - Utilize open-ended questions. Avoid answers requiring a simple factual response.
 - Have students take a stance on a controversial issue.
 - Have students embrace an argumentative prose after they have been introduced to credible opposing viewpoints regarding a topic.
 - Reward students who can appropriately change the direction or theme of a discussion with new information or ideas.
 - Have students read, judge, and justify their favorite peer discussion threads both for and against a controversial topic.
 - Create a holistic rubric and demonstrate with exemplar models in order to establish benchmark expectations.
-

Table 2 Continued
Hybrid Technology Tool Uses, Strengths, Caveats, and Suggestions

Blogs

Uses:

- Used by many companies and individuals worldwide as an informal publishing tool. For instance CNN hosts a public blog below each online news item.
- Can be used for immediate synchronous feedback as all student responses appear on the same screen real time, which would be useful for teachers to formatively assess, conduct warm-up questions, etc.
- Students can create own blogs useful as a digital portfolio.
- Provides opportunity for peer review using the ‘comments’ feature associated with each blog.

Strengths:

- Can be published or viewable by select guests providing real authoring potential.
- Easy to create and edit by either teacher or student.
- Easy to incorporate media including video, pictures, and embedded content.
- Students and teacher can leave comments on other student blogs providing authentic peer review opportunities.

Caveats:

- Blog articles are indexed monthly or weekly, which can be confusing for students to locate if the course designer builds the activity months in advance.
- Blogs are organized by creation date. If used as a portfolio – it’s important that students have an organized plan for each page subject for logical flow prior to creation.

Suggestions for classroom use:

- Use synchronous discussion prompts for rapid-fire responses valuable for formative assessment and feedback ("Blackboard exemplary," 2012).
 - Synchronous formative assessments benefit from no distracting click to read function found in discussion boards.
 - Daily warm-ups; which can be archived for students to review later.
 - Individual student generated digital portfolios with rich multimedia potential.
 - Include an analytic rubric with specific gradable expectations. Create or display a model of exemplar work establishing benchmarks.
-

Table 2 Continued
Hybrid Technology Tool Uses, Strengths, Caveats, and Suggestions

Wikis

Uses:

- Collaborative online page allowing students to post text and media.
- Anyone can modify the content at a later time.
- Teacher can view a record of additions and edits by individual student.

Strengths:

- Creates dynamic digital grouping experiences where students can asynchronously contribute and edit a group document.
- Excellent for a digital jigsaw activity.
- Students can become empowered to judge and select content to create a digital textbook that can be preserved and improved upon over the years.

Caveats:

- Only one student can edit at a time. This is a significant roadblock if the teacher wants everyone working on the wiki at the same time. Works better if students add content for homework.
- Students can override other content if they open and work on a document for lengthy periods of time while another student publishes something in the mean time.

Suggestions for classroom use:

- Groups can post individual lab results, graphs, etc., making new findings available to the entire class.
 - Dynamic digital grouping. Break class into groups of four and give each group a topic to research and publish a wiki regarding. Group can use their wiki as a short presentation piece to the rest of class. Whole class can access later and review.
 - Dynamic class publishing tool. Class can create real time digital textbook that can be archived and used again in later years.
 - Include an analytic rubric with specific gradable expectations. Create or display a model of exemplar work establishing benchmarks.
-

Table 2 Continued
Hybrid Technology Tool Uses, Strengths, Caveats, and Suggestions

Teacher Generated Content Using SoftChalk

Uses:

- Simple web publishing tool that easily embeds into Blackboard course. Great for authoring individual eBook chapters.
- Easy to include images and embed video without slowing down a web browser.
- Able to embed short formative and summative assessment questions directly into the content.

Strengths:

- Teacher can create digital mini-eBook perfectly suited to their class populations' background and individual needs.
- Media mashup potential provides rich blend of content.
- Embedded quizzes, essay questions, and review games automatically send student score to the Blackboard grade book.
- Teacher has the option of allowing students to retake the embedded quizzes to improve score through a variety of options.

Caveats:

- None

Suggestions for classroom use:

- Teacher created mini-eBooks with embedded formative and summative assessments.
-

Table 2 Continued
Hybrid Technology Tool Uses, Strengths, Caveats, and Suggestions

StudyMate Game Generator

Uses:

- Teacher can author content review questions that can be recycled in a variety of game like formats including crossword, quiz show, matching, hang man, etc.
- Students can also author this content, which is shared among all.

Strengths:

- Students have the choice in what style of game they prefer to study with.
- Students can study outside of class.
- The questions can be recycled and built upon in future years.
- Grades can be attached to both student game completion and student test question generation.

Caveats:

- Teacher should audit and correct student generated questions for errors so that inaccurate review material is not available for others.

Suggestions for classroom use:

- Teacher should generate the first review game so that students have a chance to explore and navigate the different styles of review.
 - Students can generate their own test questions to publish in the class test bank for review in the next unit.
 - When students generate their own questions, begin by having them create three questions using a variety of question types such as multiple choice or term/definition.
 - Teacher should either pre-screen student questions or edit after submissions for accuracy.
 - Create a holistic rubric and demonstrate with exemplar models in order to establish benchmark expectations.
-

General Summary of Content Utilized in the Hybrid Module

The hybrid module's design was intended to introduce useful technology tools and activities but did not jump into higher order challenges such as 21st century project-based learning activities (digital-age projects have been highlighted by ISTE and P21 as a very effective model for 21st century workplace skills). Figure 6 represents a spectrum of common tech tools supporting 21st century skills and their associated frequency of use (The researcher authored the content contained in this table based on extensive classroom instructional experience as well as Master Teacher observations of colleagues).


<p style="margin: 0;">Least Challenging</p>  <p style="margin: 0;">Most Challenging</p>	<p>More Common</p>	<ul style="list-style-type: none"> • Desktop applications (Word, PowerPoint, CAD). • Teacher directed online information retrieval. • Online simulations and activities for students. • Students navigating Learning Management Systems (Moodle or Blackboard Coursesites). • Digital data collection devices (lab probeware).
	<p>Less Common</p>	<ul style="list-style-type: none"> • Student generated web sites. • Digital communication and Web 2.0. • Open-inquiry webquests. • Student generated media (video and audio). • Student synthesis following meaningful online collaboration (wikis, blogs).
		<ul style="list-style-type: none"> • 21st century project-based learning (students choosing appropriate technologies, research methodologies, and creating new information).

Figure 6. Common uses of technology supporting 21st century skills.

In my experience, digital-age project-based learning opportunities create inspirational classroom environments; however, educators and students alike need to first build fluency and classroom routines with the use of new tech tools prior to embarking in a large open-ended project. For that reason, the climate change module utilized a variety of technology uses located in the first two rows of Figure 6.

Utilizing hybrid strategies including dynamic online grouping scenarios, online communication and collaboration tools, web 2.0 sites, and Internet research skills are all activities that can augment a curriculum. Learning management systems (LMS) such as Blackboard's Coursesites or Moodle provides teachers with a free and convenient central

repository for these activities. Blackboard's Coursesites was utilized in this research project due to its native inclusion of handy tools such as wikis, blogs, discussion boards, game generators, quiz generators, SoftChalk web content generators, YouTube mashups, and ability for students to download and upload assignment materials. The next section discusses the experimental design, use, and implementation of a hybrid module built using the standards and practices described above within Blackboard's Coursesites LMS by a consultant (researcher) for a middle school classroom.

METHODOLOGY

Overview

A unit regarding the topic of Climate Change was built by a consultant (researcher) and implemented by a host teacher in a seventh grade science elective classroom for sixteen weeks. The host teacher was a traditional face-to-face veteran teacher possessing a doctoral degree in education. Many of the activities utilized were borrowed and digitized from published lessons found through National Science Foundation (NSF) grants and National Science Teachers Association (NSTA) journals. Published lessons were intentionally used because they provided curricular activities that were approved by large audiences of science teachers, and they were more likely to be valid and reliable. This process was also a good test for converting published lessons in order to observe how they adapted to the online hybrid environment. The unit was delivered online via Blackboard's Coursesites, which is a free platform for teachers. The veteran teacher had limited experience with Blackboard and no experience incorporating hybrid online content into a middle school classroom; however, the teacher did have

extensive background instructing graduate school courses in education via other online platforms. The module paired one computer with every two students in order to provide access to a variety of online tools, however traditional face-to-face student discussions, classroom activities, laboratory investigations, and assessments were included and commonplace throughout. The host teacher observed and recorded student attitude and achievement throughout the module as students embraced the following digital experiences: navigating online course content, “how-to” video tutorials, discussion boards, blogs, wikis, online content (text, media, etc.), web research, review games, quizzes, digital progress portfolios, and also the use of traditional software applications such as Word, Excel, and PowerPoint.

The host teacher received support from the online consultant (researcher) throughout the module via the delivery of lesson plans, tutorial videos, and a few face-to-face meetings. The host teacher and researcher both recorded challenges and successes within journal entries in a private blog while working through the unit together.

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix C).

School Demographics

The online hybrid module was implemented in a small rural middle school in Manhattan, Montana. The small town of Manhattan, population 3800, is located 10 miles from the closest major airport (Bozeman airport) and 20 miles from the closest university (Montana State University). The mean home value in the area is approximately \$125,000 and the major economic influence is agriculture. The schools free and reduced lunch rate is 34%.

Manhattan Middle School is 95% white and maintains an average ratio of 15 students per teacher. The school's population tests above average for the Montana Criterion Test and the Iowa Test of Basic Skills. Eighteen students were grouped in pairs in order to use the ten PC desktop computers in the computer lab located just down the hall from the science classroom. Of the 18 students, 14 were boys. Six of the students maintained a cumulative grade average of "A" for all of their courses during the hybrid unit implementation, meanwhile nine students maintained a "B" average and three were "C" students. Seven students reported using technology for eight or more hours per week outside of school, four reported three to seven hours, five students claimed one hour or less, and one student did not answer.

Current technology resources within the science classroom included a digital projector attached to the instructor's desktop computer. Access to digital lab probeware was very limited in the middle school science lab. The host instructor recently received grants to purchase lap top computers for student use, however the school lacked Wi-Fi access at the initiation of the unit's implementation. The school was planning to install Wi-Fi access in the following academic year.

The host teacher was a veteran science teacher possessing a doctoral degree in education, with 35 years of teaching experience. The teacher was also a veteran adjunct associate professor for Montana State University's MSSE program, where he instructs core methodology courses in Action Research.

Hybrid Module Topic Rationale

Climate Science was chosen as the context for the hybrid online module in this action research study for three reasons. First, the Partnership for 21st Century Learning (P21), which embraces the NETS standards along with National Science Standards, introduced further expectations promoting schools to focus on civic responsibility including environmental literacy. P21 suggests that educators focus on 21st century themes relevant to key issues and problems of our times (Trilling & Fadel, 2009). The National Association of Science Teachers further recommends that science instruction:

- incorporate scientific issues that are personally and socially relevant;
- provide an authentic learning context by examining the societal dimensions of scientific issue, such as political, economic, and ethical considerations;
- approach decisions in an open and unbiased way, respecting and acknowledging different perspectives, views, beliefs, and other ways of knowing;
- prepare students to become future citizens who are scientifically and technically literate and willing to engage in making responsible and informed decisions.

(NSTA Board of Directors, 2010)

Second, controversial issues make for excellent online discussions and debates among students. The following international Gallup poll results demonstrate the split in opinion regarding anthropologic global warming.

People nearly everywhere, including majorities in developed Asia and Latin America, are more likely to attribute global warming to human activities rather than natural causes. The U.S. is the exception, with nearly half (47%) -- and the largest percentage in the world -- attributing global warming to natural causes. Americans are also among the least likely to link global warming to human causes, setting them apart from the rest of the developed world. Americans' attitudes in 2010 mark a sharp departure from 2007 and 2008, when they were more likely to blame human causes. (Ray & Pugliese, 2011, para. 2)

A majority of American's opinions are based on information they derive from popular media. America has long been a leading global contributor to greenhouse gas emissions. Unfortunately, many people dangerously assume that everything printed or communicated in popular media is true, even advertisement claims financed by industries dependent on carbon-based profits or biased politicians receiving campaign contributions from big business. Few people in mainstream America take the time to research primary sources for more informed understanding.

In the *climate science module*, students were exposed to a variety of primary sources based on scientific evidence as well as hands-on lab activities modeling climate systems. At the outcome of the *climate science module*, students were charged with creating a blog report citing primary sources for the support or rejection of anthropologic global warming for the mock President of the United States. Students were not assessed

on their outgoing beliefs for or against anthropologic global warming; rather, they were assessed on their ability to demonstrate information literacy skills and ability to generate arguments based on the use of supporting primary sources.

A third reason for climate science is that the topic provides a wealth of current information spanning from government reports, primary sources from field scientists, and opinionated responses from the public and private sector. The spectrum of information ranging from research findings to opinionated media provides an excellent opportunity for the host teacher to discuss and demonstrate information literacy standards (ISTE NETS Standard 3) with his students.

Treatment Plan

The *climate science module* was intentionally built and structured to gradually ease seventh grade students and a rookie hybrid teacher into daily use with the Coursesites LMS and assorted computer applications (including Vernier Probeware and Microsoft Office). The teacher utilized the LMS daily as the backbone of the curriculum. A majority of the lessons required students to log onto the course several times a week to stay organized as well as participate in discussion boards, blogs wikis, quizzes, games, labs, activities, and to access libraries of media regarding current climate research.

The course was presented in an “expeditionary” manner; students were charged with advising the mock President of the United States on 12 essential questions related to Climate Change. The expedition activities were divided into five modules.

Table 3
Hybrid Unit Module Descriptions

Module Title	Description
Introductory Module: Getting Started	The activities within this module provided students with the basic skills necessary to navigate the online classroom (e.g., course treasure hunt and video tutorials).
Module One: Climate Background	<p>The activities within this module provided a brief background on climate. Students completed each of the tasks before continuing on to Module 2. Students provided responses to the following questions at the end of the module.</p> <ul style="list-style-type: none"> • What are some commonly held beliefs regarding climate change? • How does temperature fluctuate in our schoolyard? • What is the difference between weather and climate? • What factors affect a location's climate?
Module Two: Earth's Energy	<p>This module introduced some of the complex systems responsible for regulating Earth's atmospheric conditions.</p> <p>Students provided responses to the following questions at the end of the module.</p> <ul style="list-style-type: none"> • How does Earth gain, lose, and transfer heat?
Module Three: Climate Science	<p>This module highlighted physical changes currently observed around the planet due to warming climate. The data collection techniques of climate scientists were exposed and modeled through several hands-on activities.</p> <p>Students provided responses to the following questions at the end of the module.</p> <ul style="list-style-type: none"> • How is climate studied and how has it differed in the past? • Is the Earth's climate currently changing? What evidence exists to support or reject sudden climate change? • What could be causing the Earth's climate to change?
Module Four: Global Warming	<p>This module exposed current ecological, societal, agricultural, and economic challenges created by the changing climate.</p> <p>At the conclusion of this module, students were able to answer the following questions with supporting research-based evidence.</p> <ul style="list-style-type: none"> • Could a few degrees really make that much of a difference? What are some current effects of this change? • If human actions are causing global warming, what are the likely consequences if our behavior continues? • What can be done about human-caused global warming? • If humans aren't causing global warming, what are the consequences of nations trying to reduce greenhouse emissions?

Table 3 represents a general summary; however, Appendix D includes a complete and comprehensive list of module activities (treatments), student objectives, associated technologies, and correlation to ISTE NETS standards.

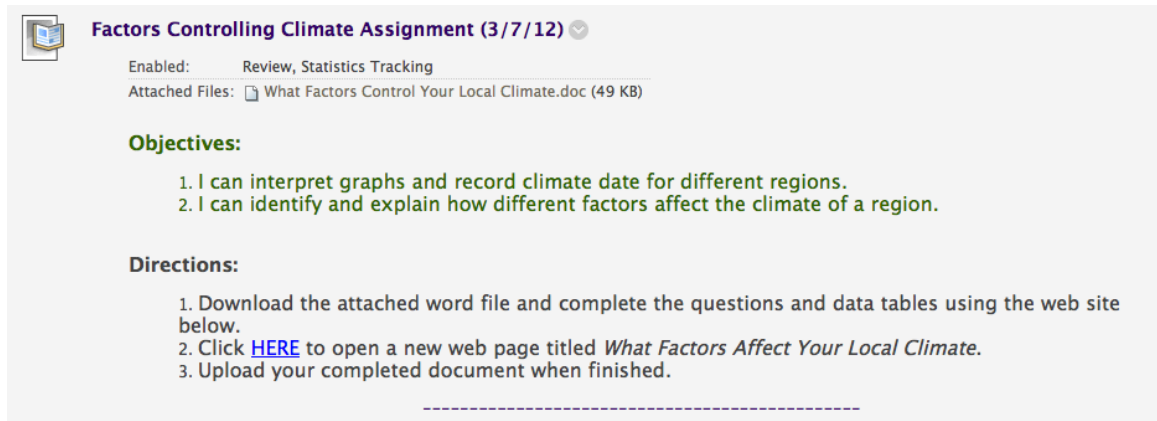
The researcher took painstaking measures to design a simple online environment with close attention to the smallest details such as course architecture, layout, button titles, clear directions, font size and complimentary font color. These design principles are the original work of the researcher and are based on extensive background experience designing and implementing over 25 LMS hybrid science courses over an eight-year span. Figure 7 below demonstrates a screenshot representation of the course “skin”. Notice that the student friendly navigation buttons (located on the left) were designed to be simple and minimal in number.




Figure 7. Screenshot of the course “Skin”.


Students were introduced to each module with a “hook” activity and reminded of the essential Presidential questions addressed within the module. Module activities were designed in a linear progression. Clicking the title of the activity or other embedded links in the activity’s directions would automatically redirect students to other locations within

the course (such as a discussion board) or open an external website within the skin of the online course. This minimized the need for students to navigate independently, which typically presents itself as an immediate challenge for beginners. Each activity contained a unique title followed by a brief objective statement that utilized verbs from Bloom's taxonomy. These objective statements were recorded through an "I can" statement. Font colors were manually selected in every assignment to provide contrast. The title was always in violet, the objective green, and directions always followed in black font. All font sizes were expanded to a larger size (font size 4) for a younger audience. The figure below demonstrates a characteristic view of an activity within a module. Note the standard Title, Objective, and Direction layout. It also included an attached file (downloadable guided student worksheet) and hyperlinked text that opened a supporting web page within the skin of the course.



Factors Controlling Climate Assignment (3/7/12) 

Enabled: [Review, Statistics Tracking](#)

Attached Files:  [What Factors Control Your Local Climate.doc \(49 KB\)](#)

Objectives:

1. I can interpret graphs and record climate data for different regions.
2. I can identify and explain how different factors affect the climate of a region.

Directions:

1. Download the attached word file and complete the questions and data tables using the web site below.
2. Click [HERE](#) to open a new web page titled *What Factors Affect Your Local Climate*.
3. Upload your completed document when finished.

Figure 8. Screenshot of an example activity's design and layout within the online LMS.

The next figure represents a characteristic view of a downloadable student worksheet used to accompany some assignments. This particular assignment required students to use an interactive website to compare climate data from several cities.

Names:

Directions: Read through the web site [What Factors Control Your Local Climate](#) and use the interactive tools to answer the questions below.

1. Why might one place have cold, snowy winters, while it rarely snows at another place only a hundred miles away?

(insert answer here)

Table 1. Comparison of climates across the United States.

Location	Latitude	Elevation (feet)	Max Temp (°F)	Min Temp (°F)	Precip (all) average (inches)	Precip (snow) average (inches)	Temp Max Jan/July	Temp Min Jan/July	Precip (all) Jan/July (inches)	Precip (snow) Jan/July (inches)
Phoenix, AZ	33.3N	1112	122	19	7.7	0	65/108	40/78	0.03/0.01	0/0
Flagstaff, AZ							40/62		0.07/0.03	0.6/0
North Bend, OR										

Figure 9. Partial view of a student worksheet accompanying an assignment.

This design was used repeatedly for every activity throughout the module in order to create consistency. Downloadable worksheets, supporting documents, and embedded mash-up media such as YouTube or NBC videos were also included in the activities' directions where appropriate. Once students were finished with an assignment, they simply clicked on the title of the activity and uploaded their completed work digitally (similar to attaching a file in an email). The teacher could later access student work and provide scores and feedback through the course's integrated grade book feature.

Assignments and activities authored by the researcher commonly included sample exemplar responses or models for students to reference. Some activities included analytic or holistic rubrics where appropriate. Figures 10 and 11 demonstrate screenshots of these example-supporting resources for students.

The top screenshot shows a list of messages in a discussion board. The messages are as follows:

Message	Author	Date
☐ ☐ Warming Arctic Discussion	Miles McGeehan	3/27/12 6:15 PM
☐ Example Student Response	Student Example	2/1/12 1:10 AM
☐ ☐ RE: Warming Arctic Discussion	Cassidy Kayla	4/2/12 4:14 PM
☐ RE: Warming Arctic Discussion	kale Lucier	4/2/12 4:27 PM
☐ ☐ RE: Warming Arctic Discussion	kale Lucier	4/2/12 4:16 PM

The bottom screenshot shows the detailed view of the 'Example Student Response' message. The header includes navigation arrows, the message title 'Example Student Response', and action buttons: Reply, Quote, Edit, Set Flag, and Delete. The message metadata is as follows:

Author: Student Example
 Posted Date: Wednesday, February 1, 2012 1:10:39 AM EST
 Edited Date: Wednesday, February 1, 2012 1:10:39 AM EST
 Total views: 18 (Your views: 5)

The message content is a 'Parent Post' with the following text:

Here are a few sample questions to get you thinking...
 Question 1)
 True or False If the question is false, then please correct the statement to make it true.
 Thawing Arctic soils may release significant amounts of carbon dioxide and methane now trapped in permafrost.

Figure 10. Partial view of an exemplar discussion post (bottom) included for student reference.

Name: **Presidential Blog Rubric**

Description: **This rubric will be used to grade each of the essential questions. Students should attempt to meet Proficient expectations. Students scoring Advanced will be given one extra credit point per category.**

Exit


Grid View List View

	Advanced	Proficient	Competent	Novice
Evidence	<p>Points: 4</p> <p>Essential question is thoroughly answered using three specific supporting details or similar evidence.</p>	<p>Points: 3</p> <p>Essential question is answered using two specific supporting details or similar evidence.</p>	<p>Points: 2</p> <p>Essential question is answered using one specific supporting detail or similar evidence.</p>	<p>Points: 1</p> <p>Essential question is answered without supporting details or evidence.</p>
Media	<p>Points: 4</p> <p>"Just Right" media such as pictures, graphs, or video is included. Each media item includes an accurate summary of important trends below it.</p>	<p>Points: 3</p> <p>OK media is used and includes a good summary of important trends.</p>	<p>Points: 2</p> <p>Poor or confusing media is used. A brief summary of trends is included but it may lack appropriate connections.</p>	<p>Points: 1</p> <p>Media does not connect or contribute to slide content. Summaries absent.</p>
Content Accuracy	<p>Points: 4</p> <p>All information is accurate and based on empirical (scientific) evidence and/or highly credible professional scientists.</p>	<p>Points: 3</p> <p>Information is mostly accurate and doesn't interfere with message. Evidence is based on empirical (scientific) evidence and/or highly credible professional scientists.</p>	<p>Points: 2</p> <p>One or two inaccuracies may exist in content. Content negatively affects overall message. Content is not based on empirical evidence or credible scientists.</p>	<p>Points: 1</p> <p>Multiple inaccuracies may exist and dramatically effect overall message. Content is not based on empirical evidence or credible scientists, rather content may be</p>

Figure 11. Partial view of an analytic rubric embedded into the presidential blog activity.

After students completed the activities in a module, they took time to reflect on the essential Presidential questions addressed within. Each student group created their own unique blog page answering each essential question. Students were provided with a rubric, which required they include supporting media collected from the web or artifacts, graphs, and information collected during labs or experiences common throughout each module. The blog pages served as a progress portfolio throughout the unit representing groups' changing attitudes toward climate change and global warming. The blogs could be viewed and commented on by other students as well as the instructor thereby emulating a publishing environment within the classroom's "scientific research community". The figure below demonstrates a partial view of an exemplar blog activity for students to view at the beginning of the activity. Note the links to instructions, rubric,



and navigation tools, which are located along the top and right side of the blog for easy access.

Presidential Questions Blog 

If a Blog or Journal can be graded, a grade assigned to an individual member is applied only to that individual. [More Help](#)

[Instructions](#) | [Alignments](#)

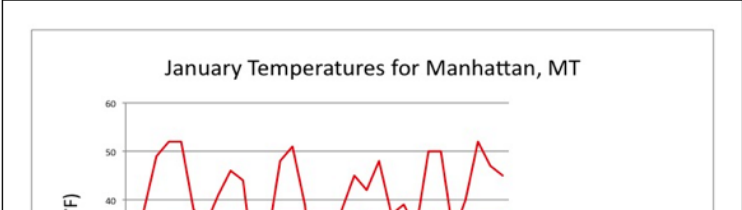
Sunday, February 5, 2012

 **Weather and Climate Differences** 

*Posted by Student Example at Sunday, February 5, 2012 1:21:14 AM EST
Last Edited: Thursday, March 1, 2012 2:04:59 AM EST*

What is the difference between weather and climate?

Begin by sharing a summary of your thoughts regarding the President's question. Then include evidence and supporting media below.



January Temperatures for Manhattan, MT

The graph shows a line representing temperature in degrees Fahrenheit (F) on the y-axis, ranging from 40 to 60. The x-axis represents time in January. The line fluctuates between approximately 40 and 60 degrees, with several peaks near 60 and troughs near 40.

About this Blog



- Type: Individual Blog
- Author: Student Example
- Entries: 3
- Comments: 0

Blog Grade

[Edit Grade](#)

Grade for: Student Example
Grade: -- out of 16
[View Rubric](#)

Grade Date: --
Feedback: --
Grading Notes: --

More Blogs  

[Show Empty Blogs](#)






- Cassidy Kayla (12) 
- cody aune (13)  
- john joe (12)  

Figure 12. Partial view of an exemplar blog page included for students to reference.

Research Design

Descriptive research collection methods were used to evaluate the impacts of the implementation of the hybrid online module on the teacher, students, and outside consultant. These collection methods included a variety of questionnaires, surveys, instructor observations, instructor's journal, and consultant's journal. Coupling these observations with ongoing student work and quantitative achievement records were used to identify patterns. Table 4 below correlates research questions with data collection methods.

Table 4
Data Collection Triangulation Matrix

Primary Research Question	Literature Review	Journal Observations	Climate Pre and Post Test	Interviews	Surveys	CATs	Direct Observation	Student Work	Modified Member Checking
What are the impacts of an outside online consultant delivering a hybrid online unit to a veteran science teacher for daily class implementation?	✓	✓	✓	✓	✓	✓	✓	✓	✓
Secondary Questions									
How are student attitudes, engagement, and achievement levels characterized while participating in their first hybrid online module?	✓	✓	✓		✓	✓	✓	✓	✓
What are the challenges and successes experienced by the host face-to-face teacher?		✓		✓	✓	✓	✓	✓	✓
What are the challenges and success experienced by the online consultant?		✓							

Activities in the *Climate Science* hybrid unit were arranged within separate content modules by topic. Appendix E comprehensively organizes the data collection instruments used by the researcher both temporally and by module. Another important evaluation method utilized was *modified member checking* (McMillan & Schumacher, 2010, p. 331) by the host teacher, who possesses a Doctorate in Education and concurrently instructs graduate courses in Action Research methodology. The host teacher repeatedly reviewed the researcher's data analysis and impact summary for accuracy and completeness. Details regarding the impacts of the hybrid unit on students and host teacher are described in the Data and Analysis section below.

DATA AND ANALYSIS

Overview

The original research questions were as follows:

Research Question

What are the impacts of an outside online consultant delivering a hybrid online unit to a veteran science teacher for daily class implementation?

Research Sub Questions

- How are student attitudes, engagement, and achievement levels characterized while participating in their first hybrid online module?
- What are the challenges and successes experienced by the host face-to-face teacher?
- What are the challenges and success experienced by the online developer and consultant?

General Impact Overview

The hybrid course was successfully implemented to completion in the host teacher's seventh grade applied science classroom. The entire unit took three times longer to implement into the classroom than expected. Developing the course took much longer than expected too. Researching outstanding resources and published curricular activities required close to 80 hours, meanwhile design and development of the hybrid course took over 100 hours. The host teacher enjoyed the experience and stated that he would use the hybrid unit again in the following year. Only *one* minor mistake was made regarding lesson sequence, which was a result of miscommunication between the

consultant and host teacher. Certainly more major mistakes could have been made during the 16-week duration so one mistake is a positive indication regarding the ease of adoption and clarity of the curriculum's design. Students repeatedly responded with overwhelming favorable support for the hybrid experience. Students also demonstrated strong achievement gains regarding climate science.

Student Impacts

Student impacts were studied under two lenses, the first being engagement and attitude, the second achievement. Students' engagement with and attitudes toward the hybrid design were more than favorable. Supporting data was collected through direct observations by the researcher, informal classroom assessment techniques (CATs), student attitude surveys, and host teacher journaling.

As the researcher, I had five years of prior formal training and experience completing annual performance evaluations and weekly coaching observations for 30+ teachers in both middle school and high school settings in six different schools throughout Eagle County School District, Colorado. Throughout my experience, both observing other classrooms and working for several years as a middle school science teacher, I have found a middle school classroom population to be a fickle beast. Their animation, enthusiasm, candor, and even seated posture serve as vivid and telling litmus regarding the overall efficacy of a lesson and preparation by the teacher. During my four researcher observations, students in the hybrid unit were not disrespectful, were not off task, worked diligently with focus, demonstrated excellent cooperation and collaboration

within partner groups, and were engaged from bell to bell in everything climate science and computer literacy.

During direct observations, I noted widespread enthusiasm throughout the population. The host teacher did a thorough job of delivering the unit with enthusiasm and a sense of importance. The teacher facilitated the project with routine messages to the students regarding how special they were to be able to participate with hybrid education at such a young age in their academic career. Students responded favorably to this attention and it was noted during each of four classroom observations by the researcher. It was impressive to see the whole group complete rapid transitions from their traditional classroom seats to their computer stations. Middle school students are notorious for socializing during these transition phases, however these students logged in with expediency and partners led each other with clear direction and work goals in mind. During one observation, the consultant overheard the following conversation between two boys during the wrap-up of a lesson.

“I will bring this home tonight and try to submit it”, stated one student.

“No, why don’t you fill it in on your paper and we’ll submit it online together tomorrow”, stated his partner.

Witnessing middle school boys politely argue over who will do the work *outside of class* was certainly a refreshing observation.

During another observation, I noted how a majority of students were reluctant to quit working on their computer assignments. Most groups worked up to the bell and made the following comments while completing the *Ice Cores of Glaciers and Past Climate Assignment*.

“Yes! We finished and we submitted our work”, said one student.

“No, No, No! We’re almost done”, responded partners when prompted to save and finish by the teacher.

“This lesson only took us one class period!” stated another group enthusiastically and with a sense of accomplishment.

The quotes directly above were in reference to a challenging lesson adopted from a ninth grade curriculum produced by McDougal Littell in conjunction with the National Science Foundation. The lesson required challenging graphic interpretation and analysis comparing 200,000 years of atmospheric composition data for CO₂, dust particulates, and climate temperature, which were collected from ice core scientists. This particular lesson took place during week 13, which demonstrates the continued level of enthusiasm and motivation students possessed even when the hybrid unit was “old hat” to them.

Another observation that stood out was the sense of self-direction displayed by 7th grade students throughout the hybrid unit. One challenging constraint in the research design was that students completed their work on desktop computers and would suspend their progress daily at the end of each class period. Absent students or groups working at a slower pace created challenges for unified class progression throughout each of the modules (on the contrary, laptops or pads checked out to students provide opportunity for unfinished work to be completed for homework, which helps to maintain unified workflow from all class participants. This topic will be discussed further in the section below titled *Challenges and Success for the Host Teacher*). During several observations, it was noted that students who were behind worked with an astonishing sense of self-direction and independence. These students briefly checked-in with the teacher and then

promptly went to work either on the computer or in the lab in order to catch up with the rest of the class. Sometimes these students worked in a separate room under little direct supervision (a student teacher adult was present but preoccupied with grading papers during his prep period). Observing this level of independence from seventh graders was impressive to say the least, but it also demonstrates the ease of operation students had progressing through the linear workflow design within each of the hybrid online modules.

During two of the later observations, I had the opportunity to informally question the entire class and receive group feedback. Students were asked the same question on both occasions: the first took place at week seven, the second at week 13. Students were asked, “Would you suggest that this unit be used again for next year’s seventh grade applied science class?” Students were to respond with a nonverbal response using thumbs up for agree, thumbs down for disagree, and thumb neutral for undecided. At week seven, students answered 12 in favor with thumbs up (75%), four undecided (25%), and zero disagreed ($N = 16$). At week 13, 15 students responded agreeably with thumbs up (94%), one undecided (6%), and zero thumbs down (0%) ($N = 16$).

Students completed attitude survey questions before (Appendix F) and after (Appendix G) the unit. The following results represent positive support for the use of hybrid education approaches by a majority of the seventh grade students. Students had the option of responding to specific statements with a spectrum of responses ranging between “strong agreements” to “strong disagreement”. They also recorded open-ended explanation responses.

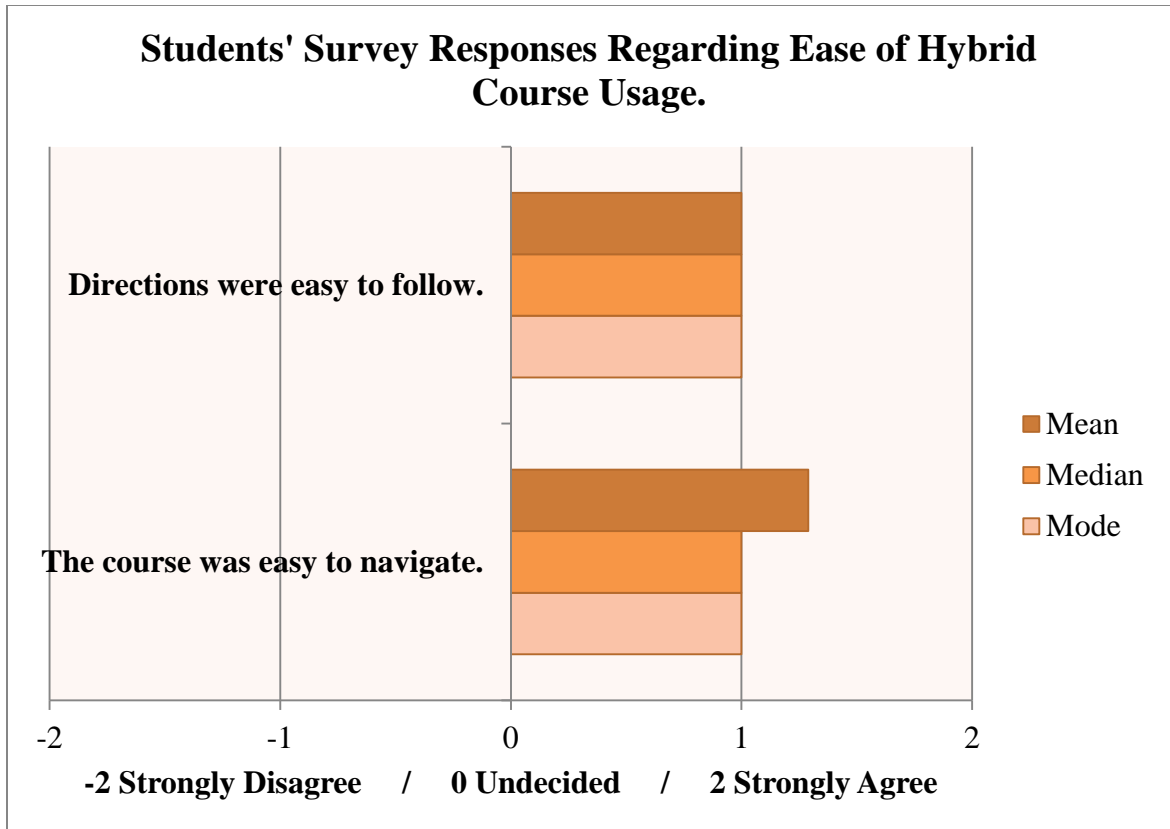


Figure 13. General impressions following the completion of the hybrid course, ($N = 17$).

Only 1 student (6%) disagreed that the directions were easy to follow. A majority of students (76%) agreed or strongly agreed that the directions provided within the hybrid unit were easy to follow and three students (18%) were undecided. Seven out of 13 open-ended comments replied that no changes were necessary to directions. Three students commented on the readability challenge of the directions stating they sometimes had difficulty with “the way they were worded”, or “sometimes they had words that were hard to understand.” Regarding navigation of the course, all but two students (88%) agreed or strongly agreed that the course was easy to move around and no students (0%) disagreed with the established course navigation. Two students (12%) were undecided. In the open-ended responses, 7 out of 13 student comments reported that “no changes” should be made to the design of the course. Two meaningful suggestions were that the

course should open directly to the “assignments” area of the course and also that more training should be implemented at the start of the course. No response trends were found associated with GPA or computer experience background.

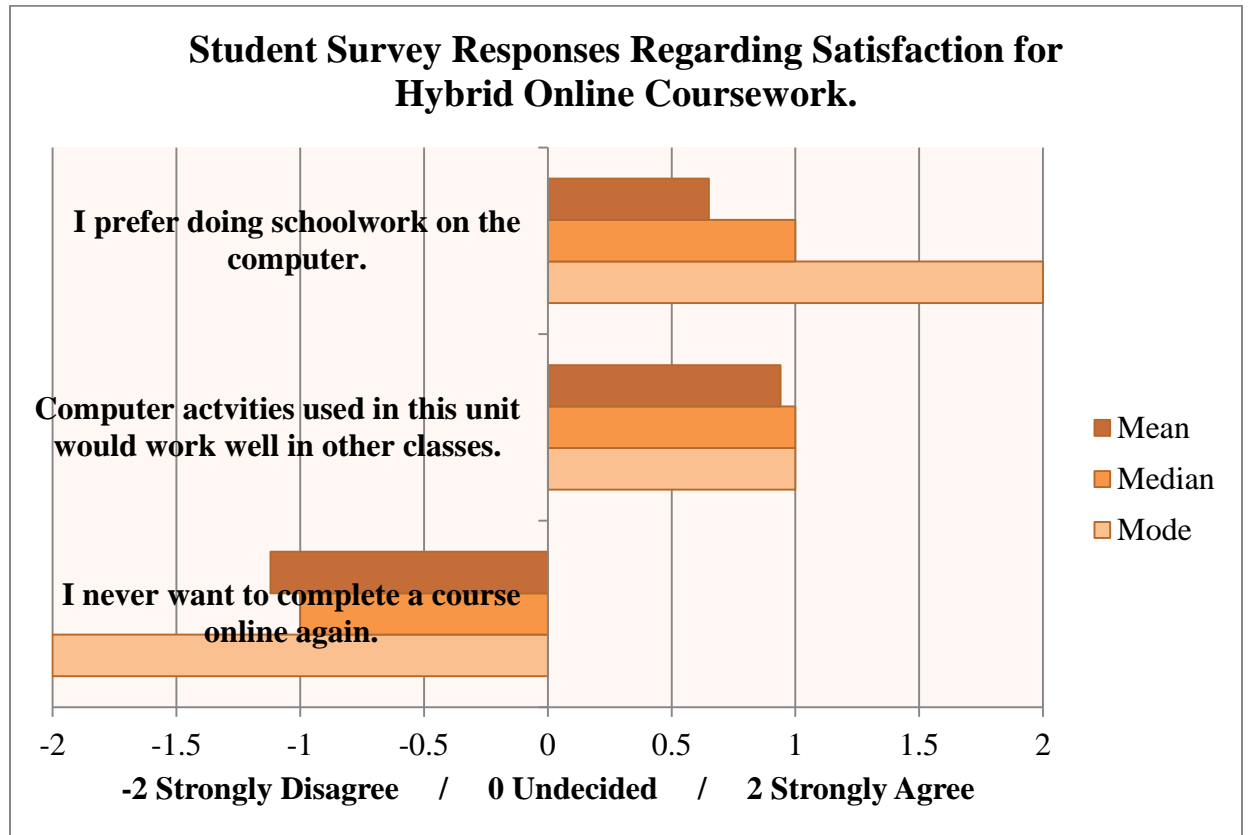


Figure 14. General impressions following the completion of the hybrid course Part II, ($N = 17$).

Figure 14 demonstrates overall appreciation for hybrid course delivery by 7th grade students. In regards to preference, 10 students (59%) responded agreeably with hybrid, 5 of which strongly agreed. Three students (18%) were undecided and 4 students (24%) mildly disagreed with hybrid. Common supportive comments included that hybrid “is funner,” “it is fun and you can do it whenever or wherever,” “because it’s easier,” and “it’s faster and neater typing than writing.” Two non-supportive comments suggested that it is “boring” and that “it’s harder to get stuff done.” Interestingly, three of the four

disagreement responses originated from students with perfect GPA (the fourth student to disagree was partnered with one of the three above). When asked why, two of them compared the computer work to labs, which they rated appreciably in later survey questions. These same two students rated hybrid better than bookwork as well as lecture in later survey questions and agreed with taking more online classes in the future. Only one of these three consistently disliked or was indifferent with the hybrid approach throughout each of the survey questions. Could this be an indication that this sub-population was not challenged enough? No other patterns were observed among the rest of the population either by GPA or computer experience background.

Similar to the above findings: when students were asked if they thought “hybrid was better than traditional schoolwork”, 12 (75%) reported “yes,” three (19%) reported “no,” and one (6%) remained undecided ($N = 16$). Strong supportive responses from 7th grade students for hybrid included that it “is more interesting and faster,” “because it teaches you more,” “it gets you ready for real life,” “it helps kids get better with technology,” “you get to do both online and offline work,” “having a combination can help,” “it is the best of both” and simply “the hybrid education is better.” Non-supportive comments included that “people don’t describe their opinions out loud,” “you are on the computer and you need to write,” “it is out there for little kids and sometimes for me.” Interestingly, the three “no” comments above were from students who also reported one or fewer hours of technology usage outside of school per week (this makes up 75% of the subpopulation that had one or fewer hours of technology usage outside of school per week).

The seventh grade students' positive and negative comments above epitomize many of the strengths of hybrid while also highlighting valuable caveats. It is important for hybrid teachers to embrace the tool appropriately by combining it with the best traditional pedagogical practices. Students should not feel that they no longer have a voice in live discussions or that they don't have the opportunity to write traditionally. However hybrid practices can better prepare students for live f2f discussions by first requiring *every* student take a moment in-class or at home to record thoughts in a public online forum. Regardless if they verbalize their thoughts in the f2f discussion that follows, the teacher can formatively check every student's thoughts recorded online and *evaluate* whether all students are interpreting the class skills and topics appropriately (and or appropriately redirect students if they are not).

Figure 14 also shows that 13 students (76%) agreed that activities within the hybrid unit would work well in other classes. Only one student (6%) disagreed and three (18%) were undecided ($N = 17$). Four agreeable students stated that it would work well in some classes and not others; two specifically stated they thought hybrid would work well in English and social studies, but not work well in math classes. The one student that disagreed with hybrid applications in other classes did not provide an informative reason. No trends in responses were found associated with GPA or computer experience background.

When students were asked to agree or disagree with a negative statement, *I never want to complete a course online again*, students responded overwhelmingly with disagreeing sentiments. Figure 14 shows that 14 students (82%) were split evenly between strong and mild disagreement while two agreed (12%) and one was undecided

(6%). Common reasons for disagreeing students were general interest and liking for hybrid, the opportunities provided by the “fast and modern approach”, and expressions regarding “fun” experiences and “fun activities” within the hybrid course. The three students who expressed disinterest or undecided opinions in hybrid here were the same that expressed similar disinterest in the other survey questions. Their explanations suggest general disinterest or boredom. No trends in responses were found associated with GPA or computer experience background.

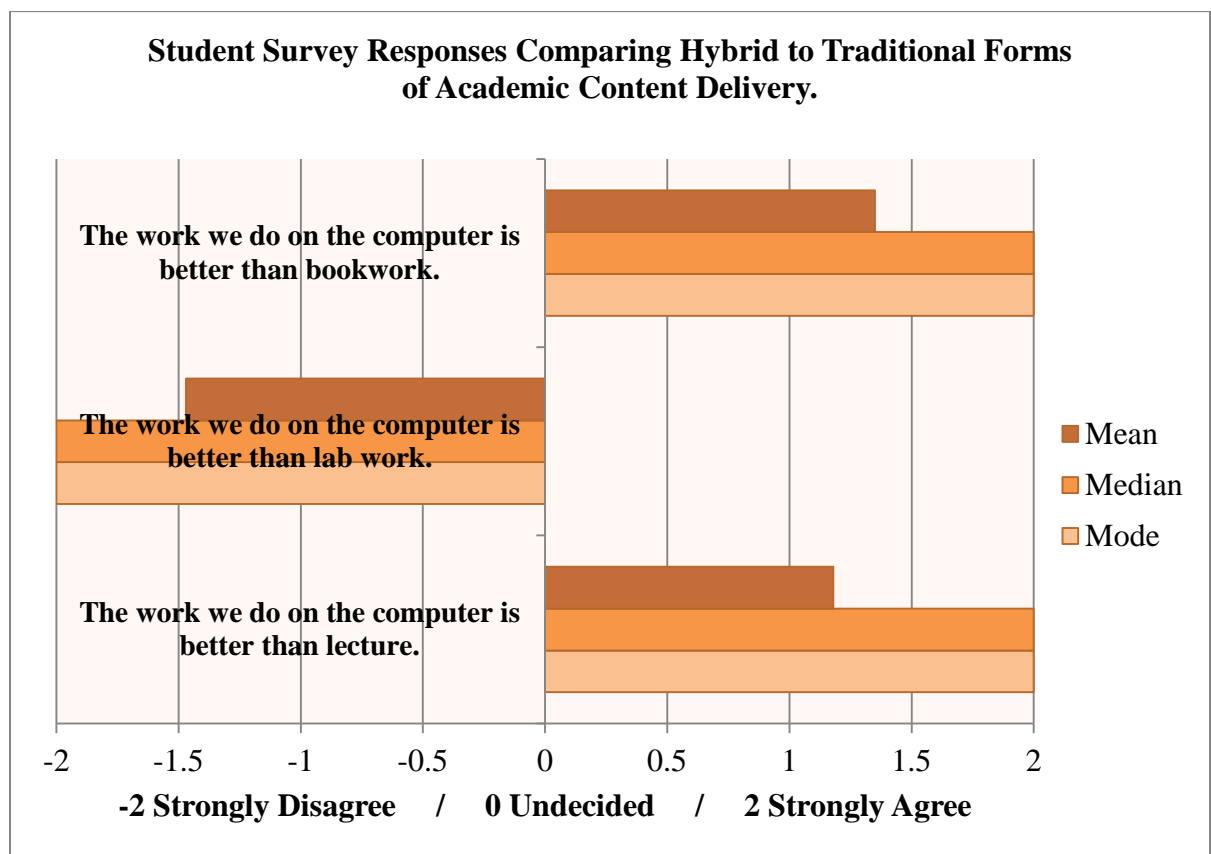


Figure 15. Student responses comparing academic content delivery preferences, ($N = 17$).

Figure 15 demonstrates polarized contrasts between students’ preferences when comparing hybrid content with traditional bookwork, lecture, and science lab work.

Fourteen students (82%) agreed that hybrid coursework is better than bookwork and ten

of those students strongly agreed, which is represented by the “strongly agree” median and mode values. Only one student (6%) disagreed that hybrid is better than traditional bookwork and two were uncertain (12%). In open-ended comments, 12 students expressed disinterest in bookwork or stated that it is boring and hard to understand compared to hybrid content. The only student to disagree stated that they learn well from reading a book. No trends in responses were found associated with GPA or computer experience background.

Similarly, 12 students (70%) agreed that hybrid coursework is better than lecture and nine of those students strongly agreed. Only one student (6%) disagreed that hybrid is better than traditional lecture and 4 were uncertain (24%). In open-ended comments, four students stated that they simply don’t like lecture and four find it boring compared to hybrid content. Two students stated that they appreciate hybrid work because they can look back over it and two students state that hybrid is easier to learn from and more fun. No trends in responses were found associated with GPA or computer experience background.

In contrast, 14 students (82%) disagreed that hybrid is better than science lab work and 11 of those strongly disagreed. Meanwhile three students (18%) were uncertain and no students agreed that hybrid is better than lab work. The hybrid course did contain a wide variety of hands-on labs and activities, however students probably answered this question by comparing general experiences in science labs with time spent strictly on the computer during the hybrid unit (their traditional science class was also concurrently utilizing labs 100% of the time to instruct a unit on mechanics). In open-ended responses, 14 students stated that they appreciate labs because they are “hands-on and

fun”. Two students stated they learn more from labs and one student stated they like both lab and hybrid equally. No trends in responses were found associated with GPA or computer experience background.

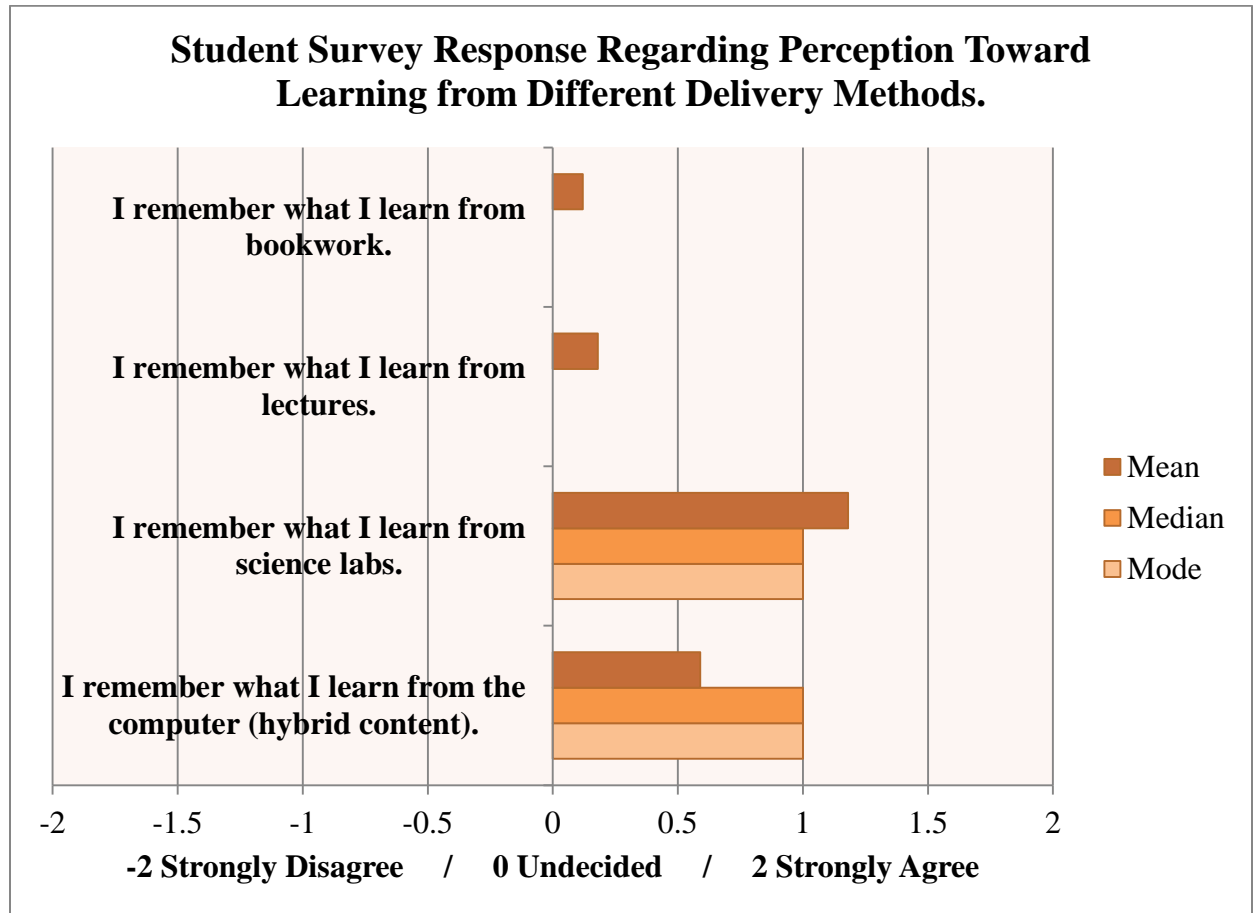


Figure 16. Student perception regarding learning efficacy associated with different content delivery methods, ($N = 17$).

Figure 16 shows that the mean slightly agrees that they learn from bookwork or lectures, more express moderate agreement with remembering hybrid content, and a majority associated the greatest learning memory from science labs. Zero students disagreed with hybrid content, seven (41%) were uncertain, and 10 (59%) moderately agreed that they remember what they learn from the computer. Four students (24%) moderately disagreed that they remember from books and four (24%) moderately

disagreed that they learn from lectures meanwhile most were uncertain for both. Almost all students agreed that they remember what they learn from labs except one student was uncertain. No trends in responses were found associated with GPA or computer experience background.

Student enjoyment and learning perception regarding specific activities throughout the unit will be analyzed next. A classroom assessment technique (CAT) was used at the end of each module to gather student enjoyment along with a summary of “two new things learned” for major assignments (Appendix H). An “enjoyment rating” was assessed within each CAT by having students provide a rating between one and five. Five represented that students enjoyed the assignment “a great deal”, three represented “kind of” and one was “not at all”. Students could elect to score with a two or four, which would lie in between the spectrum of the established scale.

Following the *Getting Started Module* and *Module 1: Climate Background*, the researcher tallied 7 comments by students claiming that they learned “nothing” from a particular activity ($N = 64$, total comments by 17 students). This tally translates to 10.9% of the assignments reviewed. These modules included a variety of basic tasks designed to introduce students to discussion boards, blogs, Microsoft Word and Excel, and course assignment completion. Background information regarding people’s attitudes and perception toward climate change was also introduced. Only one assignment contained significant new information comparing climate and weather. The full-scale inclusion of new information in a majority of assignments did not begin until Module 2.

In a similar CAT following Module 2 (Appendix H), the researcher tallied four comments by students claiming that they learned “nothing” from a particular activity (N

= 65, total comments by 17 students). This tally translates to 6.2% of the assignments reviewed. Module 2 introduced labs and activities related to the physical science topics and properties associated with Earth's energy exchange and atmospheric composition.

The CAT was used once again following Module 3 (Appendix H). Five students commented that they learned “nothing” from a particular activity ($N = 89$ total comments by 18 students). This tally translates to 5.6% of the assignments reviewed. Module 3 included a variety of labs and activities exposing students to modern research methods used by climate scientists for studying the present and past climate conditions. The results from the three modules are compared in Figure 17 below.

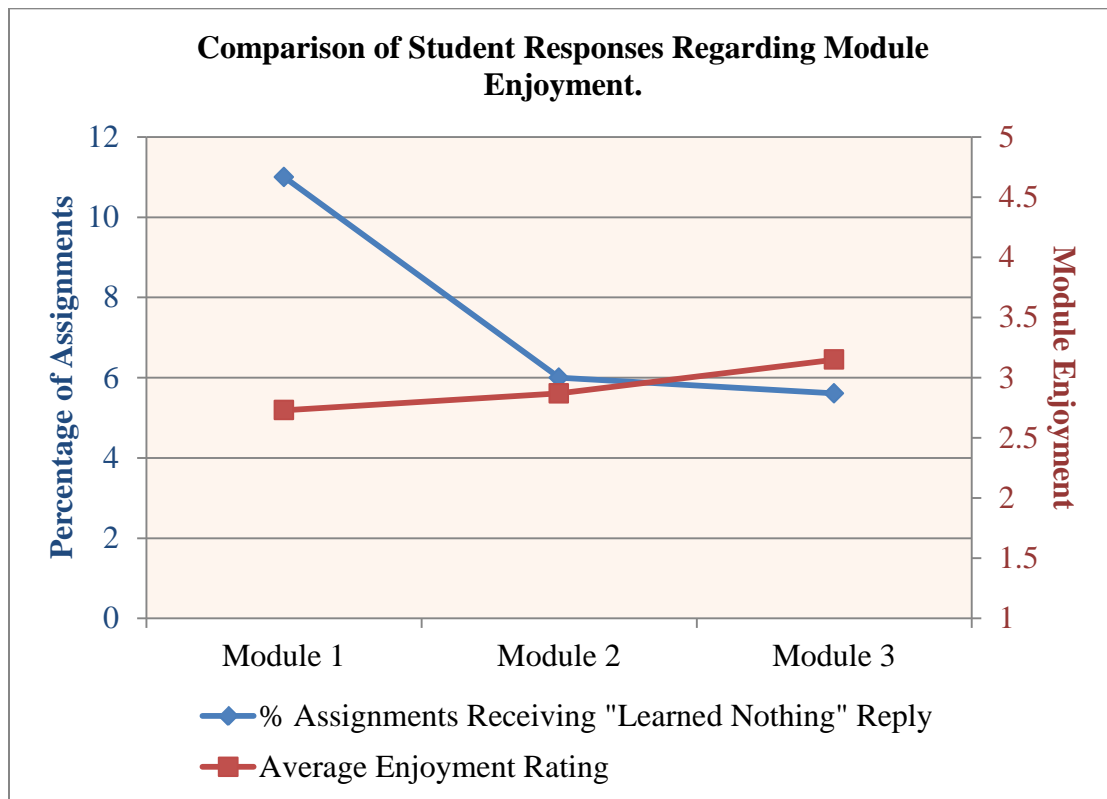


Figure 17. Comparison of student enjoyment ratings (red) and percentage of assignments receiving student feedback claiming “Learned Nothing” (blue) for each module, ($N = 18$).

Figure 17 shows that student enjoyment increases with each module, meanwhile the percent of “learned nothing” responses decreased. The trends represented in Figure 17 indicate a possible connection existing between academic challenge and student enjoyment. The unit certainly progressed from introducing less complex information in Module 1 to more sophisticated lessons, labs, and rigorous content in Module 3. As the lessons became more challenging the user enjoyment rating increased. An alternative explanation could be that enjoyment rating increased as students and host teacher became more comfortable with the hybrid environment. Figure 18 below demonstrates how the class scoring statistics changed as a result throughout the unit.

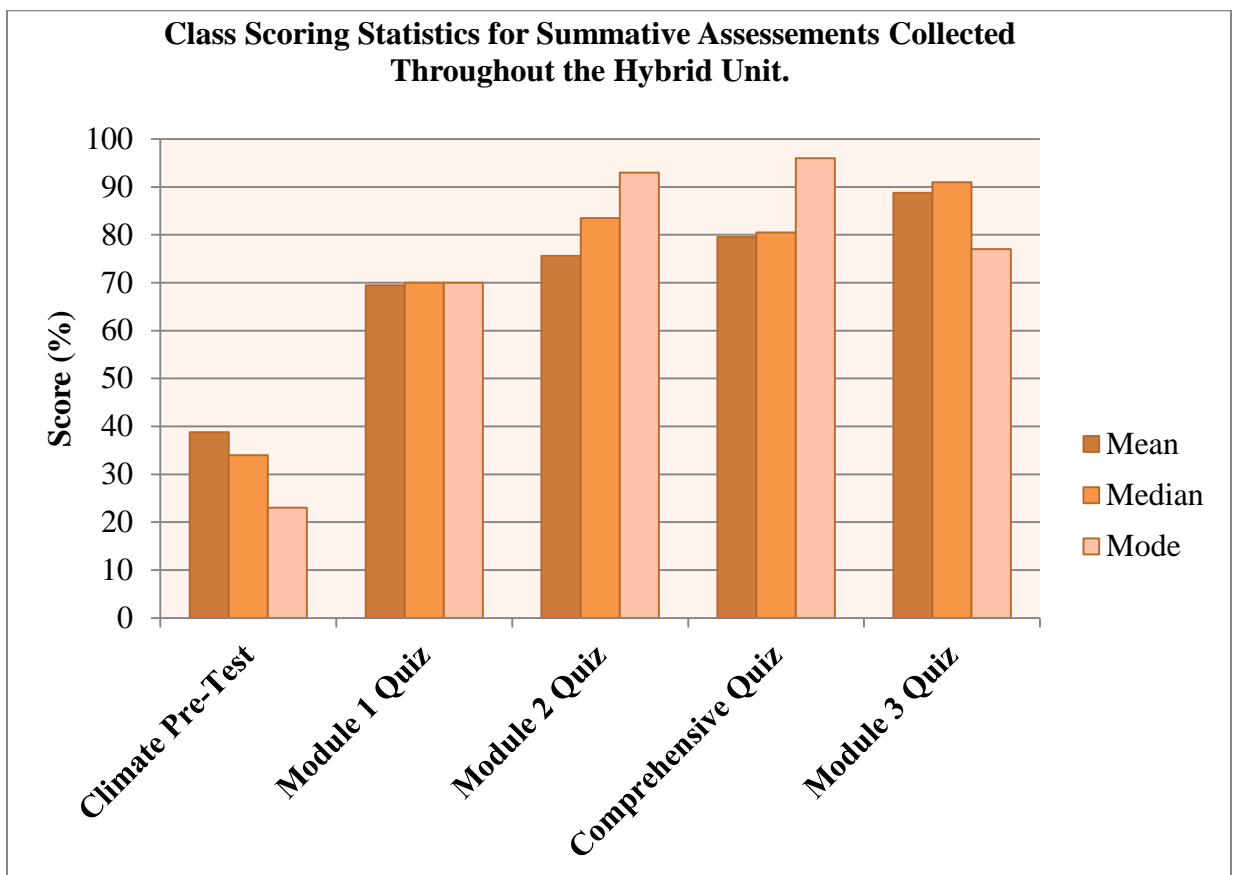


Figure 18. Class scoring statistics for individualized summative assessments organized by module, ($N = 18$).

Figure 18 represents a consistent increase in class success as noted by the increasing mean score on each assessment. Many of the Pre-Test questions were recycled later in the appropriate module assessments for score reliability. The growth in the population's mean test scores seems to parallel the increase in their reported enjoyment throughout each module (Figure 17). These trends could further support either of the hypotheses reported above (increased student enjoyment with increased challenge or increased student enjoyment with increased comfort online).

The host teacher and several students made several unfavorable comments regarding the basic nature of the work contained in the Getting Started Module and Module 1. The host teacher expressed this in blog journal entries and in interviews. The students expressed it in CATs collected. Activities in the *Getting Started Module* and *Module 1: Climate Background* intentionally included basic activities combined with slow pacing in order to ease rookie students and host teacher into the hybrid online realm. It is expected that a student population will have a range of technology backgrounds, and the 7th grade class from Manhattan, MT was no exception. In a student survey of technology usage (Appendix F), two students reported using digital tools (such as computers, smart phones, pads, or video games) zero hours per week, meanwhile one student self-reported using technology tools 50 hours per week. The mean reported usage per week was 10.4 hours, with median and mode both equaling 4 hours ($N = 16$). One student commented during a researcher's observation that he had never used email before! During an early conversation and again in an exit interview, the host teacher commented, "The first module was great for an Applied Science course (non-credit), but if this were used in a credit course it would need to cover content immediately. I can't

sacrifice content for the lengthy introduction.” On the other hand, he stated the following in a blog journal regarding an introductory activity titled Course Treasure Hunt,

“It's a great activity as it starts to get them familiar with the course, uploading, etc. I would keep this activity exactly as it is. We spent the usual time on trying to log in again. A few students forgot to save their file from yesterday so they needed to start again (good learning lesson).”

Not all students agreed that there were too many introductory activities. In response to a survey question regarding the ease of course navigation, one student commented that more training should be provided at the start of the course. It is unlikely that the perfect balance would be easily achieved, which suggests possible benefits associated with differentiated training sessions and or options for students to test out of course introductions. As a side note, these introductory course activities could be used more sparingly in courses with veteran hybrid students.

The impacts of hybrid coursework on student achievement were very positive. All students demonstrated significant growth regarding their understanding of climate science and computer literacy. Computer literacy was not specifically monitored in this research paper, however the host teacher mentioned in multiple oral and email discussions how well the students were developing critical thinking and problem solving skills associated with course navigation, assignment completion, and software downloads, etc.

With regards to student achievement in climate science, Figure 19 below represents student growth measured by individual summative assessments given periodically. A pre-test on climate science took place before the initiation of the unit

(Appendix I), followed by periodic quizzes deployed throughout the modules (Appendices J, K, L, and M), which included appropriate recycled pre-test questions as well as added open-ended response questions. Arbitrary student labels were used in replacement of actual student names in the figures below. Since students were paired into groups, the first student in the first group was labeled A1 and the partner A2. The second group received the labels B1 and B2 and so forth. The number 1 student in each group maintained the higher cumulative grade average calculated from all core classes.

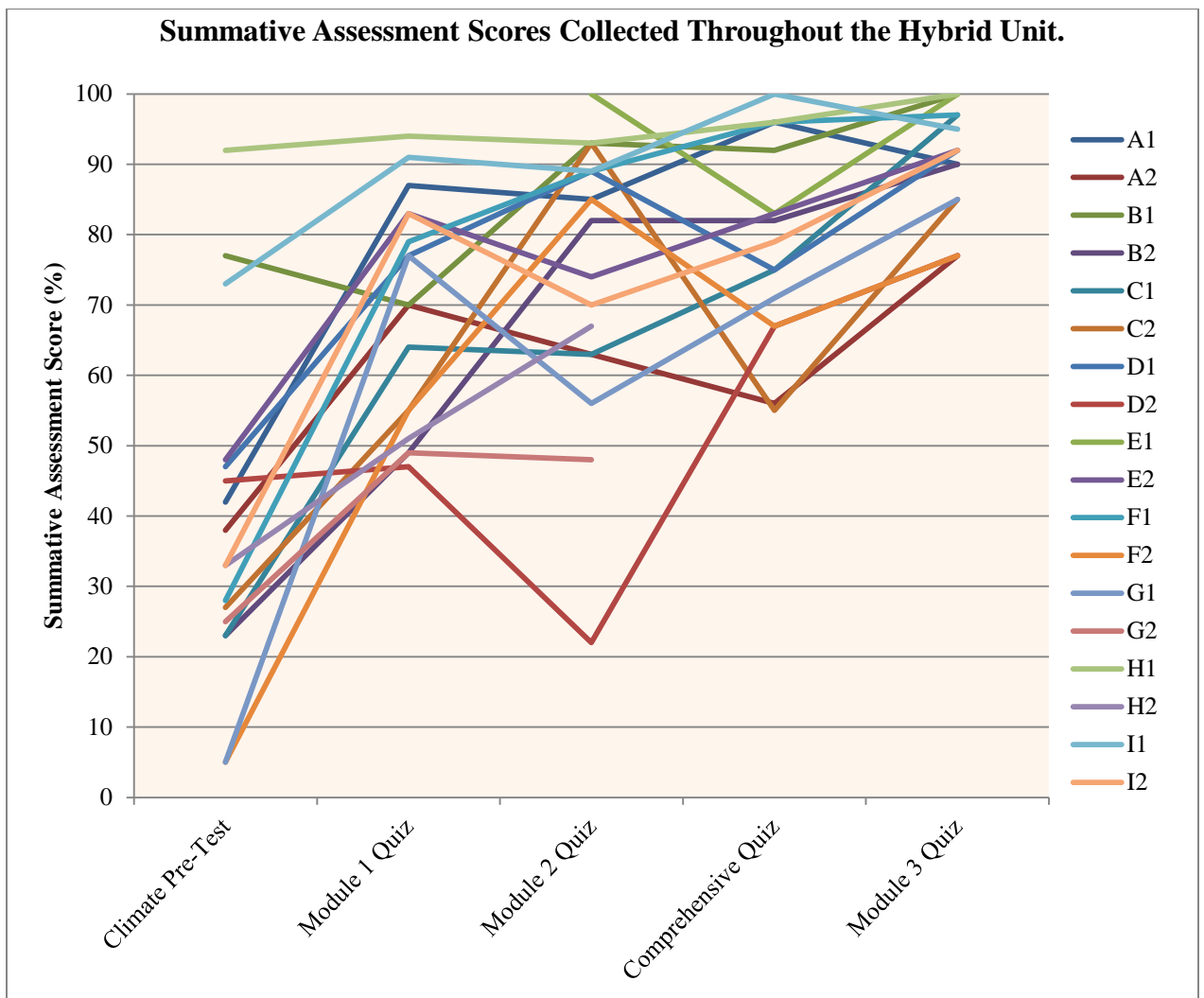


Figure 19. Individual summative assessment scores collected throughout the unit, ($N = 18$).

Figure 19 demonstrates that *all* students demonstrated significant academic growth throughout the unit or they maintained already high scores. No student showed an overall decline in the unit. The scores for the pre-test (Appendix J) covered a range of 87 percentage points (between 5% and 92%) with a mean of 39% ($N = 18$). Later the score range for The *Module 3 Quiz* (Appendix M) narrowed to 33 percentage points (between 67% and 100%) with a mean of 89% and three students scoring 100% ($N = 18$). Quiz 3 contained a variety of challenging questions that focused on the core knowledge of climate science (some of these questions were taken directly from an AP Environmental Science practice exam which was an impressive demonstration of knowledge by 7th grade students). Several students did waiver from consistent growth, specifically on the *Module 2 Quiz* (Appendix K) or the *Comprehensive Quiz* (Appendix L), however almost all students (16 / 18) continued with strong growth by the *Module 3 Quiz*. For validity, many of the pre-test questions were recycled in appropriate quizzes later.

The five students who demonstrated a sudden dip in their *Module 2 Quiz* Scores all answered question six and seven incorrectly (represented in Figure 20 below).

The diagram indicates the amount of solar radiation that is reflected by equal areas of various materials on Earth's surface.

(Source: NYS Earth Science Regents Exam)

6. Which material absorbs the most solar radiation (insolation)? (circle one)

A) grassy field
 B) fresh snow
 C) forest
 D) sand

7. Why did you choose the above answer? Explain your reasoning.

Figure 20. Module 2 quiz excerpt.

The incorrect students all seemed to express misconceptions with the vocabulary, specifically their interpretation of the word *absorbs*. For instance, one suggested that “sand is a more absorbant material [sic],” possibly indicating a misconnection with sand’s ability to absorb liquids well. One student calculated the ranges of reflected light values and found that sand had the largest range. The other three students chose the answer “fresh snow” because the diagram showed snow had the largest reflection values. These students did not accurately interpret high reflection values correspond to lower absorption rates. Missing this question and subsequent explanation reduced each student’s score by 22% on the quiz. It is interesting to note that 13 students (73%) answered this question correctly on Quiz 2 while only five students (28%) answered this

question correctly on the pre-test demonstrating growth by eight students following the completion of the Module 2 activities ($N = 18$).

The *Comprehensive Quiz* included only open-ended responses. The four students who scored below 70 percent on this quiz all answered each prompt with a minimal amount of detail. Often times their explanations were simple statements lacking explanations connection to science content. The following student answers compare a poor response and thorough response addressing the question: “Explain how pollen is used to determine ancient climates.” A poor response from one female stated, “They can see what pollen we have now and then.” A more thorough response from another female stated, “When you find pollen you can identify what plant it was from and some plants only live in certain climates showing what it was like in the past.” During an observation following this quiz, I overheard the host teacher addressing the class regarding this concern. He reinforced the need for more detail driven explanations and thorough connection to the scientific content uncovered in the module’s experiences. It was noted that students all improved their expository writing with thorough inclusion of detail on the *Module 3 Quiz*.

A few unique students were selected for further analysis of overtime growth trends. One low achieving student showed erratic scoring trends while his partner performed strongly, an average student with minimal reported technology background demonstrated and maintained significant growth, and finally three high achieving student who showed slight disapproval for hybrid in surveys received high scores on the pre-test and maintained “A” averages on all subsequent quizzes.

Student D2 was a male with a background described by the second lowest cumulative core class grade average (73%) in the study. D2 consistently expressed appreciative responses regarding the enjoyment for hybrid activities and strongly agreed with using computers in school in several surveys. This participant began the unit with a pre-test score six percentage points above the class mean and demonstrated continued growth throughout the unit, however he expressed a significant decline in their *Module 2* Quiz (54% below the class mean). Upon reviewing the student's scores and written responses throughout all of the recorded assessments, it appears that the student had a habit of recording minimal thoughts and explanations when prompted. In some of the quizzes, the minimal expression of detail included proper scientific understanding supporting earned points, however in Quiz 2 his minimal responses were not accurate but also left such little detail that the researcher was unable to identify any underlying misconceptions or significant reason as to why they scored so poorly. Because he had minimal responses, this may be an indication that it is the type of student who does the minimum, which is reflected in this score. A teacher of these types of students might encourage (and assess) them to "do more." Student D2's partner (D1) scored 14 percentage points above the class mean. Daily work submitted by the two partners appeared to be in good standing with accurate, although simple, explanations included. Could student D2 have participated less in the group work during this module? Were they absent for a portion of the module? Or did he rush through the quiz and misread the questions? Students A2, E2, G1, and I2 also demonstrated a similar pattern of growth, then decline on Module 2, then continued growth. Meanwhile eight other students demonstrated continued growth trends throughout and beyond Quiz 2 and four students

remained flat. Based on these varied trends, the researcher cannot postulate a reason for D2's low score at this time without further information.

Student F1 was a female with an 87% cumulative grade average. She reported limited exposure to technology outside of school (two hours per week compared with the class mean of 10.2 hours), but she commented agreeably with the hybrid approach and strongly agreed with the desire for completing online courses in the future. F1's pretest scores began 11 percentage points below the class mean, however she demonstrated strong and continued growth on each of the subsequent assessments and finished in the top four students in the class (Quiz 3 score 97% and overall quiz average of 90%). F1's performance on Quiz 3 exceeded her cumulative grade average by 10 percentage points. This was certainly an impressive performance from a "B" student with minimal background experience using technology outside of school!

Three high-achieving students (A1, H1, I1) made-up 75% of the subpopulation expressing disagreement or indifference regarding the use of hybrid delivery in the classroom (although at times they expressed support for hybrid). A1 was a female who consistently expressed disagreement more frequently and subsequently scored in the mid-80's on several quizzes and her overall average was a 90% for the combined summative quizzes. The other two males, H1 and I1, scored at or above 89% on all of their quizzes. Although they all showed growth compared to their pre-test scores, all three of these students' summative quiz score averages within the climate change unit were lower than their cumulative core class grades. A1's average was 7% lower, H1 2% lower, and I1 4% lower. I1 scored the highest on the pre-test (92%), while A1 and H1 scored 43% and 73% respectively, thus they certainly did not "know it all" at the beginning of the unit

and were subjected to new learning along the way. All three maintained a concurrent 4.0 GPA in their core classes; could their dislike for hybrid be based on the fact that they weren't receiving near perfect grades like they might be used to in other classes? It is interesting that they all expressed lower than average technology usage hours outside of school (A1 reported 4 hours, H1 reported 0 hours, I1 reported 8 hours compared to the class mean of 10.2 hours), could these three students prefer and excel with more linear educational delivery methods as a result of their limited technology background? By contrast, when asked whether they think that hybrid is better than traditional schoolwork they all responded with "yes" and their comments suggested that "combination approaches are good" or that "students increase their proficiency with computers". Ultimately the questions exposed with the students highlighted above cannot be answered with the collected resources however they would provide interesting topics to consider in future research endeavors.

Due to the "busyness" of the data found in Figure 19, the data is re-expressed in different fashions in the figures below followed by further analysis.

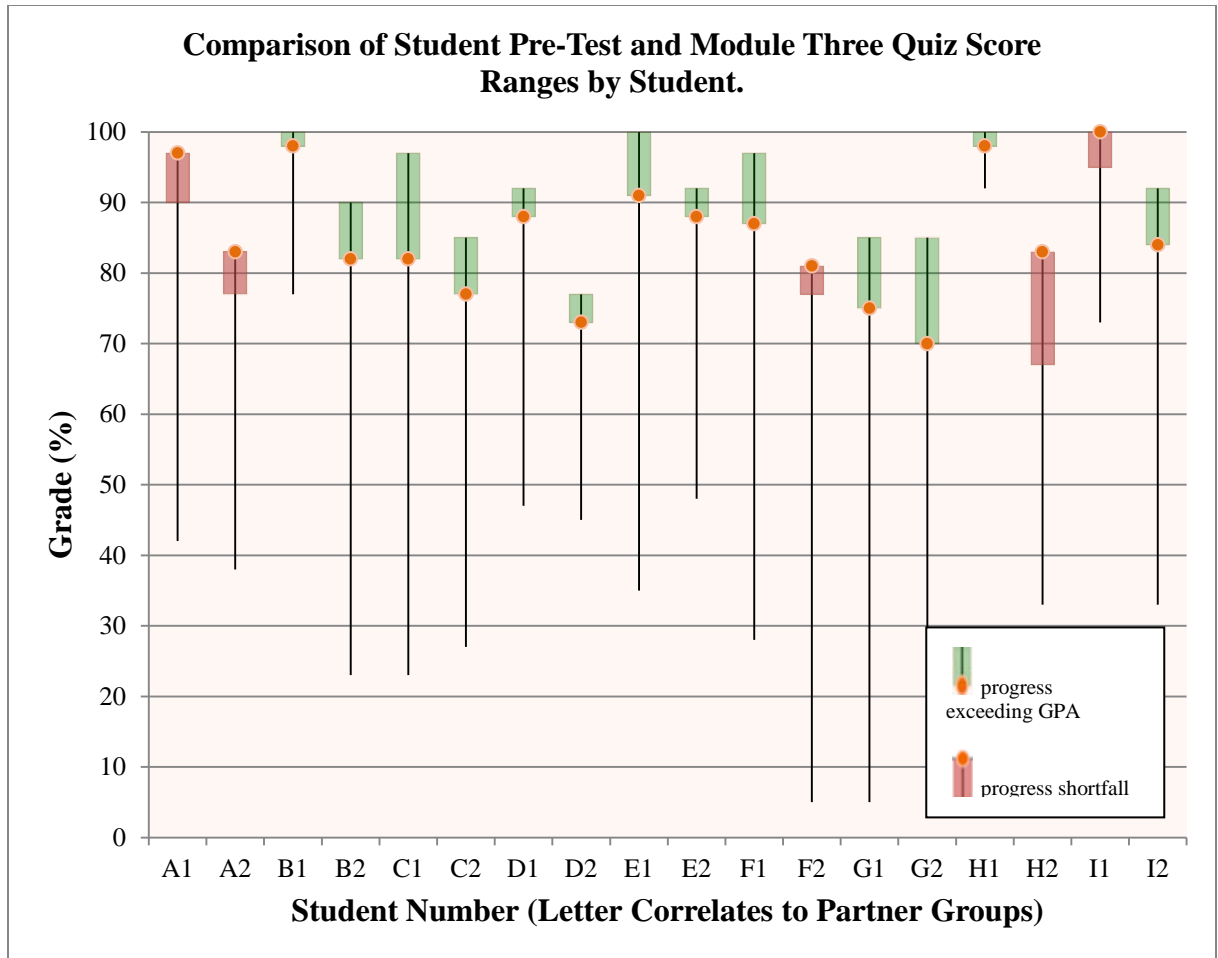


Figure 21. Range of student data comparing pre-test scores with module 3 quiz scores arranged by partner groups, ($N = 18$).

Figure 21 arranges students by partner group (A1 and A2, etc.). Each vertical line represents a student's growth range; the bottom of each vertical line represents the individual student's *Pre-Test* score while the top of each line represents their score on the *Module 3 Quiz*. The orange dot represents individual's cumulative grade percentage calculated from their third quarter core courses (science, math, social studies, and English). The green rectangles displayed on 13 students represents their individual progress on Quiz 3 that exceeds their cumulative grade percentage. The red rectangles

displayed on five students represents their individual progress on Quiz 3 that fell short of their cumulative grade percentage.

Both partners within group A fell short of their cumulative grade average, which could indicate a poor pairing of seventh grade students. Students F2 and I1 showed only minimal shortfalls between their cumulative grade average and their *Module 3 Quiz* score. Student H2 demonstrated the most significant shortfall with a score 16% below their cumulative grade average (83%). This “B” student demonstrated a 62% average on all summative quiz scores. In attitude surveys, student H2 did not express disagreement for the hybrid approach, however the student did not express strong appreciation for hybrid either. The student did suggest that the course should be reused with next year’s seventh graders because “they (next year’s students) can learn new things.” Student H2’s partner did score the highest on the pre-test (98%). Student H2 may have felt intimidated working with a high achieving partner or might have taken less than an active role in the daily hybrid work. This is not an uncommon occurrence between really high students matched with lower students regardless of the educational setting. It is commonly recommended that really high students are most appropriately matched with middle-high achieving students, however in reality this is not always possible based on class dynamics and population sizes.

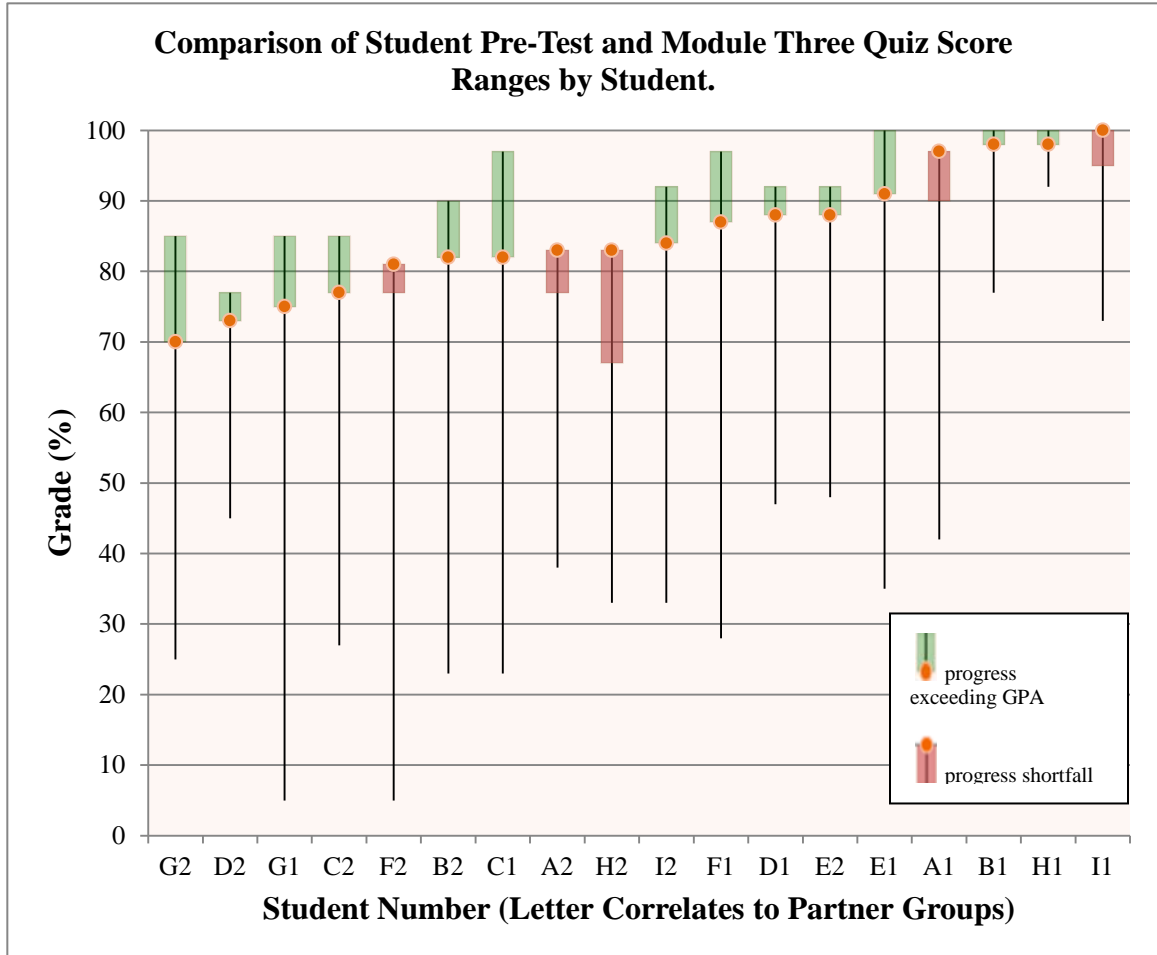


Figure 22. Range of student data comparing pre-test scores with module 3 quiz scores arranged by ascending cumulative grade average, ($N = 18$).

Figure 22 shows similar data as Figure 15; however, the students are organized in an ascending fashion by their cumulative grade averages. The orange circle within a student's score range represents their cumulative grade average (i.e., student G2 has a 70% cumulative grade average). When students are arranged in this manner, it is important to note that a variety of student profiles performed successfully and exceeded their Quiz 3 score exceeded their cumulative grade average. All four "C" range students exceeded their cumulative grade mean by an average of 9%. Three out of nine "B" students had shortfalls but this group's overall Quiz 3 scores exceeded their cumulative

grade by 3 %. Two out of five “A” students experienced shortfalls and this group’s average Quiz 3 scored equaled their cumulative grade average. There are a variety of plausible reasons for these results. Findings might indicate that lower and average ability students were in fact motivated by the hybrid experience and their grades improved accordingly. One postulate for the “A” student subgroup’s relatively smaller growth performance is that it is generally difficult to show significant growth when you’re already scoring at the top of the population. Alternatively, it was noted earlier that three of the high achieving students had fewer hours of technology exposure compared to the mean. They did show growth when comparing their pre-test scores with average quiz scores; however, their quiz scores did not exceed their normal cumulative averages.

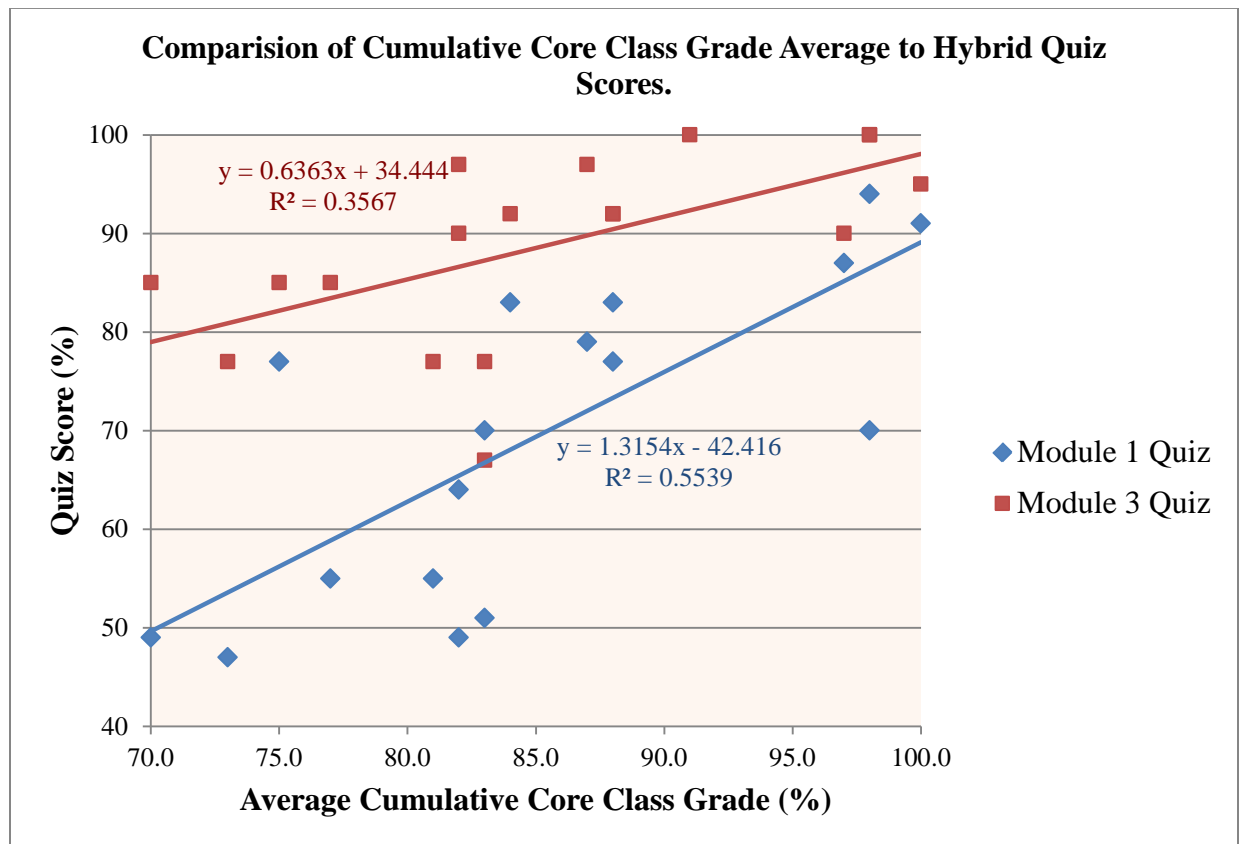


Figure 23. Comparison of cumulative grade average with quiz score from module 1 and module 3, (Module 1 Quiz $N = 17$; Module 3 Quiz $N = 18$).

Figure 23 organizes students by their cumulative core class grade percentages (X-axis) and displays each student's performance on both Quiz 1 and Quiz 3. This figure reinforces the positive growth experienced by low, medium, and high students as they progressed through each module. The blue scatter plot represents individual student scores on the *Module 1 Quiz*. Notice that students who maintained low core class grades exhibited low *Module 1 Quiz* scores. This trend holds consistent with the middle and high student sub-groups. The red scatter plot represents individual student scores on the *Module 3 Quiz*. Although the correlation for both scatter plots is not statistically significant, the vertical distance between best-fit lines represents that a large adjustment occurred in individual students with respect to their *Module 1 Quiz* and *Module 3 Quiz* scores. This scatter plot shows strong growth by the lower achieving subgroup (the best-fit line visually represents the rise in performance from this group). All students may have become more comfortable and confident with the hybrid course. Likewise, the host teacher may have adjusted his teaching practices and the students responded positively. A future research question might compare the growth potential and benefits for students working in partner groups versus students working independently through a hybrid unit.

I observed the host teacher emphasizing with students the use of detail and explanation in their work during several visits. At the beginning of the unit, the common trend for student explanations were very brief statements with little or no detail or connection to the learning experiences from within the module. The following is a journal comment the host teacher made regarding the positive influence hybrid education had on students' efficacy in written communication.

Students did a nice job on the lab and we'll see how the write up goes. With 7th graders, the write up is a major challenge. They want to write the very minimum in order to get by. So that's something we've been working hard on, and that is another positive benefit of these online modules. [*Greenhouse Gas Lab* (Module 2)]

Quiz 3 included several open-ended responses and explanations by students that required specific detailed explanations. I did notice a majority of students included thorough detail rich explanations in Quiz 3 demonstrating a positive response to the teacher's efforts discussed above. For example, when students were asked to explain what the effects of loss in polar sea ice would have on Earth's climate, they responded with rich explanations and many included recently introduced vocabulary terms. "It will rise in temperature because albedo will get less and less sun rays will reflect which will heat the Earth," stated a "B-" male student. A "B+" female student stated, "The less ice the less things light will reflect on so the Earth will get warmer." A "C+" student stated, "I said this because there will be less albedo." One "A+" male student claimed, "Less albedo will make the Earth hotter and also heat the atmosphere," while another replied, "The less ice the less reflection of light into space so earth absorbs more heat and becomes warmer." The responses above are still noticeably stratified by student grade demographic, however it is great to observe lower students using appropriate vocabulary and reasoning skills. Not all students answered this particular question with as much detail, but the researcher noted that students demonstrated heightened writing skills on at least one of the open-ended questions within Quiz 3. An interesting future research study

could focus on growth in student composition and expository skills measured by specific writing rubrics throughout the implementation of a hybrid unit.

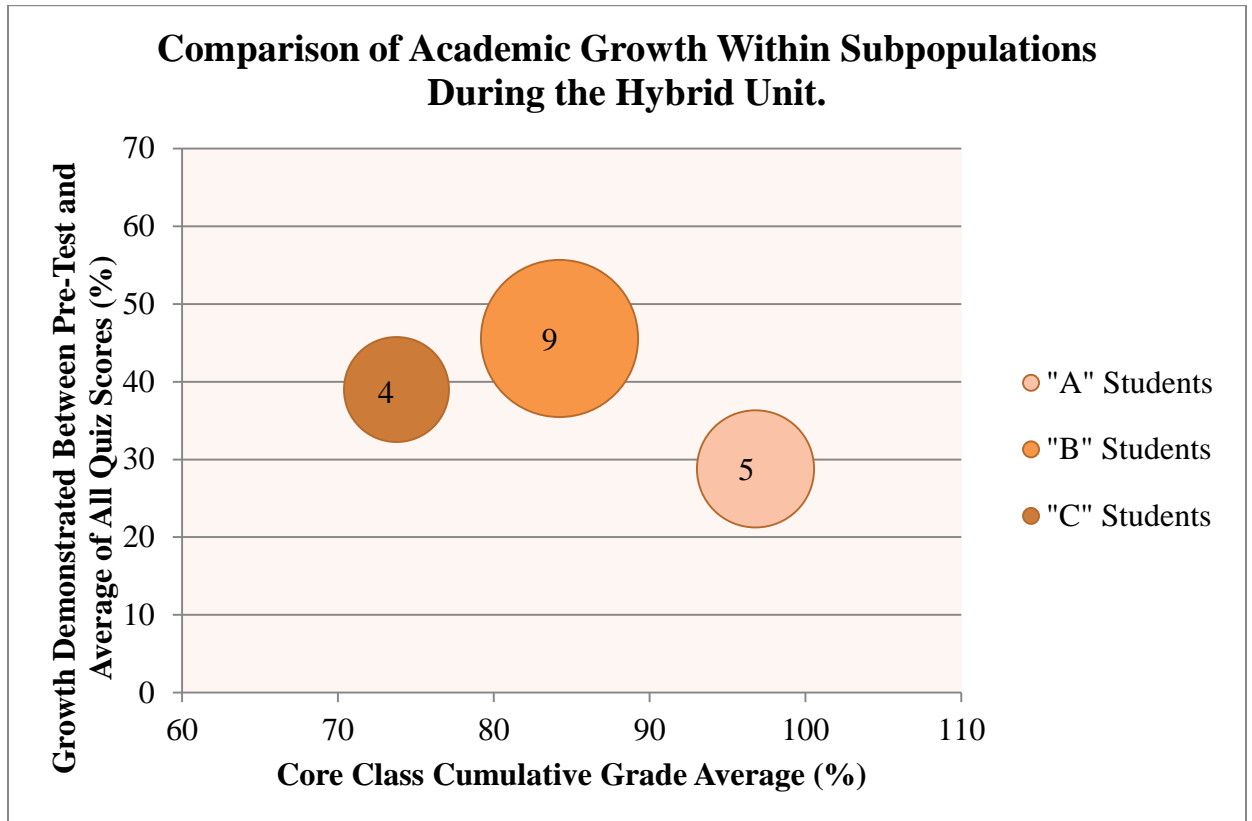


Figure 24. Comparison of academic growth averages for low, medium, and high achieving subpopulations, ($N = 18$).

Figure 24 visually displays the growth by sub-populations as recorded throughout the hybrid unit. Cumulative grade averages were compared with the individual student performance averages on all four of the summative quizzes delivered throughout the beginning, middle, and end of the unit. The four low “C” students demonstrated strong gains almost equal to the “B” population. Although the “A” population did not show as strong of gains, one must realize that it is hard to score significantly higher when an individual is already scoring near the top on the pre-test compared to the rest of the class

population. All of the “A” students did show positive overall growth as compared to their original pre-test scores.

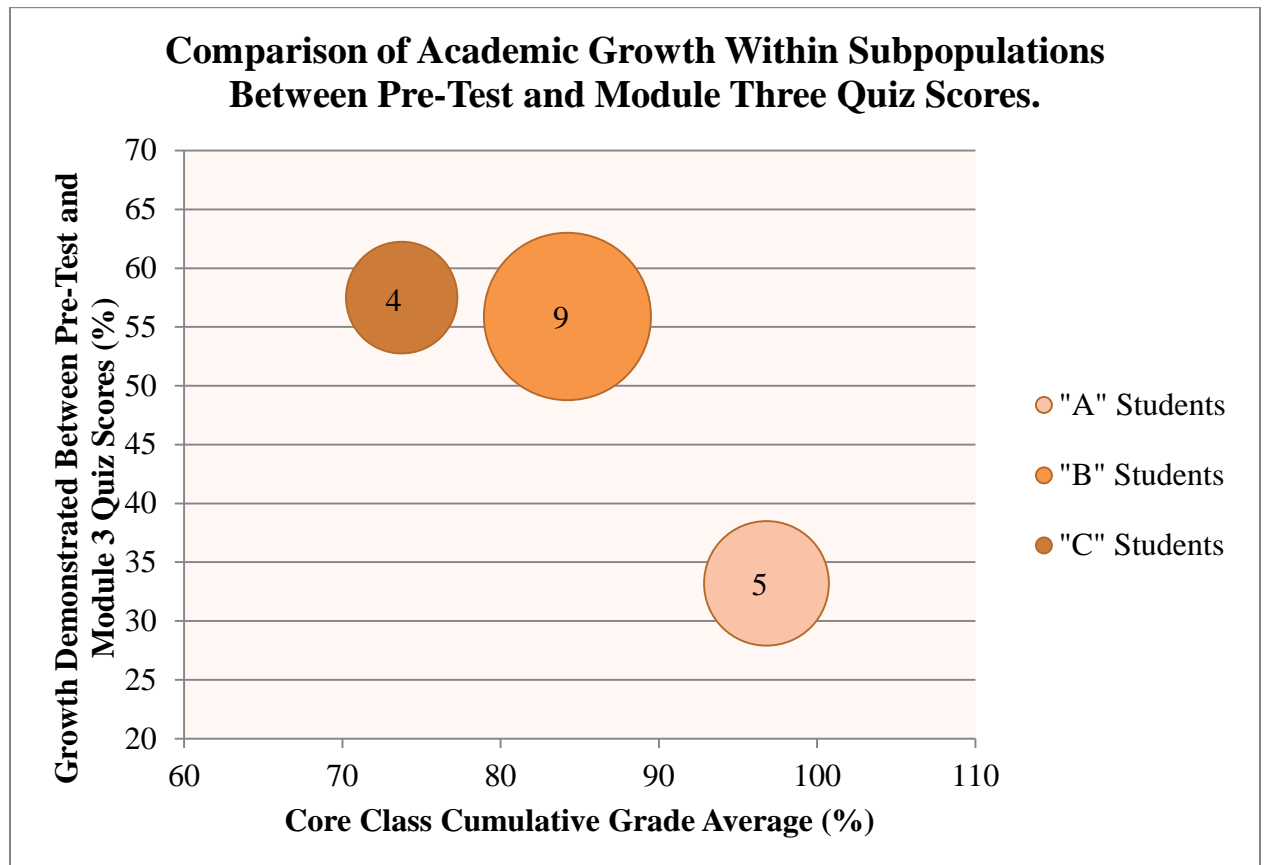


Figure 25. Comparison of academic growth differences between the pre-test and module 3 quiz for low, medium, and high achieving subpopulations, ($N = 18$).

Figure 25 compares pre-test scores with *Module 3 Quiz* scores. As mentioned early, the *Module 3 Quiz* contained rather challenging questions focusing on the core knowledge related to climate science, which serves as a good post-evaluation. It should be noted that a majority of these questions were included on the original pre-test. Notice in this figure that the low achieving “C” students demonstrated the greatest overall growth.

Challenges and Successes for the Host Teacher

The host teacher consistently expressed enthusiasm and enjoyment throughout the implementation of the course. During researcher observations, the classes appeared structured, organized, and busy. The host teacher created his own improvements to several discussion board and blog activities by having students provide additional peer feedback. The host instructed many of the other activities with fidelity for ease of the researcher data analysis, however the teacher did make comments regarding improvements, additions, and subtractions that he would implement if he repeated the unit next year. The host made organizational improvements by creating an assignment matrix to assist in monitoring individual student progress throughout the modules. He also commonly took initiative to explore Blackboard's grade book on his own and also contacted Blackboard's customer support directly once to receive an answer regarding a course layout button. The project did not go to completion without some struggle and frustration: the host teacher uncovered the typical challenges associated with a brand new lesson delivery system along with adaptation to technology, especially at the start of the unit.

Throughout interview discourse and email correspondences, the host teacher expressed appreciation for the thorough design and layout of the course, the curricular materials and activities, and the computer literacy and problem solving skills students faced while working on computers throughout the unit. The teacher utilized the lesson plans (Appendix D) delivered by the researcher occasionally and commented that they would be excellent for a young teacher however he liked to adapt the curricular materials in a manor congruent with his teaching style. He also suggested that the included tutorial

videos (<http://www.youtube.com/watch?v=XtH5a1LYgHs&hd=1>) developed by the researcher were helpful and that he played them whenever time permitted. The host teacher mentioned that the tutorials designed for students modeling more complex activities benefitted many and that students because they commonly reviewed them from their own computer stations even after watching the videos as a class.

The host teacher made only one minor mistake during the initial completion of the Presidential Blog activity in Module 1. The teacher mistakenly had students complete all 12 blog entries rather than the first four, which were assigned for Module 1. The other eight blog entries were to be completed after later modules. As the researcher, I recognize that I could have included more specific notes regarding these expectations within the blog directions. Experiencing only one mistake in sequencing throughout the entire 16-week unit is a success in itself though!

Students rated the host teacher's performance in utilizing the hybrid technology through an anonymous CAT during the eighth week (Appendix N). Students provided a numeric score between one and ten. One represented that the teacher was rough, unprepared, and confusing. Ten represented that the teacher was smooth, knowledgeable, and easy to understand. The mean students scoring for their teacher's performance was a 7.2. The median was a seven and the mode was a six. Three anonymous students who scored him a ten commented: "It went good and he knew almost everything," "It seems like he's already done this before and he was pretty cool," and "He helped us with a lot of it and he gave us time to finish." Students that scored with a six or seven commented that: "He is new to the program and can usually, but not always, solve problems and help," "He doesn't know a few things about the program and how it works", "Some

lessons are good and smooth and other lessons are rougher,” and “He’s doing a good job, but on some parts it’s kind of confusing and that makes him get messed up.” Although this is the host teacher’s first experience with using online platforms in middle school classrooms, he did have extensive knowledge as an online graduate school professor. This background experience was evident in the teacher’s ability to explore, self-instruct, and trouble shoot and his proficiency was reflected by the students’ comments above. A future research question could focus on improving teacher development and support resources, especially for instructors that have limited or non-existent knowledge regarding online LMS.

The adoption for the daily use of computers and hybrid methodologies naturally provides challenges for even the most veteran instructors. The host teacher made the following comments in the Instructor Blog Journal during the first few weeks.

Most students finished the treasure hunt today. It's a great activity as it starts to get them familiar with the course, uploading, etc. I would keep this activity exactly as it is. We spent the usual time on trying to log in again. A few students forgot to save their file from yesterday so they needed to start again (good learning lesson). About half the class will be ready to start the "mouse in the bottle" tomorrow. I really like that this models what students in future hybrid course will need to do. 7th grade is wonderful to begin doing this in. My grading and date labeling is behind and probably will remain behind as I'm not sure how fast student are working. [*Course Treasure Hunt Assignment (Getting Started Module)*]

Today we went over some of the assignments. Many sections of the assignment were missed, one assignment was submitted without any answers (probably the wrong assignment submitted), etc. We went over this, then those students who didn't get information in, could redo this. We also talked about the rubric and the importance of looking at that. Again, I look at these assignments as formative - the grade compared to my normal grading is very small. This should improve as the weeks go by and should be a significant outcome of the study -- it requires time and feedback to improve. [*Mouse in Jar Discussion (Getting Started Module)*]

Students are almost finished with the temperature activity. I really like the "hands on" mixed in with the computer. I notice 100% engagement and even a teacher in the room watching them work commented on how everyone was working. There is a lot of variety -- get survey's, go outside and do the lab, enter data, graph on Excel. So everything is very motivational. We have many of the same challenges as a regular class. I still have about 6 students (30%) that haven't brought their survey results in. I count them late points like they normally get in a class. [*Schoolyard Temperature Assignment (Module 1)*]

We started this activity yesterday with many students finishing it up. We emphasized the use of a rubric and this will take a while before students begin truly looking at it. For some students, it's the lower grade that matter. Then they

will begin to see what is going on. I had a student yesterday who posted in the g-mail an inappropriate message. The student wasn't here yesterday so when they return, I'll deal with that. That's an area an on line instructor will need to be aware of. I never mind that as I look at it as a teaching tool. I'd rather we teach such lessons in school as opposed to the student's first time on the job. Today we should begin to see the end of Module one. Our projector bulb went out so we are "working with what we have" at the moment. I'm happy with the activities and the learning that I'm seeing. [*Monthly Temperature Assignment (Module 1)*]

The excerpts above identify struggles that I feel are natural growing pains that are likely unavoidable and an issue all new hybrid teachers will face. Just as the best-trained student teacher will certainly make mistakes and learn from unforeseen challenges as they enter into the profession, a veteran educator will likely have to make rapid adaptations while they undergo a steep learning curve as they delve into hybrid management. So does the act of receiving and implementing a canned hybrid unit make the experience more agreeable? The host teacher commented during an interview that he would like to create a hybrid chemistry unit in the future but development time would be a major impedance. He likely wouldn't begin until later into the next school year.

In other considerations, the unit required three times more class time than the researcher expected. I personally completed a similar unit within my classroom in approximately 6 weeks; however, the students in that setting brought personal laptop computers to class each day. It was a normal expectation that lagging or absent students worked outside of school to keep up and meet specific deadlines. This was easier than it

sounds because students could access everything they missed online. Students would also receive routine homework assignments that were based within the online hybrid course, which dramatically expedited the unit's completion time. The host teacher did a wonderful job when juggling lagging students, however since the work was completed on a desktop computer; progress stopped each day at the outset of class. Temporal requirements will remain an important consideration for instructors choosing to embark into the fully hybrid course using only desktop computers. Whenever possible, one-to-one laptops or pad devices that students can take home should be utilized to expedite course completion (many schools across the country and world are already experimenting with this policy).

The host teacher expressed challenge with computer activities working correctly on several occasions. Often times this was due to the lack of a necessary plug-ins such as Flash or QuickTime, which is an issue instructors will likely face at one time or another. The host did a great job of turning these roadblocks into teaching opportunities in computer literacy, problem solving, and collaboration. During one observation, I noted how the host teacher maintained a routine response when students struggled while interacting with a website simulation; the host briefly coached the struggling students toward working it out together or to ask other successful groups prior to giving up and relying on the instructor. The students returned to their workstation and conferred with a neighboring group, which led to success with the simulation. Another issue that the host teacher did not face, but is a common issue to many schools, is related to the speed and capacity of the schools Internet infrastructure. Teachers need to keep a "Plan B" ready when technology interrupts, because at some point it will.

Finally, the host teacher recommended that a “green” teacher completely new to online LMS platforms would certainly need lots of time and support during the development of their own hybrid course. The host agreed that ongoing staff development should take place, which would allow teachers the opportunity to slowly dabble by trying one new tool every week or two within their traditional classroom.

Challenges and Successes for the Online Developer / Consultant

The hybrid course was successfully implemented over 16 weeks and received positive feedback from both students and host teacher. A large majority of students shared positive comments supporting the repeated use of the hybrid unit with next year’s seventh grade (94%), many stated that hybrid is fun, that it is better than traditional schoolwork (75%), they demonstrated daily enthusiasm and motivation, and all students showed educational gains. Students likened hybrid over traditional bookwork and lecture [(only one student disagreed (6%)), meanwhile all students revered the inclusion of hands-on science labs to be very important. Students found value for the inclusion of hybrid activities in other content areas especially English or social studies. Very few students (typically less than 18%) expressed disagreement with the hybrid approach.

The host teacher shared appreciation regarding the course design, layout, aesthetics, and functionality. In an interview, he commented that it was “obvious that you (researcher) have developed these before” and that the course was “easy to follow due to the linear nature of the assignments within each of the modules”. In an exit interview, the host also stated that the aesthetics were fine and the consistent colors highlighting each lesson’s title, objectives, and directions helped 7th graders with their

focus.

The host teacher made frequent comments regarding the excellent nature of the hybrid experience. In one email, the host teacher reported that, “The idea of online learning is brand new to my 7th graders so this is FANTASTIC. It's one of the high points right now. It's also great to see the excellent activities, websites, resources, etc. New material partly coming from a new source -- EXCELLENT.” In another email, I (researcher) offered to pay for printing fees, but the host retorted that the “school should be paying you for the excellent curriculum.” The host teacher included the following excerpts regarding daily lessons in the Instructor Blog Journal.

Good day today with the climate change activity. It's helpful to have this type of activity as it shows students that they need empirical evidence. They just can't believe common opinion. I also like it that they have lots of choices and need to pick four. This helps them sort through and find the best material for their work. This models very nicely what they will be doing the rest of their lives. [*What Are Some Physical Signs of Climate Change* (Module 3)]

We should be finishing our Greenhouse Gases today. The data that I've seen looks great. Students did a nice job on the lab and we'll see how the write up goes. With 7th graders, the write up is a major challenge. They want to write the very minimum in order to get by. So that's something we've been working hard on, and that is another positive benefit of these online modules. [*Greenhouse Gas Lab* (Module 2)]

This activity is a good one as we addressed Dendrochronology earlier in the year when we did plants. So this is a wonderful way to review. On the activity - it had the students find their birthday, and the trees samples were not young enough for my student's birthday. So instead I had them graph the year as compared to the growth rate. This turned out very well, and an extension on this could be to write a narrative on the history of the area based on the climate. Good activity for us.

[*Dendrochronology Lab*, (Module 3)]

The host teacher's comments above indicate appreciation not only for the content, but also for the important life skill learning opportunities that manifest themselves within hybrid delivery. Students need to be able to critically evaluate information sources delivered in today's media, they also need to have the freedom to make research choices, as well as benefit from new modes of communication that parallel trends in the workplace. The host teacher also indicated the ease in which he modified a lesson on dendrochronology, which emulates one of the major benefits that will emerge from teacher's sharing hybrid-based units. Essentially any instructor will be able to easily modify any content according to their instructional preferences and student population needs!

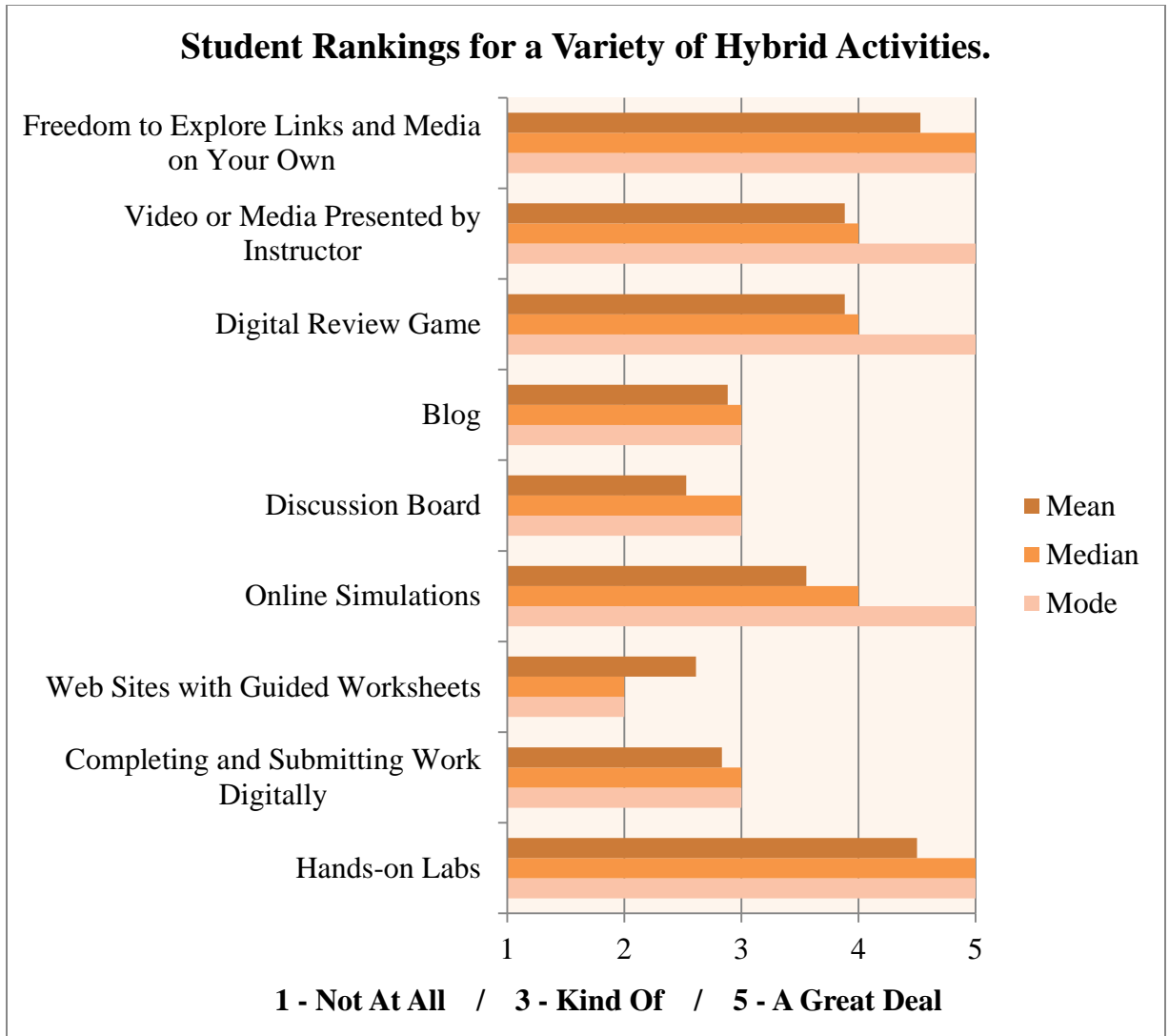


Figure 26. Summary of numeric student rankings for hybrid activities, ($N = 18$).

Figure 26 demonstrates student preference by activity type, which was collected via a survey (Appendix O). Five of the activity types included in the hybrid unit received average scores of three or greater, representing heightened student appreciation. Two activities' mean scores registered just below "3 – Kind Of" and two others were more significantly below with a mean score of 2.5.

One interesting finding was the variability in student scores and response for each activity type, for instance every activity received at least a score of "1 – Not At All" from

at least one student (except for “Hands-on Labs” and “Freedom to Explore Links and Media on Your Own”). Conversely, every assignment received a score of “5 – A Great Deal” from at least one student as well. This demonstrates the need for differentiated activity types for different learning styles. Ultimately, a goal for hybrid developers could be to create three different activity types for each content standard thus allowing students the choice in instructional delivery. This would likely take years of development time, reflection, and honing but the rewards would be worth it.

Four of the five highest scoring activities were ones that included lots of student interactivity. A variety of students commented that they liked the Online Simulation (mean score 3.56) [*Measuring Albedo Simulation (Module 2)*] because “I get to change and interact with the sim,” “You can see how stuff effects other stuff before it happens,” “You can go off with them,” “It was fun changing the variables in the computer,” and “Very fun – I like seeing worst case scenarios.”

Students commented that the Digital Review Game (mean score 3.88) [*Weather and Climate Review Game (Module 1)*] was “Fun and a good way of memorizing,” “Games are a lot more fun,” “They help me learn,” and eight students repeated: “It was fun.”

The highest documented scores were for Hands-on Labs (mean score 4.50) and Freedom to Explore Links and Media on Your Own (mean score 4.53). Student appreciation for labs is no surprise in a science course and consistent with earlier findings. Equal student appreciation for the freedom to explore is an exciting finding demonstrating younger generations enthusiasm toward the available wealth of knowledge at their fingertips. The Freedom to Explore activity type was emphasized during the

Presidential Blog (ongoing at the outset of each unit) and twice in open-ended research focused activities [*What Are Some Physical Signs of Climate Change Activity* (Module 3)] and [*Global Challenges for Earth's Inhabitants* (Module 4)]. The Presidential Blog required students report out on essential questions addressed within each module as well as requiring students to connect real world examples and connections into their responses. They could do this by selecting and embedding media collected from the web, which provided unbridled freedom for student exploration. As a side note, the host teacher commented that it was difficult to get the students to make a final choice in the Presidential Blog because they were so interested in exploring more resources. This enthusiasm speaks to the power of information at students' fingertips, which is something that 20th century research activities using dusty encyclopedias struggled to deliver.

The second research-based activity provided students with a folder of pre-selected primary source media and text resources appropriately collected by the researcher for the age group. Students had the choice of scanning and selecting four resources from a large variety of topics. The students conducted research by completing notes for each resource within a pre-scripted "note catcher" template included in the module activity. Students commented that these activities "Gives you a sense of freedom and shows adults have trust in us," "Feel more responsible and trusted to do it our self," "I enjoyed surfing the web on my own and not being told what to do," "I can choose my very own media," "exploring was fun," and five students commented, "I like freedom". The host teacher commented warmly regarding this activity in the Instructor Blog Journal, "I like that they have lots of choices and need to pick four. This helps them sort through and find the best material for their work... (and) models very nicely what they will be doing the rest of

their lives.” As a side note, I (researcher) had no experience with using activities like these before but designed them after uncovering research noted in the literature review regarding the parallel thought processes exhibited by digital generation learners. I’ve witnessed failed attempts in the past by teachers with great intentions attempting sophisticated independent student research projects using online resources. I’ve learned that providing students with a deliberate focus as well as a very structured research environment is an important necessity for success. The fact that I, acting as the course developer, could successfully build this structured inquiry-based environment for another classroom is an exciting small measure of success within the project.

Figure 26 revealed that students really enjoyed the Videos and Media (mean score 3.88) included for the host teacher to present to the whole class. Many of these climate science clips were age appropriate and produced by NASA’s Goddard Space Institute or CBS Learn. Students commented that “They are entertaining and I learn from them,” “They are interesting and fun to watch,” “I can remember a lot more from media,” “I liked the information in most of them,” “The videos can share more evidence,” “Kind of fun listening to the right people,” and “Always include something to watch or read.” With the growing number of clips on YouTube and websites producing videos with embed codes readily available, teachers are now enabled to plug in three minute videos for a “hook” that perfectly explains a complex topic by a leading research scientist from anywhere in the world. The scores and comments provided by students above demonstrate that this content should certainly be included in hybrid courses.

Figure 26 identifies that students did not appreciate blogs (means score 2.88) and discussion boards (mean score 2.54) as much as other activities. Comments for the

discussion board included that “Discussion boards are OK, but they are plain and boring. Try to spice it up,” “Kind of boring,” “They are OK,” and “Cool to see what others have to say on the subject.” Students commented that the blogs were “Quick and easy to get to and easy to submit,” “Good for sharing and comparing,” “Fun to talk to people by computer,” “Allows you to look at other peoples suggestions,” “Fun to see what people think about different things,” and “Very boring but you get to see what other people said.” The blog and discussion activities used in the unit were simplistic in nature and did not fully engage students in repeated peer discussion or cross commenting, which many educators believe to be a valuable use of the tool. In fact, many of the activities utilized throughout the unit were designed as simple as possible to merely introduce the host teacher and students to the possibilities hybrid can facilitate. Personally, I feared that utilizing more involved and complex instructional scenarios would potentially confuse the participants. The host teacher successfully experimented on his own by having students read and comment on other student’s discussion threads [*Warming Arctic Discussion* (Module 2)]. An interesting future study would be to further compare student enthusiasm and educational value gathered from more complex hybrid social communication activities.

The activity type receiving the second lowest score in Figure 25 was Web Sites With Guided Worksheets (mean score 2.61). Interestingly, these activities (three total) were taken directly from a digitized textbook resource posted online, which was created by McDougal Littell and designed in conjunction with the National Science Foundation. The site conveyed excellent information resources regarding climate science and each utilized several simple interactive graphs or maps. They also typically included guided

research prompts with supporting auxiliary web sites as an option for students to explore further on their own. From an instructor's perspective, these sites were rich in relevant information and recent research, however from the student's perspective they "Are very boring and they don't hold my interest," "Kind of dull," "They were long and boring reading uninteresting topics," and "They are very boring and they don't hold my interest." One student did rank the activity type a five stating that, "You don't have to turn pages and you can write your answers right there (digital worksheet)." The researcher feels that this type of activity has its place in hybrid but that more work should be done to improve the "likeability" of the activity. An instructor could create similar activities using SoftChalk, which would allow for built in formative assessment questions along with pop-up game-like quiz scenarios thereby enhancing the interaction from students and possibly reducing boredom.

The host teacher did make comments regarding a few lessons that were not rigorous enough such as the *Schoolyard Temperature Activity* and suggested more frequent use of activities that worked great such as the StudyMate Class review games [*Weather and Climate Review Game (Module 1)*], formative pop-up assessments within SoftChalk lessons [*Differences Between Weather and Climate Assignment, (Module 1)*], peer-to-peer communication within blogs and discussion boards, and appropriate use of the Presidential blogs. I concurred with the host's sentiments and he understood that more of these interactive activities could easily be included, but it was my intent to provide a diverse spectrum of activity types in order to expose the host and students to a wide variety of hybrid activities.

Finally, the host teacher commented that he would like to apply some of the lesson ideas into the online graduate courses he teaches, such as the formative assessment questions embedded within the SoftChalk lessons. He also mentioned the prospective use of the Presidential Blog activity with middle school students following the completion of science labs. The fact that a veteran teacher discovered a few new lesson ideas and available tools demonstrates the desired and successful impact of a consultant providing a canned unit in order to share and express a variety of best practice activities for the host to take away.

INTERPRETATION AND CONCLUSION

Overview

The study provides evidence that hybrid education has beneficial impacts on students' attitudes, engagement, and achievement. The host teacher also communicated examples of growth and plans for future adoption of strategies and methods available from hybrid methodology. Acting as the online consultant (researcher), I gained important insight regarding the creation and implementation of a hybrid curriculum for others to use. Individual conclusions regarding impacts upon students, host teacher, and online consultant will be discussed separately.

Research Questions

In question number one regarding the characterization of attitudes, engagement, and achievement levels for students participating in their first hybrid online unit, I

uncovered a 75 % student approval rating for online over traditional forms of education while the rest were either indifferent (18%) and only one student disliked (7%) hybrid. Eighty eight percent of students preferred hybrid over bookwork and 70 percent preferred it to traditional lecture (Figure 15). Fifty-nine percent of students felt they remembered more from hybrid than they do from bookwork or lecture (Figure 16). Students frequently stated that hybrid education was fun and benefits included the ability to easily go back and review as well as the content's temporal flexibility and remote accessibility. Seventy six percent of students also believed that the hybrid strategies included in the climate change unit would work well in other classes (Figure 14).

The hybrid unit demonstrated positive impacts on student engagement and attitude, which I observed and noted during all four observations. Students demonstrated rapid transitions between the f2f classroom and the online environment, demonstrated self-direction, excellent collaboration between partners, and autonomous workflow organization and goal setting. Students strongly disagreed with the statement "I never want to take an online course again" (Figure 14). These findings support the use of hybrid methodologies and contrast significantly with the negative attitudes collected from K-12 students who are forced into a fully online course first (Figure 2).

By week 10, 88% of students expressed overall ease in course navigation and 76% reported that directions were easy to follow (Figure 13). Students expressed anxiety in the first few weeks, which is a natural part of the learning curve associated with adapting to both a new learning system and daily use of the computer in class for the first time. The fact students found the course easy to navigate in later surveys represents a huge success since it was their first hybrid course that was developed by an outside

consultant and implemented by a rookie host hybrid teacher. A majority of students also expressed assignment directions were easy to understand, although a few students suggested that some of the words in the directions were difficult to understand.

All students demonstrated significant growth with regards to climate science (Figures 19). The class average increased on each summative assessment (Figure 18), which is a likely reflection of the students' comfort with the LMS and hybrid approach (as well as the teacher's increased pedagogical efficacy). Thirteen students exceeded their cumulative grade average in their core courses by the Module 3 Quiz (Figure 22), which included challenging questions collected from a practice AP Environmental Science Exam. "C" students demonstrated the largest academic gains (58% growth) with "B" students closely following (56% growth) and "A" students last (33% growth) when comparing pre-test scores and results from the Module 3 Quiz (Figure 25).

Students expressed the lowest rankings for the "Web Site with Guided Worksheet" activities and many described them as boring. Students consistently ranked activities with lots of interaction the highest, such as independent research, hands-on labs, games, and simulations. The web site activities were designed by a major textbook manufacturer and they delivered rich meaningful content related to current topics in climate science. Could student approval ratings improve if the website content was adapted to include pop-up formative quiz questions and review games? These activities could easily be modified to include greater interaction next time by using SoftChalk software.

A secondary finding showed that students transformed themselves with skills in computer literacy (as well as the topic of climate science). One student mentioned during

an observation that it was his first ever attempt at completing an email (during Getting Started Module). I noted in the *Instructor Blog Journal* that many students provided very simple responses in the Mouse In Jar discussion (Getting Started Module) however they evolved their written communication skills tremendously throughout the unit thanks to consistent modeling and reinforcement by the host teacher. Students that began the unit with short simplistic statements later articulated developed written responses using thorough analysis combined with specific sources of supporting data or evidence collected from their research or lab findings. Students also demonstrated critical analysis for their peers' ability to communicate, which was brought forth through peer review of blog and discussion board posts. The host teacher took this liberty on himself, which demonstrates a more complex use of the tools and basic activities designed within the modules. The noticeable advancement in student communication skills is an excellent preparation for the dynamic workplace ahead.

For the second research question regarding the challenges and successes experienced by the host face-to-face teacher, it was found that the host enjoyed implementing the course, gained several instructional ideas to re-use, and would consider creating his own hybrid LMS for his chemistry class when time permits. The instructor found secondary value regarding students' growth in computer literacy, problem solving, and expository writing and communication skills. The instructor noted on several occasions how valuable the hybrid experience was for middle school students as it prepared them for their future academic endeavors and life skills. The host teacher thoroughly expressed appreciation for the variety of activities and excellent curricular materials included throughout the unit. He also expressed several times how simple the

course was to navigate, how helpful the linear design in assignment workflow was for both himself and the students, and how helpful the aesthetics, font size, and font color were in guiding students and teacher.

Both the host teacher and students expressed frustration with some of the early assignments and suggested that these intro activities should contain more academic content in order to be temporally efficient. As the developer, I intentionally included a variety of introductory assignments in the first two modules in order to ease students and host teacher into the hybrid environment. Many of these assignments focused on computer literacy but were light on academic rigor. Upon reflection, some of these activities were more beneficial than others. The host teacher expressed support for the *Course Treasure Hunt* and introductory videos, however assignments such as the *Schoolyard Temperature* assignment overdrew valuable time. In my personal background experience designing and implementing over 20 hybrid courses, I found a gradual initiation process for students entering into their first hybrid course environment was very important and that negative consequences can occur if students are thrown into rigorous assignments too quickly. On the other hand, it appears from the findings above that a balance needs to be struck. Introductory LMS skills could be combined with more rigorous content and graded using formative assessment coaching feedback rather than summative scores during the first module.

The host teacher uncovered some typical frustrations that are associated with technology, such as the necessity for every computer to be prepared with appropriate plug-ins. He also observed the steep learning curve that is associated with students initially navigating the course, completing work with high levels of quality, and simple

tasks of uploading assignments. By week four, I personally observed that many of these frustrations had been successfully overcome and that students quickly and independently transitioned into their computer stations while starting their daily work with ease.

A secondary and unexpected finding was uncovered regarding the rate of assignment completion when students are working solely on desktop computers. I anticipated the project requiring roughly six weeks, when in reality it encompassed more than 16 weeks. One major reason was that students would have to suspend work daily on fixed desktop computers then resume again the next day. If students had 1:1 mobile computing capabilities then unfinished assignments could be taken home and completed for homework thus rapidly advancing assignment deadlines. Another plausible reason the unit took so long was that a rookie host teacher and relatively young student population will naturally need increased time frames to work through growing pains together. It would be interesting to see if the host teacher could repeat the same unit in a shorter period of time as a returning veteran with a new sample population.

For the third research question regarding the challenges and success experienced by the online developer and consultant, it was found that a hybrid unit can be successfully designed by an outside consultant and implemented via host teacher. Students expressed appreciation and preference for the hybrid methodology over traditional lecture or bookwork, which was witnessed through observations and attitude surveys (Figure 14). Students' knowledge of climate science improved significantly throughout the unit (Figures 18, 19, 21 - 25). The host teacher voiced appreciation for the simple linear design of the course and valued the curricular materials provided. The host teacher also

expressed gratitude for the accompanying lesson plans and tutorial videos although he stated that he used them whenever time permitted or if he became stuck.

I found that developing a course for a third party was a lot more challenging than creating a course for your personal classroom. The attention to every last detail became so important in order to make sure the host teacher and students understood each and every assignment. Hours were spent simply connecting internal links consistently throughout almost every lesson with the course. Although this takes a lot of time, it greatly benefits the students because it builds consistent expectations and navigation pathways. There's nothing worse than losing students when they log in to find, complete, and submit work. These internal links are something that I used only occasionally in my personal hybrid courses because it was just as easy to model the mouse clicks for my students, but when you're developing for other teachers it becomes vital.

Another superficial aspect that required additional development time was increasing font and altering text color for assignments (title – blue, objectives – green, directions – black). This certainly isn't necessary however it remains the researcher's opinion that course navigation becomes more reliable when a unified appearance exists with every assignment throughout the unit.

Finally, due to the controversial nature of the climate change topic, I spent nearly 80 hours researching the best grade level specific activities, resources, and lessons related to climate science in order to provide reliable and informative curriculum. I feel that the curriculum research hours I invested were magnified by the ample media rich resource options the Internet provides and that similar hours would not be necessary if I were composing a simple text based curriculum.

Future Research Considerations

The implementation of this hybrid unit uncovered a variety of new questions for consideration. They are as follows:

- How can host teacher performance be enhanced? What types of development and support activities are most appropriate?
- How does partner grouping impact individual student performance compared to students working individually?
- How do hybrid activities impact students' expository communication skills?
- How does the use of a hybrid unit impact student's computer literacy skills?
- How does hybrid's impact on student attitude and performance compare to a full text based curriculum containing similar content?
- What are the classroom management challenges and successful practices associated with using hybrid technologies?

VALUE

The process of successfully developing a hybrid curriculum for another teacher required thorough planning down to the smallest detail including designing the online course architecture, building consistency with individual assignment directions and aesthetics, and extensive research into curricular resources. The *Climate Science* unit was far superior in design to any course I created in the past for my own classroom. The successful implementation, supportive feedback from both students and host teacher, and

the strong academic achievement expressed by the seventh grade students further reinforces and supports my belief that hybrid education provides significant potential for educators. The following table includes suggestions for new teachers embarking on the design and or use of hybrid course content (in addition to the tips previously conveyed within Table 3).

Table 5
Hybrid Course Design Suggestions

Course Architecture and Design

Only one-seventh grade student (6%) stated the course was difficult to navigate and one (6%) claimed the directions were not easy to follow, (N = 18).

- Build the course with specific units or modules in mind, similar to the chapters of a book. Organize these chapters with folders within the assignment content area.
 - Keep the course navigation buttons simple. Try to establish a consensus with other instructors in the school in order to minimize confusion for students completing multiple hybrid courses (see Figure 7).
 - Organize activities in a linear fashion within each module.
 - Certain content choices within Blackboard don't contain opportunity for submission and scoring such as *Items* or *Files*. Try building a practice student account in order to log in and participate with a couple of activities from the student's perspective before building an entire course. If you didn't know better, you could build a bunch of great activities without the ability to collect and grade them within the LMS.
 - Build repetition with the layout and assignment information (objectives and directions) used throughout the course. This builds normalcy, trust, and simplifies expectations for students (see Figure 8).
 - Courses navigation can easily become confusing for even the most veteran online student because there are often multiple paths to the same content. Build trust by including an assignment description and internal course link for every activity utilized within each module. For instance, if the module includes a discussion board activity, then build a link within the chronologic order of assignments inside the module. Avoid just building a discussion thread elsewhere and verbally directing students. Absent students or students not paying attention will not be able to follow.
 - Include the date the activity was initiated in class within the title (in parentheses). This reassures students that they have found the proper assignment (see Figure 8).
 - Be sure to utilize the correct assignment title when referencing it elsewhere such as in the course calendar.
 - Embed meta-data navigation links into text (such as in the calendar) whenever a course link drop down menu is not available.
 - If time permits, make routine complementary font colors stand out for objective and directions contained within each activity. This helps students focus on one activity at a time (see Figure 8).
 - Fix mistakes as you find them or immediately after class.
-

Table 5 Continued
Hybrid Course Design Suggestions

Course Activities

75 percent of seventh grade students thought hybrid was better than traditional schoolwork, (N = 16).

- Begin by trying to use one LMS tool or activity per week within the classroom. Use the tools more frequently once you and your students are ready to commit.
 - Utilize a positive attitude and deliver with enthusiasm in order to keep student morale high. Impress the importance of preparing students for online college courses or certification courses in the workplace. Online activities may be new for a variety of students, so expect some resistance for change from some of the population.
 - Work with a colleague and share experiences and resources. Digital activities can easily be shared between colleagues within a LMS platform.
 - Include a course treasure hunt that requires students download materials, navigate the course, record findings and locations, and then upload a completed assignment. Also be sure that students know how to use the LMS email in the event they get stuck while away from school.
 - Utilize a variety of online and face-to-face activities within your hybrid unit. Don't use digital tools just because – use them when they offer resourceful advantages.
 - Many traditional lessons are easily adaptable into the LMS and often times they are enhanced due to digital resources capabilities.
 - Commit to using the LMS for everything. Blackboard Coursesites offers a lot of native tools such as blogs, wikis, discussion boards, email, quizzes, games, e-book authoring opportunities (Softchalk), etc., but the site also provides the flexibility to add mashups including the best tools on the web. Instructors can mash-up web 2.0 sites including Google Docs, Blogger, Wikispaces, and practically any informative web site can be viewed directly within the course skin. Embedding these web resources within your course module provides easy navigation for students since everything is located through one centralized portal.
 - Students rated hybrid lessons with heightened interactivity the best (Figure 26). It is important to introduce simple lessons at first allowing students to adjust to the hybrid environment, however begin using more complex lessons requiring enhanced student interaction with the content and between each other as soon as possible.
 - Students provided the highest rankings for activities that provided them freedom to explore ample media resources that were pre-selected by the instructor (Figure 26).
 - Students provided poor rankings for activities that included basic web based text and guided worksheets (Figure 26), however this is unfortunately one of the most frequently overused activities by novice hybrid instructors.
 - Spice up discussion boards by having students “judge” their peers’ responses followed by an explanatory rationale. This forces students to read through a variety of other classmates’ responses thus learning to appreciate the diversity of opinions others’ have. It’s a great practice activity that helps segue students from simple discussion board statements toward providing rich expository writing that their peers will review.
 - Include exemplars, benchmarks, and rubrics (analytic or holistic) whenever possible (see Figures 10 - 12).
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Table 5 Continued
Hybrid Course Design Suggestions

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- Provide constant ongoing modeling and reinforcement of expectations for students, especially in the first months.
 - Provide frequent timely formative assessment feedback that coaches students toward forward progression with digital citizenship and work habits.
 - Include video tutorials whenever possible. Students appreciate the option of playing video tutorials and stopping it at their own pace when completing activities requiring multiple complex steps.
 - Upload tutorial videos first to YouTube then embed them into the digital course using the YouTube Mashup in order to expedite download time.
 - Utilize a variety of short content videos collected from Blackboard's partner CBS Learn or YouTube. Students enjoy these three to four minute clips and it provides a stimulating change of pace from normal instruction (Figure 26).
 - The students and host teacher enjoyed the review games (Figure 26) so begin using StudyMate review with teacher-generated content. Have students begin recording three of their own questions during the second module. Provide a holistic rubric and model what a good game question looks like. Be sure to screen student questions for possible misconceptions or errant answers. Have students modify or build upon the question bank in following years.
-

Hybrid Don'ts

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- An online LMS platform has much to offer. Don't stop short by simply using it as a digital file cabinet for students to access worksheets.
 - Don't create elaborate lesson descriptions for each *day* of the course. Do create lesson descriptions for each *activity* within the course and remain flexible if the activity lasts more than one day. This allows each activity to be easily reused the following year without major editing.
 - Don't create a massive list of assignments without logical organization. Do utilize folders to organize your lessons sequentially by unit or module.
 - Avoid creating digital communication activities, such as blogs, wikis, or discussion board prompts using questions that generate simple yes or no answers (unless it's a warm-up post used to generate rapid student response).
 - Don't create too many course introduction activities without including more rigorous content. A balance needs to be struck. Three course introduction activities should be sufficient.
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The above list is a short set of recommendations based on the findings of this study and the researcher's past classroom experiences. Hybrid offers endless creative instructional opportunities and listing more complex uses is beyond the scope of this paper. With the increasing accessibility of computers and pads in classrooms, hybrid

education should be viewed as a valid approach that enhances traditional pedagogy, augments informational content and delivery, safely introduces 21st century workplace skills, and further prepares our nation's students for the challenges they will confront in the rapidly changing technocratic world.

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APPENDICES

APPENDIX A

LIKERT-SCALE SURVEY OF STUDENT ATTITUDES TOWARD ONLINE AND
FACE-TO-FACE.

Name: _____ Online Course(s): _____

Participation is voluntary, and you can choose to not answer any question that you do not want to answer, and you can stop at anytime.

Your participation or non-participation will not affect your grade or class standing.

SD – Strongly Disagree D – Disagree U – Uncertain A – Agree SA – Strongly Agree

1. I enjoy school. SD D U A SA

What do you like best about school?

2. I prefer online classes. SD D U A SA

What is it about on line classes that you like?

3. I prefer face-to-face (f2f) hybrid classes. SD D U A SA

Why do you say that?

4. I feel that I learn more in online classes. SD D U A SA

Why do you say that?

5. Online courses are more challenging. SD D U A SA

What is the most difficult aspect?

6. I would recommend online courses to a friend. SD D U A SA

Why do you say that?

7. I am very organized with online courses. SD D U A SA

What do you do to stay organized?

8. I am very successful with online courses. SD D U A SA

What grade are you happy with?

9. I never get behind in my online class. SD D U A SA

How do you manage your time?

10. I am very organized with f2f hybrid courses. SD D U A SA

What do you do to stay organized?

11. I am very successful with f2f hybrid courses. SD D U A SA

What grade are you happy with?

12. A mentor helps me stay organized with my online class. SD D U A SA

How does a mentor help you?

13. I would be just as successful on my own. SD D U A SA

Why do you believe this?

14. Conversational sessions with my mentor are very helpful. SD D U A SA

What do you find most beneficial?

How could these sessions be improved?

15. Taking notes for my online class helps me. SD D U A SA

How do they help?

16. I would like more strategies to help improve online work. SD D U A SA

17. I would like more school time for online work. SD D U A SA

18. I am very skilled with online technologies. SD D U A SA

19. I would like extra help managing online technology. SD D U A SA

What are you struggling with?

20. I prefer Aventa over Colorado Online. SD D U A SA

Why do you say that?

21. My Aventa Teacher provides helpful feedback. SD D U A SA

How could they improve?

22. I remember what I learn in an online class. SD D U A SA

Estimate the percent of information you can remember.

What types of information do you remember the best?

23. I remember what I learn in a f2f hybrid class. SD D U A SA

Estimate the percent of information you can remember.

What types of information do you remember best?

24. Being honest during a test is difficult online. SD D U A SA

25. Describe how much time you spend completing online work in a week.

APPENDIX B

ISTE'S NATIONAL EDUCATION TECHNOLOGY STANDARDS FOR STUDENTS

1. Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students:

- a. apply existing knowledge to generate new ideas, products, or processes.
- b. create original works as a means of personal or group expression.
- c. use models and simulations to explore complex systems and issues.
- d. identify trends and forecast possibilities.

2. Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students:

- a. interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
- b. communicate information and ideas effectively to multiple audiences using a variety of media and formats.
- c. develop cultural understanding and global awareness by engaging with learners of other cultures.
- d. contribute to project teams to produce original works or solve problems.

3. Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students:

- a. plan strategies to guide inquiry.
- b. locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
- c. evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
- d. process data and report results.

4. Critical Thinking, Problem Solving, and Decision Making

Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students:

- a. identify and define authentic problems and significant questions for investigation.
 - b. plan and manage activities to develop a solution or complete a project.
-

-
- c. collect and analyze data to identify solutions and/or make informed decisions.
 - d. use multiple processes and diverse perspectives to explore alternative solutions.

5. Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students:

- a. advocate and practice safe, legal, and responsible use of information and technology.
- b. exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
- c. demonstrate personal responsibility for lifelong learning.
- d. exhibit leadership for digital citizenship.

6. Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students:

- a. understand and use technology systems.
 - b. select and use applications effectively and productively.
 - c. troubleshoot systems and applications.
 - d. transfer current knowledge to learning of new technologies.
-

APPENDIX C

INSTITUTIONAL REVIEW BOARD APPROVAL



MEMORANDUM

INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

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Immunology & Infectious Diseases
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TO: Miles McGeehan

FROM: Mark Quinn, Ph.D. Chair *Mark Quinn CM*
Institutional Review Board for the Protection of Human Subjects

DATE: December 8, 2011

SUBJECT: "Blended Learning: A Study of the Impacts Felt by Students and Veteran Teachers Alike During the Completion of a Hybrid Online Module" [MMG120811-EX]

The above research, described in your submission of December 8, 2011, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal Regulations, Part 46, section 101. The specific paragraph which applies to your research is:

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

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX D

COMPREHENSIVE LIST OF ACTIVITIES (TREATMENTS) USED THROUGHOUT
THE UNIT

Climate Change Expedition
Lesson Landscape Overview

1

Title / Location	Description	Teacher Objectives	ISTE NETS	Time (min)	Materials
<i>Expedition Overview</i>	Students read through the Expedition Description, Expedition Questions, and Expedition Road Map located in the Expedition Overview (left side).	Introduce expedition by hosting a group read-along of the Expedition Overview items.		10	
<i>Course Basics Video Tutorial Expedition Activities → Getting Started Module</i>	Whole class watches a 15-minute video highlighting course navigation and basic tools.	Display the video tutorial located in the Getting Started Module.		17	<input type="checkbox"/> Digital projector <input type="checkbox"/> Speakers <input type="checkbox"/> Embedded video tutorial.
<i>Course Treasure Hunt Assignment Expedition Activities → Getting Started Module</i>	Students download a word document file. This file requires students to effectively navigate the course to complete 6 tasks. Students will save and upload the completed treasure hunt.	Introduce and model effective navigation of the course using digital projector. Monitor and assist students in downloading, completing, and uploading <i>Treasure Hunt</i> assignment.		30	<input type="checkbox"/> Download <i>Climate Treasure Hunt.doc</i>
<i>Warm-Up Blog Expedition Activities → Getting Started Module</i>	Students practice commenting in a blog.	Introduce and model effective blog comments. Monitor and assist students in using the COMMENT button to respond (NOT the CREATE BLOG ENTRY button).	2a	15	
<i>Mouse in Jar Discussion Expedition Activities → Getting Started Module</i>	Students practice participating in first online discussion. A visual image depicting a mouse in a jar (taken from a National Geographic article) contains rich symbolism for students to analyze. Students answer 4 questions using complete sentences.	Introduce and model effective use of a discussion thread. Monitor and assist students in using the QUOTE button to create a discussion thread response.	2a	25	

Getting Started Module

Module One					
Title / Location	Description	Teacher Objectives	ISTE NETS	Time (min)	Materials
Module Introduction	Students read over information and analyze 4 pictures of a receding glacier in the North Cascade Mountains of Washington.	Host a verbal whole group discussion in response to the <i>Class Discussion Question</i> .		10	
<i>Expedition Activities</i> → <i>Module One</i>		Manage a read-aloud of the <i>Climate and State of the Union</i> item.	2c	30	<input type="checkbox"/> Digital projector <input type="checkbox"/> Speakers <input type="checkbox"/> Download <i>Climate Change Survey Questions.doc</i>
<i>Climate Change Viewpoint Activities</i> → <i>Module One</i> → <i>Climate Change Viewpoint Activities</i>	Students first read over Gallup Poll results regarding American's opinion of global warming. Next, students watch or listen to 4 media items extending a variety of opposing opinions to the controversial subject. Finally, students survey 2 people regarding climate change for homework.	Display the four 3 minute media clips using a digital projector and speakers. Discuss downloaded survey tool, make changes if necessary, and print two copies for each student.			
<i>Climate Change Survey Results</i>	Students enter their survey results into an electronic Blackboard Survey. They repeat twice entering data for each participant surveyed.	Model and assist students with data entry into the electronic survey located in the Climate Change Viewpoints Activities area.	2c, 4d	35	
<i>Expedition Activities</i> → <i>Module One</i> → <i>Climate Change Viewpoint Activities</i>		Model effective communication through blog comments.	2a, 2b, 4c	25	
<i>Climate Change Survey Results Blog</i>	Students will analyze demographic trends in survey results collected by the class. Students will view and comment on the trends using a Blackboard blog. The blog will be available the day following data entry.	Monitor and assist students in using the COMMENT button to respond (NOT the CREATE BLOG ENTRY button).			
<i>Expedition Activities</i> → <i>Module One</i> → <i>Climate Change Viewpoint Activities</i>		Model effective and accurate measurements with a thermometer.	3a, 3b, 3d	50 total	<input type="checkbox"/> One thermometer per group. <input type="checkbox"/> Rubric posted in Blackboard . <input type="checkbox"/> Download <i>Schoolyard Temperatures Lab.doc</i> <input type="checkbox"/> Download <i>Schoolyard Temperatures Graph.xls</i>
<i>Schoolyard Temperature Assignment</i>	Students collect temperatures from 5-6 locations around the schoolyard. This investigation will work best on a sunny day.	Model entering graph data in Excel. Model how to change titles and axes labels (single mouse click on appropriate graph title).			
<i>Expedition Activities</i> → <i>Module One</i>	Students enter data into a pre-built excel graph and create graph titles and labels.	Model how to cut, paste, and resize graph into lab document.		[30 graph / lab]	
	Students copy and paste their graph into the lab document.				
	Students save and upload their completed lab document.				

Module One (Continued)					
Title / Location	Description	Teacher Objectives	ISTE NETS	Time (min)	Materials
<p>Schoolyard Temperatures Discussion Expedition Activities → Module One</p>	<p>Students respond to five questions posted in a discussion thread. These questions will require students analyze and describe temperature trends collected in the schoolyard lab.</p> <p>Students associate observed surface differences with real world relevance.</p> <p>Students share opinions regarding climate change predictions in a discussion thread and verbally.</p>	<p>Model effective communication in a discussion thread.</p> <p>Monitor and assist students in using the QUOTE button to create a discussion thread response.</p> <p>Host a verbal whole group discussion regarding student responses to each question following student completion of the discussion questions.</p>	<p>2a, 3d 2b, 3d</p>	<p>30+</p>	
<p>Monthly Temperatures Assignment Expedition Activities → Module One</p>	<p>Students visit the Accuweather web site to collect January temperature data for Manhattan, MT.</p> <p>Students enter data into a pre-built excel line graph and analyze differences between observed and average temperatures.</p> <p>Students save and upload completed Excel graph file.</p>	<p>Display and Model the information collected from the Accuweather website.</p> <p>Model entering graph data in Excel. Model how to change titles and axes labels (single mouse click on appropriate graph title)</p>	<p>3d, 4b, 6d</p>	<p>35</p>	<p><input type="checkbox"/> Download <i>January Temperature Data.xls</i> file.</p>
<p>Differences Between Weather and Climate Assignment Expedition Activities → Module One</p>	<p>Students read definitions of weather and climate then answer several embedded formative assessment questions.</p> <p>Students will need to analyze their January Temperatures for Manhattan Graph (created in the previous assignment) to answer some of the questions.</p>	<p>Model how to complete the self-check and quiz questions embedded within the reading content.</p> <p>Reinforce expectations regarding thoughtful thorough answers based on evidence collected from the January Temperature Graph.</p> <p>Access and grade student responses through the BBoard Gradebook.</p>	<p>3d, 4c</p>	<p>25+</p>	

Module One (Continued)					
Title / Location	Description	Teacher Objectives	ISTE NETS	Time (min)	Materials
<p>Factors Controlling Climate Blog <i>Expedition Activities → Module One Assignment</i></p>	<p>This activity would serve as a good warm-up prior to starting the <i>Factors Controlling Climate Assignment</i>.</p>	<p>Model effective communication through blog comments.</p> <p>Monitor and assist students in using the COMMENT button to respond (NOT the CREATE BLOG ENTRY button).</p>	<p>3b, 4c</p>	<p>70</p>	<p><input type="checkbox"/> Download <i>What Factors Control Your Local Climate.doc</i></p>
<p>Factors Controlling Climate Assignment <i>Expedition Activities → Module One</i></p>	<p>Students read through a website containing interactive tools and guided questions regarding factors affecting local climates.</p> <p>Students download an accompanying word document to record answers to the guided questions they encounter in the website.</p> <p>Students compare six different distinct climates found throughout the country before analyzing Bozeman's climate data.</p> <p>Students upload the completed assignment when complete.</p>	<p>Demonstrate how to navigate the website and how to record answers to the guided questions on the accompanying word document.</p> <p>Remind students how to upload their assignment.</p> <p>Access and grade student work through the Board Gradebook.</p>			
<p>Weather and Climate Review Game <i>Expedition Activities → Module One Presidential Blog</i> <i>Expedition Activities → Module One</i></p>	<p>Students review vocabulary introduced in the module through a variety of games such as crossword, matching, fill in blank, etc.</p> <p>Students watch a 15 minute video tutorial demonstrating how to create blogs within Blackboard.</p> <p>Students create a new blog entry for each of Module One's Essential Questions.</p> <ul style="list-style-type: none"> • What are some commonly held beliefs regarding climate change? • How does temperature fluctuate in our backyard? • What is the difference between weather and climate? • What factors affect a location's climate? <p>A rubric is included in a downloadable word document and redundantly included in the Blackboard blog area.</p>	<p>Model how to choose and play different games. Ask students to practice with a variety of games for 15 minutes or more.</p> <p>Display Blog tutorial video using the digital projector and speakers.</p> <p>Circulate and support students as they begin creating blogs. Provide constructive feedback emphasizing the rubric expectations.</p>	<p>6b</p>	<p>25</p>	<p><input type="checkbox"/> Digital projector Speakers <input type="checkbox"/> Embedded video tutorial. <input type="checkbox"/> Download <i>Presidential Question Rubric.doc</i></p>

Module Two						
Title / Location	Description	Teacher Objectives	ISTE NETS	Time (min)	Materials	
<p>Module 2 Introduction <i>Expedition Activities → Module Two</i></p>	<p>Students will watch a short video prepared by NASA regarding factors that affect Earth's global climate. Students will then summarize and discuss the three factors in a class discussion.</p>	<p>Introduce expedition by focusing students' attention on the Module's one essential Presidential Question. Play the short NASA video for the whole class then hold a brief discussion on the 'Class Discussion Question'</p>		15	<ul style="list-style-type: none"> <input type="checkbox"/> Digital projector <input type="checkbox"/> Speakers <input type="checkbox"/> Embedded NASA video 	
<p>Greenhouse Effect Lab <i>Expedition Activities → Module Two</i></p>	<p>Students monitor, compare, and summarize the effects of carbon dioxide on temperature within a closed container. Students download the digital lab document and complete before uploading.</p>	<p>Guide students to the correct assignment in order to download the digital version of the lab document. Model the experimental set-up before initiating the investigation. Circulate and assist students throughout the lab.</p>	1c, 3b, 3c, 3d	50	<p>The Following Items are Needed Per Station</p> <ul style="list-style-type: none"> <input type="checkbox"/> 2 Temperature probes or 2 thermometers. <input type="checkbox"/> Lamp with 100 watt bulb <input type="checkbox"/> 2 rulers <input type="checkbox"/> tags <input type="checkbox"/> 2 600 ml beakers <input type="checkbox"/> soil <input type="checkbox"/> plastic wrap 	
<p>Goldilocks Principle Activity <i>Expedition Activities → Module Two</i></p>	<p>This activity introduces students to the atmospheric differences between the three "sister" planets in a graphic and hands-on way. They should get an overall appreciation of the important similarities and differences. Students will use this understanding later as they begin to appreciate the scope and importance of the greenhouse effect on earth.</p>	<p>Teacher's introduction and instructions: 30 minutes -Discuss Goldilocks Principal Student model-building: 30 minutes -Demonstrate proper use of materials and briefly discuss how models help scientists to make comparisons. Discussion/assessment: 30 minutes -Assist students with authoring rich quality responses.</p>	1c	90	<ul style="list-style-type: none"> <input type="checkbox"/> Downloadable worksheet. <input type="checkbox"/> Downloadable teacher guide located in Helpful Resources. <input type="checkbox"/> Jelly Beans or similar – 5 different colors needed. <input type="checkbox"/> 3 zip-lock bags per group. 	

Module Two (Continued)						
Title / Location	Description	Teacher Objectives	ISTE NETS	Time (min)	Materials	
Radiant Energy Lab <i>Expedition Activities</i> → <i>Module Two</i>	Students monitor, compare, and summarize the effects of the darkness of paper and its ability to transfer light to radiant heat energy. Students download the digital lab document and complete before uploading. This activity can be set up as a station or demonstration along with the next lab, "Reflectivity of Light Lab".	Model the experimental set up then monitor and observe students work. Regular thermometers can easily replace digital thermometers if resources are limited. This lab and the next lab pertain to the shrinking polar ice cap and the physical properties associated with sunlight on ice vs. dark sea water.	3b, 3c, 3d	30 min	<input type="checkbox"/> 2 Temperature probes or 2 thermometers. <input type="checkbox"/> Lamp with 100 watt bulb <input type="checkbox"/> White and black construction paper. <input type="checkbox"/> Tape.	
Reflectivity of Light Lab <i>Expedition Activities</i> → <i>Module Two</i>	Students monitor, compare, and calculate the reflectivity of different colored surfaces. Students download the digital lab document before uploading. This activity can be set up as a station or demonstration along with the last lab.	Model the experimental set up then monitor and observe students as they are working through this station. This lab and the next lab pertain to the shrinking polar ice cap and the physical properties associated with sunlight on ice vs. dark sea water.	3b, 3c, 3d	30 min	<input type="checkbox"/> Lamp with 100 watt bulb <input type="checkbox"/> White Paper <input type="checkbox"/> Black Paper <input type="checkbox"/> Aluminum Foil <input type="checkbox"/> 2 other colors. <input type="checkbox"/> Light sensor	
Ice Scientist Career <i>Expedition Activities</i> → <i>Module Two</i>	A brief article highlighting the career of an ice scientist composed for middle school aged students.	Read over this article with the whole group. Consider hosting a very brief discussion and highlight important items before progressing to the next activity.	2c	15 min	<input type="checkbox"/> Downloadable PDF article.	
NASA Research: Recent Warming of Arctic May Affect Climate <i>Expedition Activities</i> → <i>Module Two</i>	Students will read over an excellent research based article with embedded videos regarding the topic of melting polar ice caps, which was published by NASA. At the conclusion of the article, students will create four unique test questions in a discussion board thread. Students will later have an opportunity to answer the questions posed by other groups.	Model how to open the assignment by using the "Click Here" prompt. Model how to play the videos by simply clicking on each embedded video. It may be helpful for students to have student groups share headphones or play the videos with audio at the appropriate time on the digital projector.	1d, 2c	40	<input type="checkbox"/> Headphones or digital projector with audio.	

Title / Location	Description	Teacher Objectives	ISTE NETS	Time (min)	Materials
Warming Arctic Discussion Expedition Activities → Module Two	Students will create four unique test questions in a single discussion board thread. Students will later have an opportunity to answer the questions posed by other groups.	Demonstrate how to navigate to the discussion by clicking on the title of the activity. Remind students by modeling how to create a reply to a thread. Students only need to create one reply containing four different test-style questions.	2a	30	
Warming Arctic Discussion Part 2 Expedition Activities → Module Two	Students will answer the Warming Arctic discussion questions posed by other groups.	Note that example Create a system to have each group answer the questions generated by another group (without overlap so all groups are answered). Model how to reply directly to another group within the discussion board.	2a, 2b	20	
Warming Arctic Quiz Expedition Activities → Module Two	Students will complete two essay questions regarding the Warming Arctic.	Written summative assessment.		20	
Measuring Albedo Simulation Expedition Activities → Module Two	Students will explore the relationship with albedo, cloud cover, greenhouse gas, and atmospheric temperature using a computer simulation.	Prepare ahead of time by opening the attached documents. One is a word doc and the other a PDF. The important images embedded within the word doc may not work well with PC computers. If this is the case, then print the PDF out for each group to complete by hand.	1c	50 – 70	<input type="checkbox"/> Downloadable activity sheet. <input type="checkbox"/> Online simulation.
NASA Ocean Research Expedition Activities → Module Two	Excellent 5-minute video prepared by NASA regarding ocean currents and their influence on Earth's energy cycle.	Explore the simulation by following the activity directions included within the downloaded worksheets prior to modeling for students.	Play this short video on the digital projector and hold a brief discussion regarding important facets.	2c	10
NASA Water Cycle Expedition Activities → Module Two	Excellent 5-minute video prepared by NASA regarding the water cycle followed by a brief connection with climate change's impact on the cycle.	Play this short video on the digital projector and hold a brief discussion regarding important facets.	Play this short video on the digital projector and hold a brief discussion regarding important facets.	2c	10
Presidential Questions Blog II Expedition Activities → Module Two	Students answer the fifth Presidential Blog question regarding "How does Earth gain, lose, and transfer heat?"	Students answer only the fifth question specific for this module.	1ah, 2abc, 3abcd, 6abcd	30	

Module Two (Continued)

Module Three		Title / Location	Description	Teacher Objectives	ISTE NETS	Time (min)	Materials
<p>Module 3 Introduction</p> <p><i>Expedition Activities</i> → <i>Module Three</i></p>	<p>The module hook includes some brief background regarding a climate change skeptic, Piers <i>Cobbyn</i>, and a 3-minute video of his vocal beliefs during an international news interview. Students will discuss their reaction to the video through these three questions:</p> <ol style="list-style-type: none"> 1. Does Mr. <i>Cobbyn</i> relay opinion based or evidence based arguments? Does he cite any empirical evidence or specific research in his claims? 2. How might an average television viewer with little scientific background interpret Mr. <i>Cobbyn's</i> claims. Do you think they would tend to believe or disbelieve? Why? 3. What effect can the media have on the beliefs held by the general public? What responsibilities should the media agree to? 	<p>Be sure to preface the importance of empirical evidence in science with students before playing the video. Then follow up with discussing whether <i>Cobbyn</i> is relaying opinion or empirical evidence in his interview. Following this, discuss the three discussion questions provided.</p>	<p>3b, 3d</p>	<p>60 – 80</p>	<p><input type="checkbox"/> Embedded video played on digital projector with audio. <input type="checkbox"/> Digital projector <input type="checkbox"/> Classroom audio</p>		
<p>What Are Some Physical Signs Of Climate Change</p> <p><i>Expedition Activities</i> → <i>Module Three</i> → <i>What Are Some Physical Signs of Climate Change?</i></p>	<p>This activity provides 14 media rich news articles regarding current events related to physical phenomenon associated with climate change. Students will have the freedom of choosing to record a summary and personal reaction to a minimum for 4 of the 14 articles.</p> <p>A guided note-taking document is attached to the first directions page. Students should upload the completed document to the same location when finished.</p>	<p>Consider modeling how to complete the first blank row in the guided notes with a news article of your choice. Walk students through a full example then require that they complete four additional examples on their own.</p> <p>Students are given flexible choice in the articles they choose to review. Emphasize that they should peruse all of the article titles before beginning and that hopefully the class will choose a variety of different resources.</p> <p>Feel free to modify the guided notes page as needed. Differentiation opportunities exist with regard to how groups record notes. If a student has a different style of summarizing then consider their request and make appropriate accommodations.</p>			<p><input type="checkbox"/> Digital Projector for Demonstration</p>		

Title / Location	Description	Teacher Objectives	ISTE NETS	Time (min)	Materials
<p>Time Cycles and Dendrochronology Activity <i>Expedition Activities</i> → <i>Module Three</i></p>	<p>Students download a guided worksheet with analysis questions. The worksheet includes the activity background, procedure, and reflective analysis questions. Students will upload the finished questions once completed.</p> <ol style="list-style-type: none"> Students will understand that data for past climate changes can be gathered from sources beyond long-term weather observations. Students will recognize the direct impact of climate on annual tree growth patterns. 	<p>It is important to visit the Helpful Resources area within Blackboard to download the full version of the lesson plan. Approximately 20 minutes of prep time is needed to print and prepare copies of the "tree samples" for students.</p> <p>The lesson plans located in Blackboard provide detailed description of the teacher objectives.</p>	1c	<p>Teacher Prep 90</p> <p>Class Time 95</p>	<p><input type="checkbox"/> Print outs of tree samples included in the teacher lesson plan (located within helpful resources area in Blackboard).</p>
<p>Paleoclimates and Pollen Activity <i>Expedition Activities</i> → <i>Module Three</i></p>	<p>Students download a guided worksheet with analysis questions. The worksheet includes the activity background, procedure, and reflective analysis questions. Students will upload the finished questions once completed.</p> <ol style="list-style-type: none"> Students will understand that plant pollen is physically distinct in size and shape in different plant species. Students will understand that plant pollen may survive for long periods of time in sediment deposits, providing a record of plant species in the area. Students will understand that climates naturally undergo changes that can be monitored with pollen data. 	<p>It is important to visit the Helpful Resources area within Blackboard to download the full version of the lesson plan. Approximately 90 minutes of prep time is needed to prepare the soil samples for classroom use.</p> <p>The lesson plans located in Blackboard provide detailed description of the teacher objectives.</p>	1c	<p>Teacher Prep 90</p> <p>Class Time 95</p>	<p><input type="checkbox"/> Print out of the pollen picture for each group.</p> <p><input type="checkbox"/> 1000ml grad CSL for class demo.</p> <p><input type="checkbox"/> 6 different types of sediment (sand, mud, soil, mulch, etc).</p> <p><input type="checkbox"/> 1 zip-lock per group.</p> <p><input type="checkbox"/> 1 pie pan per group.</p> <p><input type="checkbox"/> 1 pollen table print out per group.</p> <p><input type="checkbox"/> Tweezers</p> <p><input type="checkbox"/> Downloaded guided worksheet for students.</p> <p><input type="checkbox"/> Downloaded Answer Keys in Helpful Resources.</p>

Module Three (Continued)

Module Three (Continued)						
Title / Location	Description	Teacher Objectives	ISTE NETS	Time (min)	Materials	
<p>Ice Cores of Glaciers and Past Climates Assignment</p> <p><i>Expedition Activities</i> → <i>Module Three</i></p>	<p>Students compare the impact of atmospheric carbon dioxide and dust on global temperature provided through ice core records dating back for the last 200,000 years.</p> <p>Students read through a website containing interactive tools and guided questions regarding factors affecting local climates.</p> <p>Students download an accompanying word document to record answers to the guided questions they encounter in the website.</p> <p>Students upload the completed assignment when complete.</p>	<p>Demonstrate how to navigate the website and more specifically how to use the interactive graphs appropriately. Model how to record answers to the guided questions on the accompanying word document.</p> <p>Remind students how to upload their finished assignment.</p> <p>Access and grade student work through the Board Graderbook.</p>	<p>1a, 1c, 1d, 3d</p>	70	<ul style="list-style-type: none"> <input type="checkbox"/> Downloaded Student Worksheet. <input type="checkbox"/> Accompanying web site. <input type="checkbox"/> Adobe Shockwave is required on each computer. This is a free downloadable plug-in. 	
<p>Ice Core Investigation Activity</p> <p><i>Expedition Activities</i> → <i>Module Three</i></p>	<p>Students dissect an actual ice core sample (that the teacher created), analyze physical properties, and make predictions regarding atmospheric conditions and climate represented by layers within the ice core.</p> <p>Students select appropriate lab tools, design a procedure, and analyze a sample before reporting out.</p>	<p>Prepare the ice cores over a couple of days by following the lesson plan located in the Helpful Resources area of Blackboard.</p> <p>Consider creating two versions of ice core samples, labeled A and B. Half of the groups can analyze A samples and half B samples. Students will later publish findings in the discussion board then compare with other groups and discourse on similarities and differences.</p> <p>This lesson can be delivered using a more general inquiry approach. The previous assignment introduced background regarding ice core scientists and the data they collect. In this assignment, the option exists to allow students the flexibility of creatively designing their own procedures, analysis techniques, and data organization methods.</p> <p>Students should download the attached word document that provides a set of skeletal directions. Students should complete and upload when finished. Following this, students will report their findings in the discussion board in the next assignment.</p>	<p>1c, 1d, 3a, 4a, 4b, 4c</p>	70	<p>Prep Materials</p> <ul style="list-style-type: none"> <input type="checkbox"/> Newspaper <input type="checkbox"/> 1000 ml water <input type="checkbox"/> foamcore <input type="checkbox"/> 10.11mm, grad, 5x1 <input type="checkbox"/> 1 sheet cardboard (to support grad 5x1 from falling in freezer) <input type="checkbox"/> vitaezax <input type="checkbox"/> pH test kit (ranging from 4 – 7 or 1 – 14). <p>Tools per Student Group</p> <ul style="list-style-type: none"> <input type="checkbox"/> Mortar and pestle <input type="checkbox"/> Colored pencils <input type="checkbox"/> 3 rulers <input type="checkbox"/> 5 petri dishes <input type="checkbox"/> pH indicator <input type="checkbox"/> coffee filters <input type="checkbox"/> 5 pipettes or eyedroppers <input type="checkbox"/> 3 watch glasses <input type="checkbox"/> 3 magnifying glasses <input type="checkbox"/> butter knife <input type="checkbox"/> dissolvable microscope 	

Module Three (Continued)					
Title / Location	Description	Teacher Objectives	ISTE NETS	Time (min)	Materials
<p>Ice Core Investigation Conclusion</p> <p><i>Expedition Activities</i> → <i>Module Three</i></p>	<p>Students publish their results from the Ice Core Investigation Activity in a discussion board.</p> <p>Other students will have an opportunity to conduct peer-peer evaluations of findings in the next lesson.</p>	<p>Demonstrate how to navigate to the discussion board following the assignment link in Module 3 and how to properly reply (show students how to change the subject title of their thread to include reference to the appropriate sample (A or B) they evaluated. This is important for a later lesson.</p> <p>Remind students to publish their findings in paragraph form using proper grammar and organization. Reinforce that the six questions in the parent thread must be answered in their conclusion.</p> <p>Feel free to edit the requirements for the conclusion paragraph in order to conform with the typical writing requirements of your school's science department.</p>	<p>2a, 2b, 3d, 5d</p>	<p>25</p>	
<p>NASA Videos:</p> <p>1. Taking Earth's Temperature</p> <p>2. Climate Model Supercomputers</p> <p><i>Expedition Activities</i> → <i>Module Three</i></p>	<p>Two excellent 5-minute videos prepared by NASA regarding modern data collection techniques, technologies, and sophisticated computer-modeling applications.</p>	<p>Play the short videos on the digital projector and hold a brief discussion regarding important facets for how current climate changes are being studied.</p>	<p>2c</p>	<p>18</p>	<p><input type="checkbox"/> Digital Projector w/ Audio</p>
<p>Ice Core Investigation Peer Analysis & Reflection</p> <p><i>Expedition Activities</i> → <i>Module Three</i></p>	<p>Students will evaluate their peers' published findings for the Ice Core Investigation activity.</p>	<p>Model digital citizenship and communication standards.</p> <ol style="list-style-type: none"> Discuss the value of constructive criticism and differences in opinion. Model and reinforce clear well-constructed and thoughtful written replies. Model a poor example of a peer reply. 	<p>2a, 4d, 5a, 5b, 5d</p>	<p>30</p>	

Title / Location	Description	Teacher Objectives	ISTE NETS	Time (min)	Materials
<p>Presidential Questions Blog III</p> <p><i>Expedition Activities</i> → <i>Module Three</i></p>	<p>Students answer three Presidential Blog questions regarding:</p> <p>6) How is climate studied and how has it differed in the past? 7) Is the Earth's climate currently changing? What evidence exists to support or reject sudden climate change? 8) What could be causing the Earth's climate to change?</p>	<p>Students answer only the sixth, seventh, and eighth questions specific for this module.</p>	<p>1a, 2abc, 3abcd, 6abcd</p>	<p>45</p>	
<p>Module Four Introduction: Climate Change a Hoax?</p> <p><i>Expedition Activities</i> → <i>Module Four</i></p>	<p>Students will then summarize and discuss answers to some critical thinking questions.</p> <p>Students assess some of the impacts of atmospheric carbon dioxide on climate and environment.</p> <p>Students read through a website containing graphs and information then answer guided questions regarding impacts of greenhouse gases and changing climates.</p> <p>Students download an accompanying word document to record answers to the guided questions they encounter in the website.</p> <p>Students upload the completed assignment when complete.</p>	<p>Introduce expedition by focusing students' attention on the Module's Presidential Question.</p> <p>Play the short videos for the whole class then hold a brief discussion on the 'Class Discussion Question'</p> <p>Demonstrate how to navigate the website and more specifically how to use the interactive graphs appropriately. Model how to record answers to the guided questions on the accompanying word document.</p> <p>Remind students how to upload their finished assignment.</p> <p>Access and grade student work through the Board Gradelbook.</p>	<p>1a, 1c, 1d, 3d</p>	<p>15</p>	<p><input type="checkbox"/> Digital projector <input type="checkbox"/> Speakers <input type="checkbox"/> Embedded NASA video</p> <p><input type="checkbox"/> Downloaded Student Worksheet. <input type="checkbox"/> Accompanying web site. <input type="checkbox"/> Adobe Shockwave is required on each computer. This is a free downloadable plug-in.</p>
<p>Module Four</p>					

Title / Location	Description	Teacher Objectives	ISTE NETS	Time (min)	Materials
<p>Now You Sea Ice, Now You Don't Assignment</p> <p><i>Expedition Activities</i> →</p> <p><i>Module Four</i></p>	<p>Now You Sea Ice, Now You Don't is Jigsaw activity. Students will be arranged in home groups of 5 and each student will become the "specialist" on the topic handed too them. The students will move to work with the other similar specialists in the room (JIGSAW). Specialist groups will together on one computer to graph data using excel, create a powerpoint slide with the graph, save the powerpoint slide as a JPEG, then upload the JPEG to Module 4's Antarctica Wiki. Only one group can upload to the Wiki at a time so manage this accordingly.</p> <p>Each expert will return to their original group of 6 to report back using the Wiki. Students will record notes on each of the expert presentations within their group.</p> <p>An example PowerPoint slide completed by an 8th grade student is located in the Teacher Resource folder. Use this as a brief demonstration only (do not distribute).</p> <p>Student note catchers are also attached (Specialist Report Notes). Students should use the note catchers to record trends, evidence, and summaries during the expert presentations.</p> <p>A video demonstrating the computer skills for students is available and embedded into the assignment</p>	<p>Print out appropriate handouts: Overhead transparency of Figure 3 and Figure 4. 3 copies of each: Figure 5, 6, 7, 8, 9.</p> <p>Show the Antarctica Challenge video, share an overview of the assignment with students, share the video demonstration of tech skills.</p> <p>Arrange students into home groups of 5 then distribute the specialist scientist handouts. Each student will take on a different role within the home group. Have students move into specialist groups and begin graphing their data and build their PowerPoint (students are only allowed to create a one page powerpoint presentation)</p> <p>Model how to Save As JPEG then upload into the appropriate Wiki specialist area.</p> <p>Distribute student note catcher worksheets and have students present within their home groups. Other students within group record notes of each presentation.</p>	<p>1d, 2a, 2b, 2d, 3d, 4c, 5a, 5b, 6a, 6c, 6d</p>	<p>100 min</p>	<p>Print out appropriate handouts:</p> <p><input type="checkbox"/> Overhead transparency of Figure 3 and Figure 4.</p> <p>3 copies of each:</p> <p><input type="checkbox"/> Figure 5, 6, 7, 8, 9.</p> <p><input type="checkbox"/> Note catcher worksheets (4 sides per student)</p> <p><input type="checkbox"/> Excel, PowerPoint</p>

Module Four

Module Four					
Title / Location	Description	Teacher Objectives	ISTE NETS	Time (min)	Materials
Global Challenges for Earth's Inhabitants <i>Expedition Activities</i> → <i>Module Four</i>	This activity provides media rich primary source research regarding impacts of recent climate change, which is organized into four topic folders: wildlife, agriculture, civilization, and general impacts. Students will record a summary and personal reaction for a minimum of 2 sources within each of the four folders.	Students are given flexible choice in the articles they choose to review. Emphasize that they should peruse all of the article titles before beginning and that hopefully the class will choose a variety of different resources. Feel free to modify the guided notes page as needed. Differentiation opportunities exist with regard to how groups record notes. If a student has a different style of summarizing then consider their request and make appropriate accommodations.	3b, 3d	60 – 80	<input type="checkbox"/> Digital Projector for Demonstration
Sea Level Rise Activity <i>Expedition Activities</i> → <i>Module Four</i>	Students will investigate and compare the impacts of melting glaciers versus melting polar ice caps with regard to sea level rise. A complete lesson plan is available in the Teacher Resource folder within Blackboard.	Short inquiry demonstration. Allow students the opportunity to design and investigate melting land ice and melting sea ice scenarios with the objective of determining which raises the sea level the most.	1c, 3a	40	<input type="checkbox"/> Student handouts. <input type="checkbox"/> Clay <input type="checkbox"/> Ice cubes of similar size. <input type="checkbox"/> Popstick sticks <input type="checkbox"/> Paper towel <input type="checkbox"/> Marker <input type="checkbox"/> Pencil
Calculate Your Carbon Footprint <i>Expedition Activities</i> → <i>Module Four</i>	Students use a web site to calculate their carbon footprint.	Consider comparing the footprint of average citizens in a variety of other countries.		20	<input type="checkbox"/> popstick
10 Solutions for Climate Change <i>Expedition Activities</i> → <i>Module Four</i>	Read over this article from Scientific American as a class.	Discuss options regarding the choices and impacts each participant in the class may have.		20	<input type="checkbox"/> Handout Attached
Presidential Questions Blog 4 <i>Expedition Activities</i> → <i>Module Four</i>	Students answer three Presidential Blog questions regarding: 9. Could a few degrees really make that much of a difference? What are some current effects of this change? 10. If human actions are causing global warming, what are the likely consequences if our behavior continues? 11. What can be done about human-caused global warming 12. If humans aren't causing global warming, what are the consequences of nations trying to reduce greenhouse emissions?	Students answer only the sixth, seventh, and eighth questions specific for this module.	1ah, 2abc, 3abcd, 6abcd	45	

APPENDIX E

TIMELINE OF INSTRUMENTS

Module	Timeframe	Instrument	Description
Getting Started	Beginning	Technology Inventory Survey (Appendix F)	Survey gathers information regarding students' historic use of technology.
	Beginning	Student Climate Change Survey	Used to characterize students' initial beliefs and understanding regarding climate change.
	Beginning	Climate Change Pre-Test (Appendix I)	Used to gather students' initial background knowledge regarding the science of climate change
	Beginning	Instructor and Consultant Interview	Short introductory interview of the instructor regarding instructional background.
	Middle	Consultant Observation	Observation of student and instructor interactions in the classroom environment.
	Ongoing	Instructor and Consultant Blog	Digital journal shared between instructor and consultant, which is used to report trends, successes, and challenges.
	Ongoing	Instructor and Consultant Email Record	Ongoing check-ins between instructor and consultant.
	Ongoing	Student Work	Activities required students to experiment navigating and completing online assignments including blogs, discussions, and a treasure hunt.
	Ongoing	Classroom Assessment Techniques (CATs)	The f2f teacher could implement CATs based on their discretion in order to collect student opinion and feedback.
Module One	Ongoing	Instructor and Consultant Blog	Digital journal shared between instructor and consultant, which is used to report trends, successes, and challenges.
	Ongoing	Instructor and Consultant Email Record	Ongoing check-ins between instructor and consultant.
Module One	Ongoing	Student Work	Students participated in discussion boards, blogs, lab investigations, and conduct surveys of public opinion, interactive web sites, as well as Microsoft Word and Excel.

	Ongoing	Classroom Assessment Techniques (CATs)	The f2f teacher could implement CATs based on their discretion in order to collect student opinion and feedback.
	End	Module One Content Quiz (Appendix J)	Test recycled questions from the original Climate Change Pre-Test to monitor potential student growth.
	End	Module One Presidential Blog	Student partner groups complete blog posts regarding essential questions posed by the mock President.
	End	Module One CAT: Student Ranking Survey (Appendix H)	Students ranked individual assignments and described what they learned.
Module Two	Middle	Consultant Observation	Observation of student and instructor interactions in the classroom environment.
	Ongoing	Instructor and Consultant Blog	Digital journal shared between instructor and consultant, which is used to report trends, successes, and challenges.
	Ongoing	Instructor and Consultant Email Record	Ongoing check-ins between instructor and consultant.
	Ongoing	Student Work	Students participated in discussion boards, blogs, and lab investigations using digital probeware, Logger Pro software, interactive web sites, online simulations as well as Microsoft Word and Excel.
	Ongoing	Classroom Assessment Techniques (CATs)	The f2f teacher could implement CATs based on their discretion in order to collect student opinion and feedback.
	Middle	Comprehensive Quiz (Appendix L)	Quiz reviewing a variety of major content topics covered to date.
	End	Module Two Content Quiz (Appendix K)	Test recycled questions from the original Climate Change Pre-Test to monitor potential student growth.
	End	Module Two Presidential Blog	Student partner groups complete blog posts regarding essential questions posed by the mock President.
	End	Module Two CAT: Student Ranking Survey (Appendix H)	Students ranked individual assignments and described what they learned.

	End	Instructor and Consultant Interview	Interview of the instructor regarding overall perception, growth, and associated challenges.
Module Three	Ongoing	Instructor and Consultant Blog	Digital journal shared between instructor and consultant, which is used to report trends, successes, and challenges.
	Ongoing	Instructor and Consultant Email Record	Ongoing check-ins between instructor and consultant.
	Ongoing	Student Work	Students participated in discussion boards, blogs, and lab investigations using digital probeware, Logger Pro software, interactive web sites, online simulations as well as Microsoft Word and Excel.
	Ongoing	Classroom Assessment Techniques (CATs)	The f2f teacher implemented CATs based on his discretion in order to collect student opinion and feedback.
	End	Module Three Content Quiz (Appendix M)	Test recycled questions from the original Climate Change Pre-Test to monitor potential student growth.
	End	Module Three Presidential Blog	Student partner groups completed blog posts regarding essential questions posed by the mock President.
	End	Module Three CAT: Student Ranking Survey (Appendix H)	Students ranked individual assignments and described what they learned.
	Outcome	End of Unit	Exit Survey Regarding Hybrid Course Usage (Appendix G)
End of Unit		Exit Survey Regarding Activity Types (Appendix O)	Students ranked hybrid activities then explained their rankings.

APPENDIX F

INTRODUCTORY STUDENT SURVEY ON TECHNOLOGY USAGE AND
ACADEMIC ATTITUDE

Why do you say that?

What do you like the best about labs?

6. Book work is my favorite activity in science class. SD D U A SA

Why do you say that?

What do you like the best about book work?

7. I remember what I learn in lectures. SD D U A SA

Why did you select the answer you did in the above?

8. I remember what I learn in labs. SD D U A SA

Why did you select the answer you did in the above?

9. I remember what I learn from bookwork or practice problems.

SD D U A SA

Why did you select the answer you did in the above?

10. Do you enjoy using computers or other web devices like smart phones?

SD D U A SA

Why did you select the answer you did in the above?

**11. How many hours a week do you use a computer or web device *outside* of school?
List hours here _____**

Make a list of three reasons you regularly use the computer outside of school, such as for computer gaming, email, IM, skype, browsing the internet, shopping, research, etc.

12. How many hours a week do you use a computer or web device in all of your classes *other than a computer class*? _____

Make a list of three activities you regularly use the computer for in a science, math, english or social studies class.

13. Computers should be used more in your regular classes.

SD D U A SA

Why did you select the answer you did in the above?

14. Circle ALL digital activities or tools that you feel you are very skilled with.

MP3 Player (iPod) iPad iTouch Smart Phone
Computer

Digital Camera Video Camera Internet Apps iTunes

Photo Storage Email Facebook MySpace PodCasts

Movie Software (e.g., iMovie) Music Software (e.g., Garage Band)

Blogging Google Wikipedia Video Games Other:

15. Do you ever use two devices at once? For instance, do use a smart phone while playing video games? Y or N _____

IF you answered Yes, then please describe how and when you use two devices simultaneously.

APPENDIX G

EXIT STUDENT SURVEY ON HYBRID COURSE USAGE

Student Exit Survey on Hybrid Course Usage

Participation is voluntary, and you can choose to not answer any question that you do not want to answer, and you can stop at anytime.

Your participation or non-participation will not affect your grade or class standing.

SD – Strongly Disagree **D** – Disagree **U** – Uncertain **A** – Agree **SA** – Strongly Agree

1. The course was easy to navigate once we had some practice.

SD D U A SA

What could make it better?

2. The directions in the course were easy to understand and follow.

SD D U A SA

What was confusing about them?

3. Computers should be used more in your regular classes.

SD D U A SA

Why do you say this?

4. I never want to complete a course online again.

SD D U A SA

Why do you say that?

5. I prefer doing schoolwork on the computer.

SD D U A SA

Why do you say that?

What do you like the best about computer work?

6. I remember what I learn on the computer. SD D U A SA

Why did you select the answer you did in the above?

7. The work we do on the computer is better than lectures.

SD D U A SA

Why do you say that?

8. The work we do on the computer is better than labs.

SD D U A SA

Why do you say that?

9. The work we do on the computer is better than bookwork.

SD D U A SA

Why do you say that?

10. The computer activities used in the last few months would work well in other classes.

SD D U A SA

Why did you select the answer you did in the above?

11. Would you suggest that your teacher repeats this experience with next year's 7th grade students? Why or why not?

12. You've been participating in an experience called hybrid education throughout the Climate Change Unit. Hybrid blends online coursework with daily classroom activities.

What do you like best about this approach?

What did you like least about this approach?

How could it be improved?

13. Do you think hybrid education is better than traditional schoolwork? Why or why not?

14. Would school be better if *each* student had an iPad or laptop instead of a textbook to use throughout the year? Why?

APPENDIX H

CAT - STUDENT SURVEY REGARDING MODULE ACTIVITY ENJOYMENT AND
TWO THINGS LEARNED

Module 1 CAT

Fill out the Table below.

Name of Activity Type	How well did you enjoy it? 5 – a great deal 3 – kind of 1 – not at all	Name two things you learned.
Mouse in a Jar		
Climate Change Survey		
Temperature in the School Yard		
Differences in Weather and Climate		

Module 2 CAT

Fill out the Table below.

Name of Activity Type	How well did you enjoy it? 5 – a great deal 3 – kind of 1 – not at all	Name two things you learned.
Radiant Energy Lab – thermometers and colored paper.		
Goldilocks Principle		
Greenhouse Gasses Lab – thermometers in beakers telling temperatures.		
Arctic Warming Activity		

Module 3 CAT

Fill out the Table below.

Name of Activity Type	How well did you enjoy it? 5 – a great deal 3 – kind of 1 – not at all	Name two things you learned.
Physical Signs of Current Climate Change		
Time Cycles and Dendrochronology		
Paleoclimates and Pollen Activity		
Ice Cores of Glaciers and Past Climate		
NASA videos		

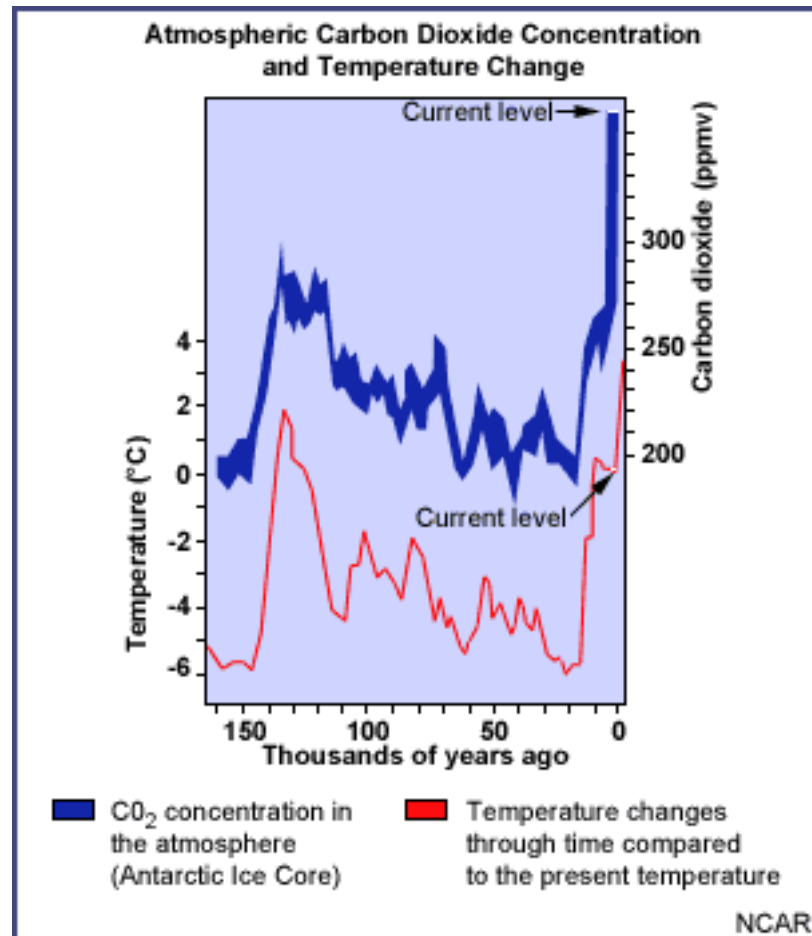
APPENDIX I

CLIMATE SCIENCE PRE-TEST

Name: _____

Directions: Read each of the questions and look at the graphs carefully before selecting the best answer. Provide complete statements when asked.

The graph shows the variation of carbon dioxide concentration and air temperature in Antarctic ice cores over 150,000 years (left side) to present (right side). The blue line shows carbon dioxide concentration in parts per million (ppm). The red line shows the change in air temperature.



The CO₂ concentration in the year 2000 was measured at 370 ppm. Scientific models predict that atmospheric CO₂ will increase to 500 ppm in the year

2050.

1. Will the temperature be higher or lower in 2050? (circle one)

A) higher

B) lower

2. Predict: how many degrees will the temperature change?

3. Explain how you made your prediction in the previous question.

4. How certain about your prediction for the air temperature in 2050?

(1) Not at all certain

(2)

(3)

(4)

(5) Very certain

5. Explain what influenced your certainty rating in the last question.

More sunlight can be absorbed by an object with a darker surface than one with lighter surface. In the 1970s, sea ice covered about 10.8 million square kilometers of the Arctic Ocean. In 2010, sea ice covered 8.7 million square kilometers of the Arctic Ocean.

6. How might the decrease in sea ice affect Earth's atmospheric temperature in the future? (circle one)

- A) It will increase the atmospheric temperature.
- B) It will decrease the atmospheric temperature.
- C) There will be no effect on the atmospheric temperature.

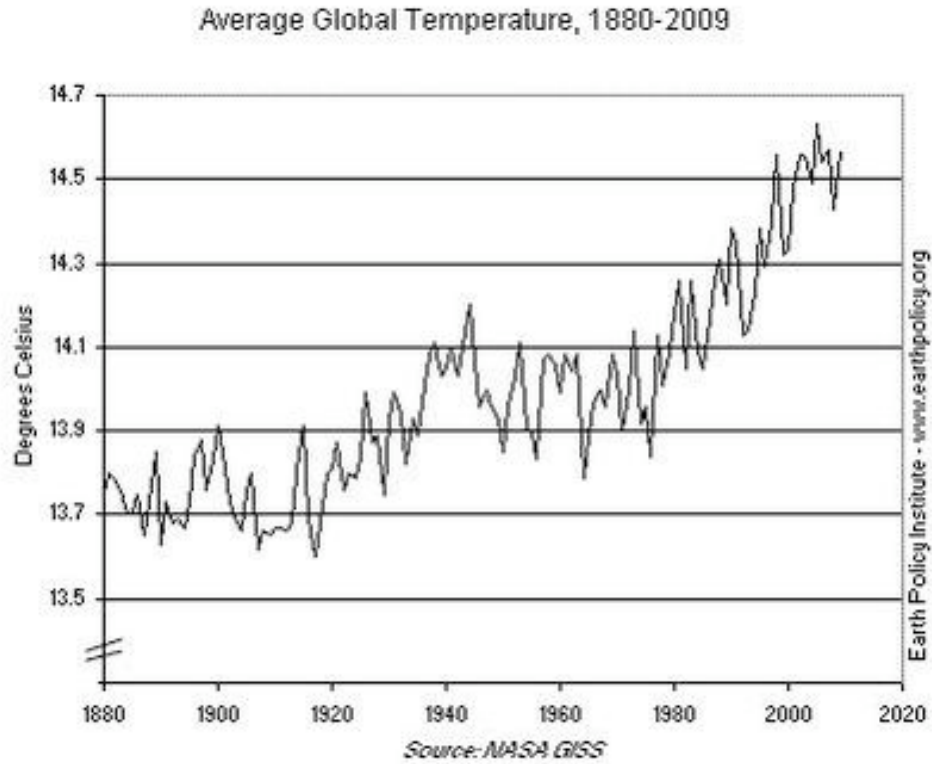
7. Explain your prediction.

8. Are you certain about your prediction in the previous question?

- (1) Not at all certain
- (2)
- (3)
- (4)
- (5) Very certain

9. Explain what influenced your certainty rating in the previous question.

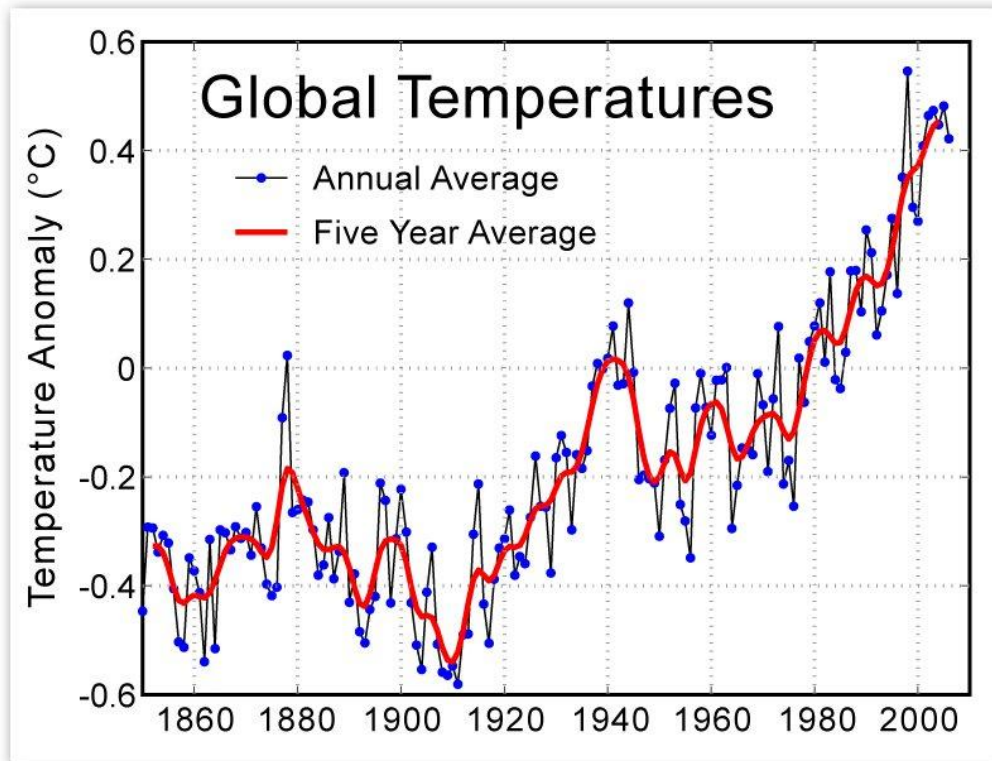
The graph below shows the average global temperature from 1880-2009.



10. Which event might have contributed to the increase in the average global temperature? (circle one)

- A) a decrease in ice cover
- B) an increase in cloud cover
- C) a decrease in the burning of fossil fuels
- D) an increase in photosynthetic activity by plants

The graph shows the deviation of one-year and five-year average global temperatures from the long-term average (measured between 1950 and 1980).



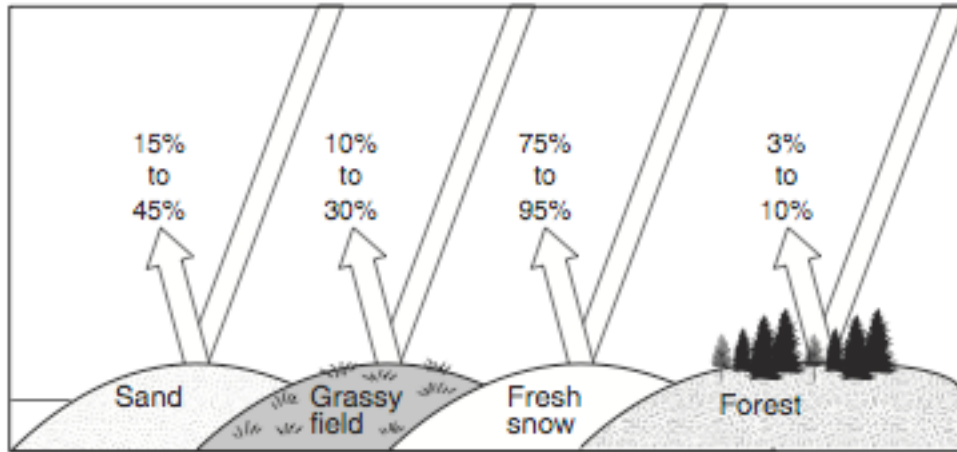
(Source: http://www.globalwarmingart.com/wiki/File:Instrumental_Temperature_Record_png)

11. Which statement best explains the difference between the one-year and five-year averages?

Longer-term averages fluctuate less than shorter-term averages because long-term averages (circle one)

- A) are not affected by human activities.
- B) are calculated using larger amounts of data.
- C) are calculated differently than short-term averages.
- D) are not affected by short-term events like volcanic eruptions.

The diagram indicates the amount of solar radiation that is reflected by equal areas of various materials on Earth's surface.



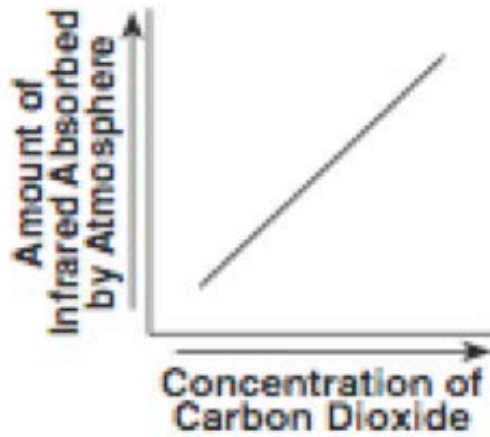
(Source: NYS Earth Science Regents Exam)

12. Which material absorbs the most solar radiation (insolation)? (circle one)

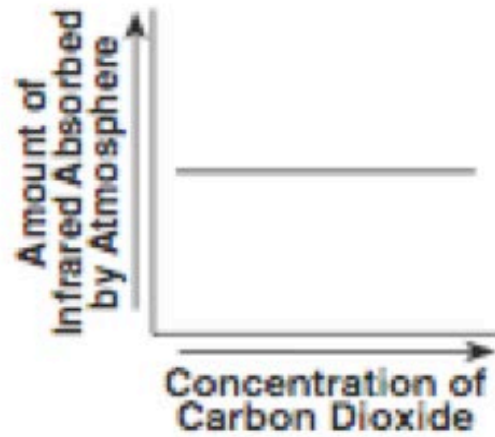
- A) grassy field
- B) fresh snow
- C) forest
- D) sand

13. Which graph best shows the relationship between the concentration of carbon dioxide in Earth's atmosphere and the amount of Earth's infrared radiation (heat) absorbed by the atmosphere? (circle one)

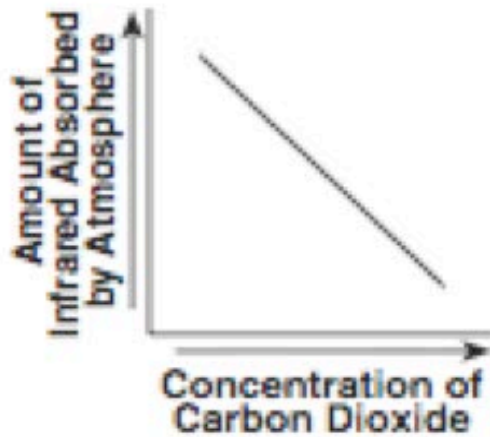
- A) Graph (1)
- B) Graph (2)
- C) Graph (3)
- D) Graph (4)



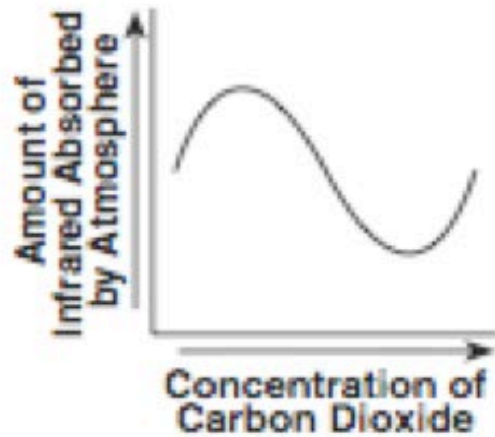
(1)



(3)



(2)



(4)

(Source: NYS Earth Science Regents Exam)

Image "A" shows a real greenhouse, where light from the sun passes through glass panels to heat the inside. The glass panels of the greenhouse keep the heat energy from escaping.

Image "B" shows the greenhouse effect that happens on Earth.



Picture A



Picture B

14. Which part of Image B is like the glass of the greenhouse shown in Image A? (circle one)

- A) Sun
- B) space
- C) atmosphere
- D) Earth's surface

15. Explain your answer to the previous question.

16. What factors are most likely responsible for the North Bend, OR climate?

Climatology for North Bend, OR

Latitude: 43.2°N Longitude: 124.2°W

Elevation: 10 feet

Number of years of data (1961-1990): 30

Maximum temperature: 95°F

Minimum temperature: 13°F

Mean Annual Precipitation: 63.3 inches

Mean Annual Snowfall: 1.8 inches



Circle 3 factors that likely provide the greatest influence.

- A) Latitude
- B) Elevation
- C) Nearby Water
- D) Ocean Currents
- E) Topography
- F) Vegetation
- G) Prevailing Winds

17. Explain your choices to the previous question.

18. Are you certain about your answer in the previous question?

- (1) Not at all certain
- (2)
- (3)
- (4)
- (5) Very certain

19. What factors are most likely responsible for the Fargo, ND climate?

Climatology for Fargo, ND

Latitude: 46.5°N Longitude: 96.5°W

Elevation: 895 feet

Number of years of data (1961-1990): 30

Maximum temperature: 106°F

Minimum temperature: -35°F

Mean Annual Precipitation: 19.5 inches

Mean Annual Snowfall: 40.1 inches

Circle 3 factors that likely provide the greatest influence.

- A) Latitude
- B) Elevation
- C) Distant from Water
- D) Ocean Currents
- E) Topography
- F) Vegetation
- G) Prevailing Winds



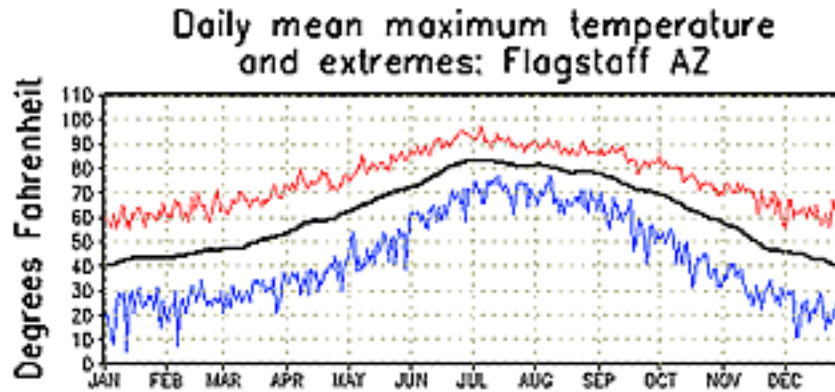
20. Explain your choices to the previous question.

21. Are you certain about your answer in the previous question?

- (1) Not at all certain
- (2)
- (3)
- (4)
- (5) Very certain

22. **Short Answer:** How do scientists measure changes in the Earth's climate hundreds or thousands of years ago? Identify one process and explain how scientists collect the information.

23. What is the daily mean temperature for Flagstaff, AZ in August?



- A) 90
- B) 80
- C) 70
- D) 40

24. Explain your answer to the previous question.

25. Are you certain about your answer in the previous question?

- (1) Not at all certain
- (2)
- (3)
- (4)
- (5) Very certain

26. **Short Answer:** Identify two important factors that scientists believe are impacting our current climate. Explain how these factors influence the climate.

1)

2)

APPENDIX J

MODULE 1 QUIZ

1. The “Mouse in the Jar” diagram best showed
 - A. The relationship between the jar and the Earth’s atmosphere
 - B. The relationship between the mouse eating the plant
 - C. The relationship between the mouse and the plant living together in the jar
 - D. The relationship of the plant killing the mouse

2. The elevation of Bozeman, Montana is closest to
 - A. 1000ft
 - B. 2000ft
 - C. 6000ft
 - D. 10,000ft

3. What climate factor creates a major difference in weather between Dallas, TX and Fargo, ND?
 - A. nearby water
 - B. altitude
 - C. latitude
 - D. ocean currents

4. What climate factor is responsible for the significant difference between Phoenix, AZ and Flagstaff, AZ?
 - A. latitude
 - B. elevation
 - C. prevailing winds
 - D. ocean currents

5. Circle the True statements
 - A. weather is short term and climate is long term
 - B. elevation has little to do with climate
 - C. if we took temperatures in the school yard, they would change depending on the surface they are on
 - D. there are only two major climates in the world
 - E. the shape of the landforms is known as topography
 - F. latitude also influences climate
 - G. for land areas, the ocean has little impact on climate

6. Image "A" shows a real greenhouse, where light from the sun passes through glass panels to heat the inside. The glass panels of the greenhouse keep the heat energy from escaping.

Image "B" shows the greenhouse effect that happens on Earth.



Picture A



Picture B

Which part of Image B is like the glass of the greenhouse shown in Image A? (circle one)

- A) Sun
- B) space
- C) atmosphere
- D) Earth's surface

Explain your answer to the previous question.

8. What factors are most likely responsible for the Fargo, ND climate?

Climatology for Fargo, ND

Latitude: 46.5°N Longitude: 96.5°W

Elevation: 895 feet

Number of years of data (1961-1990): 30

Maximum temperature: 106°F

Minimum temperature: -35°F

Mean Annual Precipitation: 19.5 inches

Mean Annual Snowfall: 40.1 inches

Circle 3 factors that likely provide the greatest influence.

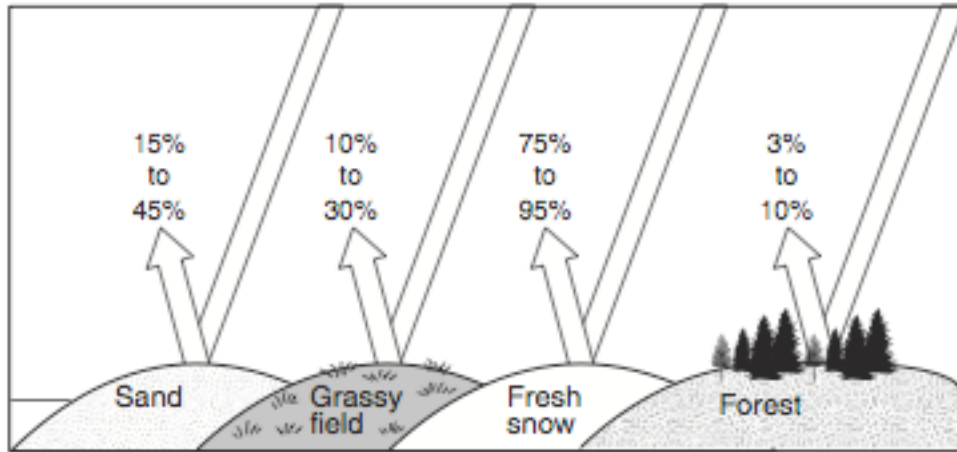
- H) Latitude
- I) Elevation
- J) Distant from Water
- K) Ocean Currents
- L) Topography
- M) Vegetation
- N) Prevailing Winds



9. Explain your choices to the previous question.

10. Short Answer: How do scientists measure changes in the Earth's climate hundreds of thousands of years ago? Identify one process and explain how scientists collect the information.

The diagram indicates the amount of solar radiation that is reflected by equal areas of various materials on Earth's surface.

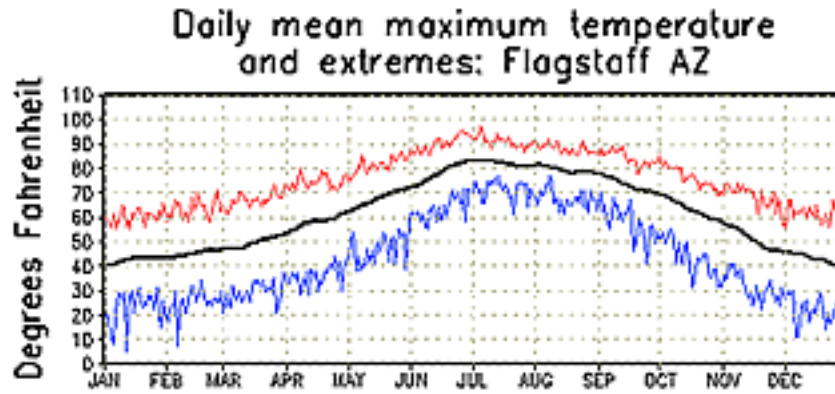


(Source: NYS Earth Science Regents Exam)

11. Which material absorbs the most solar radiation (insolation)? (circle one)

- A) grassy field
- B) fresh snow
- C) forest
- D) sand

12. What is the daily mean temperature for Flagstaff, AZ in August?



- A) 90
- B) 80
- C) 70
- D) 40

13. Explain your answer to the previous question.

Short Answer: Identify two important factors that scientists believe are impacting our current climate. Explain how these factors influence the climate.

1)

2)

APPENDIX K

MODULE 2 QUIZ

More sunlight can be absorbed by an object with a darker surface than one with lighter surface. In the 1970s, sea ice covered about 10.8 million square kilometers of the Arctic Ocean. In 2010, sea ice covered 8.7 million square kilometers of the Arctic Ocean.

1. How might the decrease in sea ice affect Earth's atmospheric temperature in the future? (circle one)

- A) It will increase the atmospheric temperature.
- B) It will decrease the atmospheric temperature.
- C) There will be no effect on the atmospheric temperature.

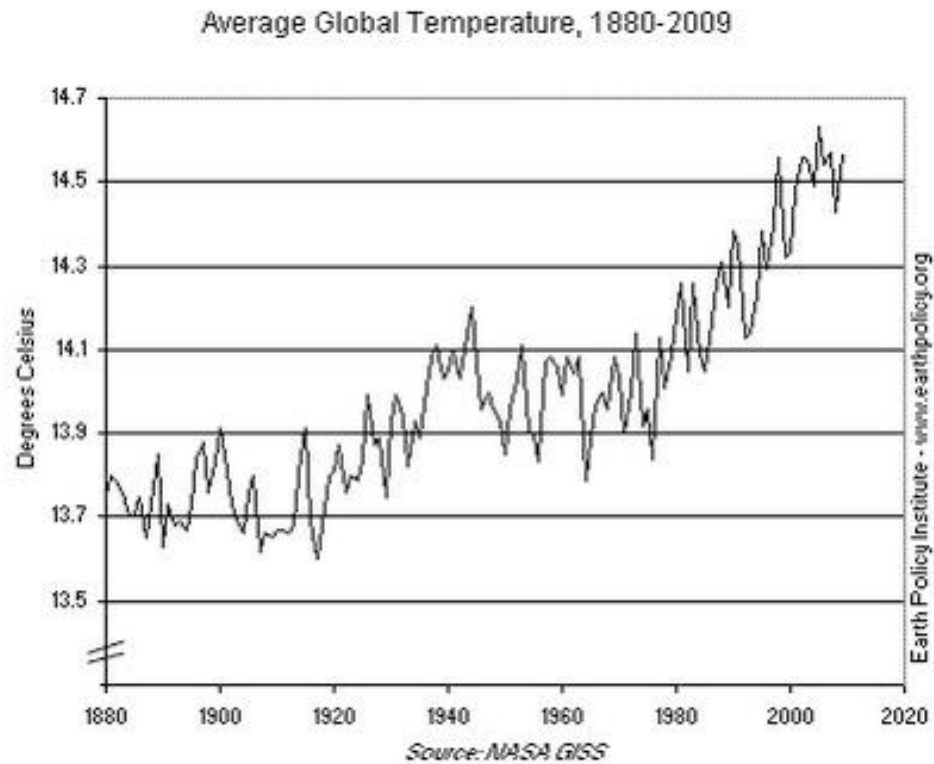
2. Explain your prediction.

3. Are you certain about your prediction in the previous question?

- (1) Not at all certain
- (2)
- (3)
- (4)
- (5) Very certain

4. Explain what influenced your certainty rating in the previous question.

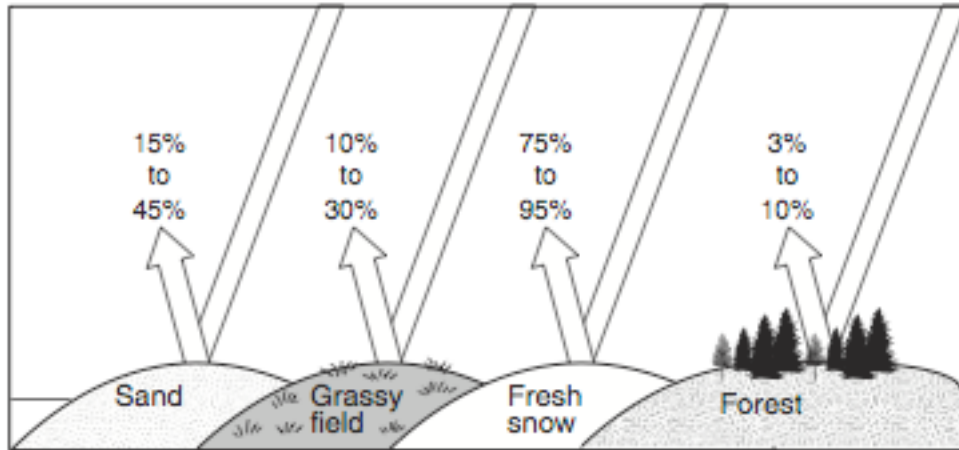
The graph below shows the average global temperature from 1880-2009.



5. Which event might have contributed to the increase in the average global temperature? (circle one)

- A) a decrease in ice cover
- B) an increase in cloud cover
- C) a decrease in the burning of fossil fuels
- D) an increase in photosynthetic activity by plants

The diagram indicates the amount of solar radiation that is reflected by equal areas of various materials on Earth's surface.



(Source: NYS Earth Science Regents Exam)

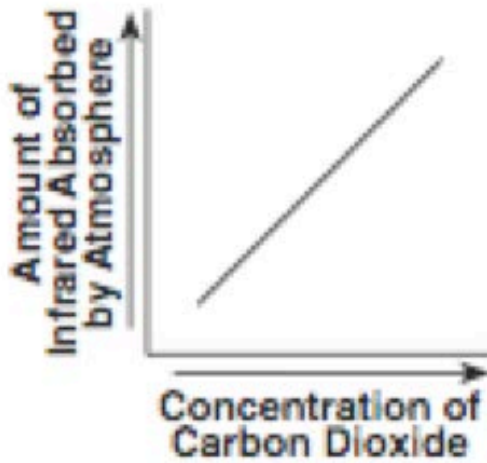
6. Which material absorbs the most solar radiation (insolation)? (circle one)

- A) grassy field
- B) fresh snow
- C) forest
- D) sand

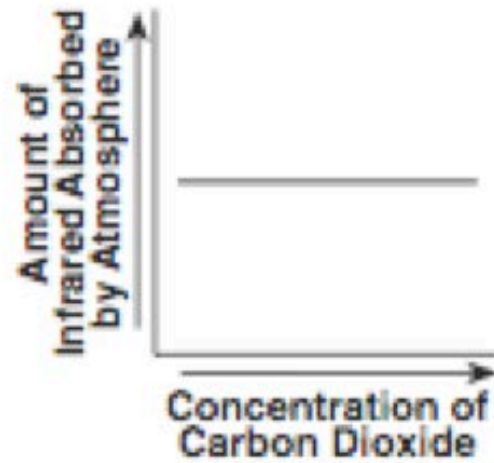
7. Why did you choose the above answer? Explain your reasoning.

8. Which graph best shows the relationship between the concentration of carbon dioxide in Earth's atmosphere and the amount of Earth's infrared radiation (heat) absorbed by the atmosphere? (circle one)

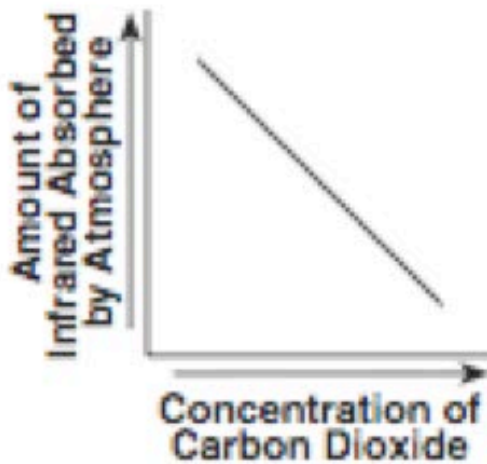
- A) Graph (1)
- B) Graph (2)
- C) Graph (3)
- D) Graph (4)



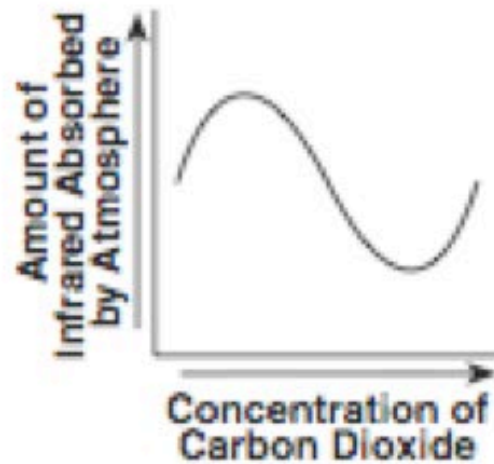
(1)



(3)



(2)



(4)

(Source: NYS Earth Science Regents Exam)

Image "A" shows a real greenhouse, where light from the sun passes through glass panels to heat the inside. The glass panels of the greenhouse keep the heat energy from escaping.

Image "B" shows the greenhouse effect that happens on Earth.



Picture A



Picture B

9. Which part of Image B is like the glass of the greenhouse shown in Image A? (circle one)

- A) Sun
- B) space
- C) atmosphere
- D) Earth's surface

10. Explain your answer to the previous question.

11. What would happen to the temperature of the Earth's atmosphere if it contained significantly more carbon.

APPENDIX L

COMPREHENSIVE QUIZ

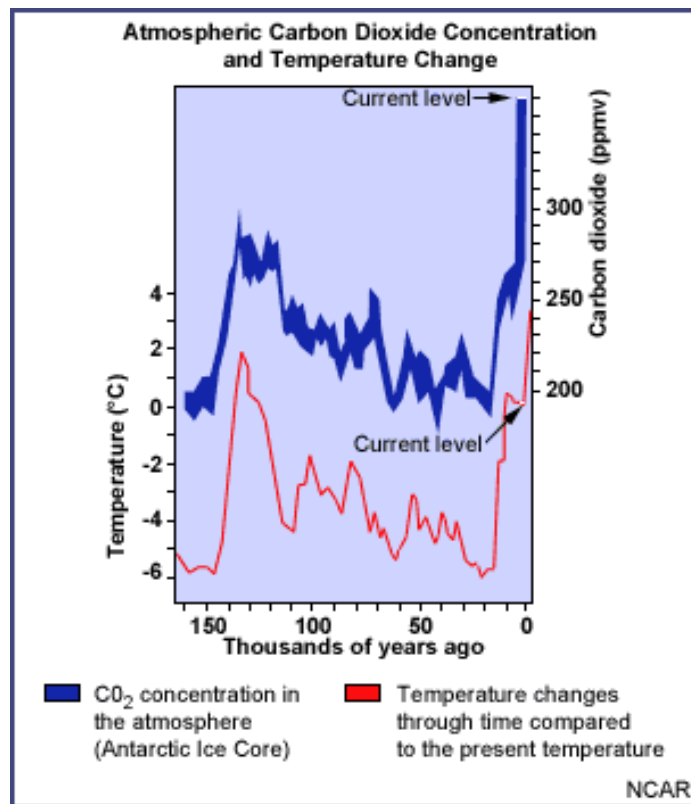
1. Is the Earth's climate changing? List evidence to support your answer.
2. Name and discuss two ways that the Earth transfer's, gains or stores heat.
3. List three factors that impact a location's climate.
4. What is the difference between weather and climate?
5. Explain and do a drawing showing how dendrochronology can be used to detect ancient climates.
6. Discuss and give examples as to how temperatures vary in our school yard. Be sure to include specific examples in your explanation.
7. Explain how pollen is used to determine ancient climates.
8. You are at a family reunion, and uncle Jack says there's no such thing as global warming as we've had lots of snow these last couple of years. Aunt Bertha claims that many websites she has looked at indicate that experts also agree that there isn't any global warming. Based on what we've been learning in science, how might you respond to them?

APPENDIX M

MODULE 3 QUIZ

Directions: Read each of the questions and look at the graphs carefully before selecting the best answer. Provide complete statements when asked.

The graph shows the variation of carbon dioxide concentration and air temperature in Antarctic ice cores over 150,000 years (left side) to present (right side). The blue line shows carbon dioxide concentration in parts per million (ppm). The red line shows the change in air temperature.



The CO₂ concentration in the year 2000 was measured at 370 ppm. Scientific models predict that atmospheric CO₂ will increase to 500 ppm in the year 2050.

1. Will the temperature be higher or lower in 2050? (circle one)

A) higher B) lower

2. Why do you say this?

3. Use the graph above to predict: how many degrees will the temperature change?

4. Explain how you made your prediction in the previous question.

5. How certain about your prediction for the air temperature in 2050?

Why?

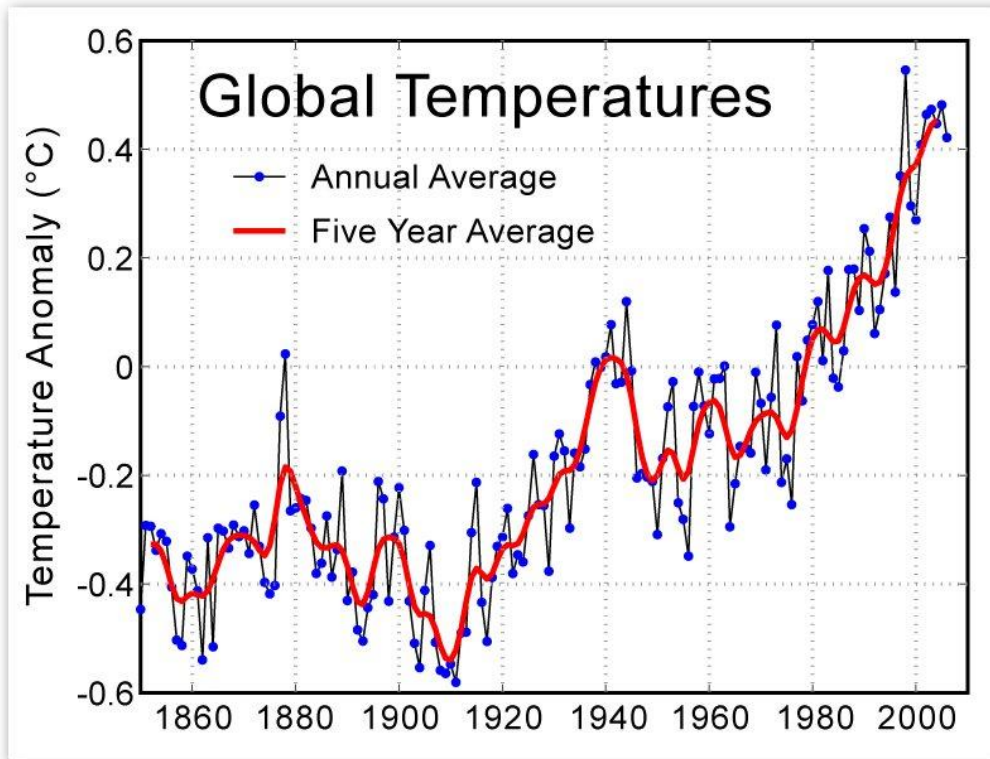
(1) Not at all certain

(2)

(3)

(4)

(5) Very certain



6. What type of natural event could quickly reverse the trend in the graph above? Why?

7. In the 1970s, sea ice covered about 10.8 million square kilometers of the Arctic Ocean. In 2010, sea ice covered 8.7 million square kilometers of the Arctic Ocean. How might the decrease in sea ice affect Earth's atmospheric temperature in the future? (circle one)

- A) It will increase the atmospheric temperature.
- B) It will decrease the atmospheric temperature.
- C) There will be no effect on the atmospheric temperature.

8. Explain your prediction.

- 9. Predict what would happen if the carbon dioxide in the Earth's atmosphere were to double in the next 100 years (change from 370ppm to 740ppm). Explain your reasoning.**
- 10. Identify and briefly describe two different physical signs of recent climate change on the planet.**
- 11. Summarize how scientists collect global climate data for *present* conditions?**
- 12. How do scientists measure changes in the Earth's climate thousands of years ago? Identify one process and explain how scientists analyze this information.**
- 13. Explain how a greenhouse gas affects the temperature of a planet.**
- 14. Identify one specific greenhouse gas then discuss two different causes for the recent rise of these gases in our atmosphere.**

APPENDIX N

CAT - SURVEYING STUDENTS ON INSTRUCTOR PERFORMANCE

Anonymous

Please rank the smoothness and ease of your teacher's proficiency in introducing the new technology into your classroom using a scale of 1 – 10 (1 being rough, unprepared, and confusing and 10 being smooth, knowledgeable, and easy to understand).

Ranking: _____

Please give some idea why you scored as you did (thanks for doing this).

APPENDIX O

CAT - SURVEYING STUDENTS ON HYBRID ACTIVITY TYPE PREFERENCE

Fill out the Table below.

Name of Activity Type	How well did you enjoy it? 5 – a great deal 3 – kind of 1 – not at all	Why did you rank it this way? Other comments or suggestions?
Discussion Board		
Blog		
Digital review games (puzzles, flash cards)		
Videos and Media		
Freedom to explore the links and media on your own.		

Name of Activity Type	How well did you enjoy it? 5 – a great deal 3 – kind of 1 – not at all	Why did you rank it this way? Other comments or suggestions?
Hands-on labs.		
Completing and turning in work digitally.		
Web sites with guided worksheets.		
Online simulations.		