Summer 2002

The Globe Program and the Essential Academic Learning Requirements: Joining Together to Help Washington Students Achieve Higher Academic Standards

Travis Brian Peterson

THE GLOBE PROGRAM AND THE ESSENTIAL ACADEMIC LEARNING REQUIREMENTS: JOINING TOGETHER TO HELP WASHINGTON STUDENTS ACHIEVE HIGHER ACADEMIC STANDARDS

A Project Report

Presented to

The Graduate Faculty

Central Washington University

In Partial Fulfillment

of the Requirements for the Degree

Master of Administration

---

by

Travis Brian Peterson

July, 2002

THE GLOBE PROGRAM AND THE

ESSENTIAL ACADEMIC LEARNING REQUIREMENTS:

JOINING TOGETHER TO HELP WASHINGTON

STUDENTS ACHIEVE HIGHER ACADEMIC STANDARDS

by

Travis Brian Peterson

July, 2002

The purpose of this project was to develop a guide that aligned the Washington State Essential Academic Learning Requirements (EALRs) with the Global Learning and Observations to Benefit the Environment (GLOBE) program for teachers in Washington State. To accomplish this purpose, a review of related current literature was conducted. Additionally, related information/materials from selected sources were obtained and analyzed.

ACKNOWLEDGEMENTS

This project is dedicated to my father, who continues to be my source of energy and inspiration. I would like to especially recognize my wife and daughter as well for all their incredible patience, understanding and love throughout this journey.

I would also like to express my appreciation to Dr. Leland Chapman for his commitment to excellence and his willingness to literally "go the extra mile" (even through snowstorms) for his students. In addition I would like to thank Dr. Jack McPherson and Dr. Gary Shelly for their participation as members of my committee.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

CHAPTER I

BACKGROUND OF THE PROJECT

Introduction

The Washington State Essential Academic Learning Requirements call for students to "know and apply the core concepts and principles of mathematics; social, physical and life sciences…" It also asks them to "think analytically, logically, and creatively, and to integrate experience and knowledge to form reasoned judgements and solve problems (Washington State Commission on Student Learning, 1997).

The GLOBE program is an excellent vehicle for achieving these goals. GLOBE is an international partnership of students, scientists, and teachers wherein students from all corners of the earth make observations and take measurements of their local environment. The students enter the information they have collected onto a World Wide Web database. Scientists then use this data to study global phenomena such as climate change and global warming.

GLOBE transforms innocuous and irrelevant story problems into meaningful and important investigations and it connects students to their learning in ways that textbooks cannot. Regardless of its perceived value, however, no program will be utilized effectively if it does not show a direct correlation to the Essential Learnings. The EALRS and their much maligned child, the WASL (Washington Assessment of Student Learning) have created a supercharged environment in our schools. The pressure on educators to justify how and what they teach continues to grow. No longer may teachers use curriculums or programs simply because they "like them." Today's educator must show how what they are doing in the classroom fits the standards established by the

State. With the WASL looming over their heads like a Guillotine blade, teachers are sacrificing their "pet projects" and all extra activities from their classrooms. Elementary science, already an endangered species in many classrooms, is in jeopardy of being eliminated altogether in this environment. Science is often seen as a "fluff" subject in the lower grades, and there simply isn't room for that in today's classroom.

Ironically, no other subject is as well suited as is science for meeting many of the state standards. A good science program challenges students to draw inferences from their investigations, to utilize mathematical concepts in meaningful ways, to apply their knowledge to real world situations, and to analyze problems from a logical point of view. These skills are at the heart of the Essential Learnings.

Purpose of the Project

The purpose of this project was to develop a guide that aligned the Washington State Essential Academic Learning Requirements (EALRs) with the Global Learning and Observations to Benefit the Environment (GLOBE) program for teachers in Washington State. To accomplish this purpose, a review of related current literature was conducted. Additionally, related information/materials from selected sources were obtained and analyzed.

Limitations of the Project

For the purposes of this project, it was necessary to set the following limitiations:

1. Research: The preponderance of literature reviewed in Chapter II was essentially limited to research current within the last ten (10) years.
2. Audience: The GLOBE Essential Learning Guide was designed to be used by K-12 teachers in the State of Washington.
3. Scope: The GLOBE Essential Learning Guide is limited to the learning activities and protocols that make up the GLOBE project content and the science and mathematics benchmarks detailed in the EALRs.

Definition of Terms

Significant terms used in the context of this study have been identified as follows:

1. Authentic science: term used to characterize a variety of methods that examine students ability to solve problems or perform tasks that closely resemble authentic situations.
2. Commission on Student Learning: provided for the development of the EALRS, and created an assessment system to monitor student progress toward the standards.
3. Earth systems science: scientific discipline that centers on the ecological themes or "big ideas" of the planet, such as cycles, ecosystems, and adaptation.
4. Essential Academic Learning Requirements (EALRS): more specific academic and technical skills and knowledge, based on the basic education goals.
5. Essential Learnings: same as above.

6. Geographic Information System (GIS): a system of hardware and software used for storage, retrieval, mapping and analysis of geographic data.
7. Global Learning and Observations to Benefit the Environment (GLOBE): an international environmental educational education program designed to form partnerships between scientists, students, and teachers.
8. Global Positioning System (GPS): a group of 24 well-spaced satellites owned by the Department of Defense that orbit the Earth and make it possible for people with ground receivers to pinpoint their geographic location.
9. Hypothesis- an informed prediction which attempts to describe or explain.
10. Inquiry-based instruction: a type of science instruction that involves a hands-on approach that stimulates curiosity and motivates students. In this type of instruction, the students generate meaning independently by looking at different materials.
11. Remote sensing: the measure or acquisition of information of some property of an object or phenomenon, by a recording device that is not in physical contact with the object under study.
12. Solar Noon: time of day when the sun is at its highest point in the sky.
13. Washington State Assessment on Student Learning (WASL): the assessment component of the EALRS.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

The review of research and literature summarized in Chapter II has been organized to address:

1. History and Explanation of the GLOBE Program
2. Improving Student Learning
3. Inquiry-based Learning
4. Learning Styles
5. Technology
6. Environmental Awareness
7. Challenges to the Program
8. Successful Implementation of the Program
9. Summary

Data, current primarily within the past ten (10) years were identified through an Educational Resources Information Center (ERIC) computer search. Various other online and print resources were used to conduct research.

History and Explanation of the GLOBE Program

The GLOBE program sprang from the mind of former Vice President Al Gore. In his book, *Earth in the Balance,* Gore (then a senator from Tennessee) called for a K-12 system in which students could collect data for scientists studying global patterns. Gore believed that in order to ensure that children would grow up to make appropriate choices about protecting and preserving the environment, they would need to create real and lasting connections to that environment early in life (Finarelli, 1998). The GLOBE Program is the realization of that vision. In a ceremony on Earth Day, 1994, Gore officially introduced GLOBE to the world, thereby kicking off one of the most ambitious science and education programs in history.

Gore's backing of GLOBE has given the program a level of support not commonly found in other science education programs. Representatives from the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautic and Space Administration (NASA), the National Science Foundation (NSF), the Department of Education, and the State Department have all worked together to develop and implement the program (Means, 1998).

GLOBE also differs from other science education programs in that it was conceived as a genuine partnership between scientists and students. That is, it was designed to benefit both parties in the endeavor (Means, 1998). Students take part in authentic scientific inquiry, and the scientists gain valuable data for their research. The program's three primary objectives are to contribute to the scientific understanding of the earth, help all students reach higher levels of achievement in science and math, and enhance the environmental awareness of the world.

With regard to GLOBE's contribution to the scientific community, the jury is still out. It may be years before enough data is collected for scientists to use it in their studies. It is simply too soon to know if GLOBE will make significant contributions to the body of scientific knowledge (Means, Coleman and Lewis, 1998). One of the major concerns expressed by scientists has been whether children could collect accurate enough data to be used in authentic scientific studies. Those fears, however persistent, seem to be unsubstantiated. Several analyses comparing GLOBE student data with that of other sources have shown a high level of agreement, thus lending credibility to the student data. (Means, et al., 1998).

Brooks (2000), in describing some of the pitfalls existing between GLOBE-participating schools and scientists, specifically pointed out that the ability of students to collect data in a professional way was not an issue. The concern for accuracy has proven to be a great motivator for students involved in the program. The sense of a real partnership with scientists is a very large part of GLOBE's appeal. In a 1996 study, ninety-three percent of fourth grade students participating in the program believed that the measurements they took were "important to science" (Means, et al.).

When asked about their attitudes toward GLOBE, students have shown a high degree of enthusiasm. Ninety-five percent of fourth graders said they liked doing GLOBE activities, and ninety-three percent thought that the GLOBE Program would help people understand the earth better. "I feel like we proved what we can do," said one GLOBE sixth grader, "that we're really scientists" (Means, 1998). Older students apparently share this enthusiasm as well. Seventy-one percent of seventh and tenth grade students liked participating in the program, and nearly three-quarters of them thought that it would help people better understand the planet (Means et al., 1997).

Improving Student Learning

This information indicates that students like the GLOBE Program, but are they learning from it? Their teachers seem to think so. When asked about the extent to which their students had acquired various skills through GLOBE experiences, they reported gains in observation, measurement, technology, and critical-thinking skills, as well as the ability to work in small groups and understand data. Teachers also reported an increase in content knowledge as a result of GLOBE. Teachers participating in the GLOBE investigation areas were asked to tell whether they believed their student's skills had increased "very much," "somewhat," "not very much," or "not at all" as a result of the program. The majority of active teachers reported that their students' knowledge had increased either "very much" or "somewhat." The teachers also reported a significant impact on student understanding of geography and Earth as a system, although these two areas are not directly addressed by GLOBE (Means, et. al, 2001).

Implementation is a key variable when determining a program's impact on student learning. As would be expected, there is a positive relationship between the level of use and student success. Where GLOBE was implemented at a high level, there was a greater increase in student improvement than in those settings where the program was not as actively carried out. For example, seventy-five percent of the teachers who were using the program to a great degree reported that their students' observational skills has improved "very much," whereas only forty-seven percent of the teachers who had used GLOBE to a lesser extent made the same comment. (Means, et al., 1996).

To better understand GLOBE's utility in enhancing content knowledge, Means (2001) conducted an analysis in which teacher evaluations of student knowledge were reported only for those teachers who had actually implemented activities in the related investigation areas. By eliminating the implementation variant, a truer sense of the program's effectiveness in increasing student content knowledge could be ferreted out. That is, it follows that those students who are actively involved in learning activities will make greater gains than those who are not. When, for example, all active GLOBE teachers were asked if their student's content knowledge had increased "very much," "somewhat," "not very much," or "not at all" with concern to seasonal cycles, only nineteen percent of them said "very much." However, nearly half (forty-six percent) of the teachers who had done activities in that investigation area said the same.

It might be expected that teachers participating in the GLOBE program would be more likely than non-GLOBE teachers to cover content areas related to Earth science, but what is not as immediately obvious, Means asserts, is the degree of difference in performance expectations between GLOBE and non-GLOBE science classes. GLOBE teachers are much more likely than their non-GLOBE counterparts to require one or more higher-level tasks such as collecting and analyzing data, and applying concepts (1996).

Students in GLOBE classrooms are more likely than non-GLOBE students to say that they spend their class time working in small groups and using computers, whereas non-GLOBE students are more likely to report that they answer questions from a book or do worksheets most or all of the time.

GLOBE and non-GLOBE students, who had all been exposed to the same content areas in their classes, were assessed in measurement taking, sampling and measurement principles, and data interpretation. GLOBE students outperformed their non-GLOBE counterparts in each of these categories. The fact that GLOBE students, who participated in a program heavily laden with activities requiring careful measurements, outperformed their peers in questions about measuring things is hardly surprising. Less predictable, however, was their superior performance in the less literal components of the assessment (sampling and measurement principles and data interpretation). Students were asked to effectively read data presented in different forms, use important environmental science concepts in making sense of information, and show understanding of principles like control of variables. In each of these tasks, GLOBE students outscored their non-GLOBE peers. "Taken as a whole, the assessment data are very encouraging. There is evidence of enhanced science and mathematics learning in classrooms where GLOBE is being implemented" (Means, et al., 1996, p. 6-15).

Encouraging, yes, but finding evidence that definitively links the GLOBE program to improved student performance in math and science has proven to be difficult. "Unfortunately, we do not have quantitative data related to student achievement at this time," explains Dr. Carol Conroy, Chief Educator and Director for US Partnerships of the GLOBE Program. "We are planning a student assessment component for our evaluation that will be conducted over the course of the next three years" (personal communication, May 29, 2002).

Even with such assessment data, researchers may never be able to unequivocally connect the GLOBE program to higher scores in math and science. There are simply too many variables involved. GLOBE's philosophy has always been one of local control. The program provides resources but leaves decisions concerning curriculum and pedagogy to individual teachers and districts. Therefore, it is difficult to discern whether student improvement in a particular discipline is due to GLOBE or some other factor, such as a change in school curriculum or teaching styles. Add to that the varying degree to which GLOBE is implemented in classrooms, and the result is a program that is tough to get a handle on. Nevertheless, the design of the GLOBE program embodies many features valued in education reform efforts and on math and science standards. The entire program is based on the idea that it is more valuable to have students engaged in doing real science investigations than it is to have them reading about someone else's work, or watching or mimicking demonstrations (Means, et al., 1996).

Unlike traditional science programs in which students perform isolated experiments with no consequence beyond that of a grade or hope for contributing to the collective scientific knowledge, GLOBE students and teachers are involved in actual scientific investigations known as protocols. Each protocol places a heavy emphasis on data collection and reporting (Murphy and Coppola, 1997). GLOBE's focus on data demands that students be accurate, consistent, and persistent in their measurements (Finarelli, 1998). These authentic investigations allow students to take part in active learning experiences rather than passive ones. Learning, in the GLOBE program, is not simply the by-product of an activity. It *is* the activity. Skills such as question formulation, hypothesis testing, and theory development all promote learning through problem solving (Hamil, 1998). In other words, the answer a student comes up with is less important than how he or she came up with it. A third grade GLOBE student explains:

> In GLOBE you get to have your own ideas, whereas in textbooks they give you the facts and you are just supposed to go by the facts...But some people think differently [than that], and when you are in GLOBE, you can just sit down and say, 'Well if one scientist says something,' you can say 'Well, I don't agree with that', or 'I agree with that' and express your own opinions and then check them out. (Jacobson and Jacobson, 1998.)

This student's comment speaks to perhaps the most powerful attribute of GLOBE. The program is rooted in authentic inquiry-based investigation.

Inquiry-based Learning

Inquiry is the most natural of all approaches to learning. Driven by curiosity and wonder, it is inherent in a child's question of "why." The process of inquiry uses this most elemental question as a catalyst for understanding. The underlying belief is that if one is diligent and rigorous enough in his or her search for understanding, there is no phenomenon that cannot be explained.

The process begins when the student becomes intrigued, either by something new or by a piece of the puzzle that does not fit within the learner's previous conceptions. The next step is to act on that curiosity through continued observation, questioning, predicting, hypothesizing, and theorizing. This description might imply that inquiry is a series of steps or a checklist that the learner follows, but the process is more cyclical than linear. There is much ebb and flow, and each learner must find his or her own way to the answer. Finally, the learner must be able to make sense of what she or he has observed. This requires reflection, comparing and interpreting data, and applying new ideas to other situations (Dow, 2000).

Historically, human progress has flourished in places where inquiry has been valued. Whether it took place in the markets of Athens, atop a tower in Pisa, aboard a little boat in the Galapagos Islands, or from a distant vantagepoint in the New Mexican desert, the great societies have always allowed for the quest of understanding. Of course, this search for truth comes with consequences. Socrates' reward for his relentless probing and uncompromising attitude was a glass of hemlock. Galileo was convicted of heresy and spent the last decade of his life on permanent house arrest. Darwin, six score after his death, is a favorite subject for bumper sticker debate, and the scientists who unleashed the apocalyptic power of the atom forced us all to realize that unlocking the secrets of the universe is not always to the net benefit of man.

"The power to destroy," says Dow, "now rivals the power to invent. Perhaps now, more than ever before, the ability of average citizens to think for themselves may be the best protection in a world of increasing technological and scientific complexity" (2000, p. 2). The philosopher and educator John Dewey saw inquiry as "the only authentic means at our command for getting at the significance of our everyday experiences of the world in which we live"(1938, p.111). He understood that the ability to reason in a scientific way was a primary skill needed to cope with the ever-changing complexities of modern life. That complexity has continued to grow at an exponential rate since Dewey's time. We now have the ability to bring whole libraries into our homes and to communicate with people around the globe in milliseconds. Being able to discern fact from fiction and to look at information with a skeptical eye has become just as essential to education as reading or writing.

Most schools today do not look like one that Dewey might have envisioned. They are stratified and subject-based institutions where inquiry only exists on the periphery. Teaching by telling, after all, is certainly a far more efficient enterprise than inquiry. Setting up an inquiry-based classroom like that which Dewey espoused means creating an environment that requires students to direct their own learning by coming up with their own questions and hypotheses for investigation. This represents a great shift in the role of the teacher from one of sage to one of facilitator. Dewey recognized the need for this change some sixty years ago, but that transition has been a difficult one to make. Rather than encourage self-directed investigations of problems, most lab experiences today are designed to simply help students understand a particular science concept (Edwards, 1997). Add to the mix the pressure applied by state and national standards to "hit different areas," and the potential for an inquiry classroom becomes slimmer still. Evidence has shown, however, that inquiry-based instruction has "delivered results in emotional engagement, memory retention, and cognitive understanding that challenge the results of didactic teaching" (Dow, 2000, p. 3).

The content-driven curriculum of today's science classroom came out of the fervor over *Sputnik I,* and the subsequent race to the moon. American students were seen as inferior to their Soviet peers in their level of scientific knowledge. The solution to this problem was to add more complex and abstract concepts while reducing or even eliminating hands-on activities (Christensen, 1995). As a result, we now have a curriculum that the Third International Mathematics and Science Study (TIMMS) termed as "a mile wide and an inch deep" (Schmidt, McKnight, and Raizen, 1997, p. 122).

In today's world, where knowledge doubles almost as quickly as bacteria on yesterday's chicken, a content based approach to teaching science seems futile. There is no way to "know it all," and even if we could get the bulk of what is known today to our students, a good deal of that information would be obsolete by the time they graduated from high school. The key, then, is to decide what children should know and how they should know it (Dow, 2000).

The National Science Education Standards were born out of this thought. Members of the National Research Council (leading scientists, researchers, and educators) sought to determine what types of knowledge were most essential to the field, and then drafted documents that described what things we should expect most people to know (Bartels, 2000). Recognizing the increasingly scientific nature of our lives and work, reformers sought to develop a wider and more comprehensive view of science education (Bybee and McInerney, 1995). If students were to succeed in our hyper-paced and knowledge intensive society, they would need more than factual knowledge and rote skills. They would need the ability to construct their own knowledge and to take an active role in the learning process (Stepanek, 1995).

Ironically, standards-based education is often thought of as being content driven. This is an understandable interpretation, considering how the Essential Academic Learning Requirements (EALRS) break down learning components into specific skills that students must perform in order to meet the standard. Critics interpret the Standards as rigid rules that strip teachers of academic freedom and go against student centered principles of learning (Stepanek, 1997). The stated purpose behind the EALRS, however, is just the opposite. The idea is not to create "education in a can." Rather, it is to help students "develop the ability to be independent thinkers who can solve real-life problems and keep up with the latest developments. And students must see the connection between their studies and their world." (Washington State Commission on Student Learning, 1997). This shift from memorizing facts to understanding the meaning behind the facts is at the heart of educational reform.

How the Standards are viewed is an important distinction to make. Are they bureaucratic checklists designed to extract teacher compliance, or are they vision-setting documents designed to increase the level of understanding for all students? The answer, of course, is "yes." State legislators and some school administrators may be more interested in the former, but that is not to say that the Standards cannot make valuable contributions to the advancement of science education.

The Standards can help to actually simplify the curriculum. By serving as editor for the massive amount of content through which teachers must sift, the Standards take the onus off teachers in deciding what should and should not be taught. The Standards can also help bring different, and sometimes competing, stake holders together. With the Standards as the reference point, divergent groups may be able to find common ground, and the focus can remain directed on those essential topics of schooling- curriculum, instruction, and assessment. Accountability is another important and certainly much talked about element of the Standards. Without them, the quality of instruction and the learning opportunities for students can vary a great deal. The Standards level the playing field by ensuring everyone is getting the same content and type of instruction (Bartels, 2000).

The Standards also have the potential to inspire us to do more. Bartels (2000) argues that the "best standards are a step or two ahead of where the rest of us are" (p.3). That is, they challenge us to look beyond our current practice and see how much more we can do. A prime example of this idea in practice was the inclusion of inquiry in the National Science Education Standards. The document states:

> "Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data,

thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments"(1996, p. 105).

As this statement suggests, inquiry-based learning provides students with the chance to gain a wide array of skills and qualities. However, if they are to take advantage of this opportunity, students also need to be involved in activities that consider their curiosity and interest (Edwards, 1997). Because inquiry is an active enterprise, students have the chance to make decisions and try out ideas. Children rarely get to make judgements of any consequence- especially in the eyes of adults. Inquiry, however, allows them to make first-hand decisions that directly impact their investigations. This active engagement provides them with the opportunity to get instant and accurate feedback from their results. The authentic investigation of phenomena also gives students the chance to assess their own level of understanding. Students must check their conceptions against the results of their tests: "I thought this, but then this happened, so I had to figure out why" (Dyasi, 2000).

Inquiry-based science requires that students use a number of process skills in order to be successful. They include observing, questioning, hypothesizing/ predicting, investigating, interpreting, and communicating. All of these skills, of course, are valuable across disciplines (Dyasi, 2000).

Observation, the skill embedded in GLOBE's name, kicks off the inquiry process. In making observations, the learner gathers pieces of evidence that he or she then uses for comparing and ordering. The observer may start to notice patterns, or the sequence of events. Observation skills are more easily developed than other process skills, so this is the beginning and end of inquiry in many primary classrooms. Even the youngest children, however, can move beyond observation and into other areas of investigation (Ash, 2000).

Questioning is the definitive aspect of the inquiry process. To inquire means to question, after all. Young students have no problem in asking questions; in fact they seem to have a never-ending supply. Older students, however, have been conditioned to sit passively in their desks, regurgitating memorized facts and allowing the teacher to direct the discussion. Overcoming this behavior, then, is a major factor in successfully implementing inquiry. Teachers can promote a more inquisitive nature in their students by providing them with interesting phenomena to observe and ask questions about. Teachers can also encourage this behavior by having students read articles concerning interesting issues in science, and by suggesting possible topics for investigation (Edwards, 1997).

Student questioning is like a train. It may be difficult to get started, but once rolling, it is even harder to stop. The thing about questioning is that it invariably leads to more questioning. As the learner searches for a solution to the original problem, he or she will find more questions emerging, like stars in an early evening sky. Each new question is an invitation to the learner to delve deeper into the phenomena, and is, therefore, an opportunity to gain greater understanding. As Confucius would say, "There are many paths to the truth." The inquiry process, when done effectively, should also lead children to asking the right kind of question. Through experimentation, they can understand better which questions can be answered and which cannot (Ash, 1998).

Being able to predict what will happen next is a critical skill for children to develop, and the inquiry process provides an avenue for that growth. Through hypothesizing and predicting, the learner creates explanations for phenomena that are consistent with the evidence he or she has observed. The "if/then statement" so desired in today's classrooms is simply the language of inquiry.

Investigating requires students to decipher between variables and constants. While critical to creating fair tests in science, the ability to identify the elements that create change is important in any context. Investigating also helps children learn how to react to unanticipated events. The "path to the truth" referred to before often takes many unexpected turns along the way, and learning how to handle that adversity appropriately is as much an important life skill as it is a process skill. Interpreting data is another important skill learned through the inquiry process. Making sense of the information one collects means recognizing patterns, connecting findings to initial questions and observations, and synthesizing data into clear statements (Ash, 2000). The authentic nature of the investigations in GLOBE makes the process all the more valuable. By putting their studies in a real world context, especially when those projects actually contribute to understanding in local issues (such as the impact of suburban development on the health of local streams), students take greater ownership in their learning. Students learn with deeper understanding and retain that knowledge to a greater degree because they are immersed in it (Jarrett-Weeks & Stepanek, 2001).

Communication is essential to the success of an inquiry classroom. Students must talk to one another, listen to evidence and explanations, and represent their own results clearly. Aside from the benefits inquiry provides students in learning, it can also assist them in their social development. The process requires that students be active participants in their learning. "Communication in the inquiry classroom," says Ash, "goes beyond simply exchanging knowledge. It implies that socially gathered and shared information informs individual learning" (2000, p.6). Students discuss plans and work together through group activities, keep science notebooks containing written and pictorial records and reflections, and present their work orally to their peers (Dyasi, 2000).

Activities such as group work, reflective writing, and public speaking have academic benefit as well. This integration of skills and different learning styles is another important quality of the inquiry process, and it is critical to the practical implementation of GLOBE into the classroom.

Learning Styles

Although it has been nearly two decades since Howard Gardner shook up the education world with his Theory of Multiple Intelligences, most classroom structures and assessments still languish in the more traditional sense of learning, which views intelligence as a singular trait that can be easily measured through IQ tests. Gardner, on the other hand, defines intelligence as the ability to solve problems and create products valued by society. Gardner's first seven individual types of intelligence are linguistic, logical-mathematical, bodily-kinesthetic, spatial, musical, interpersonal, and intrapersonal. An eighth intelligence-naturalist, has recently been added to the list, and a ninth-existential, has been considered (Harvard Project Zero, 1999).

All people possess all of the intelligence types, and they may exhibit particular strengths in a number of domains. It follows, then, that effective instruction would include all the learning styles. Traditional classroom instruction, however, has focussed primarily on the logical-mathematical and linguistic forms of intelligence, while ignoring the rest (Harvard Project Zero, 1999). These two learning styles clearly fit with the traditional sense of intelligence, and therefore typical school and classroom structures are set up to deliver this kind of instruction. "Most 'real world' situations, however, require multiple approaches, tools, collaboration, and physical performance over time" (Moran, 2000, p.1). In order for our teaching to be relevant, then, we must paint with broader strokes. Inquiry based programs like GLOBE can serve as the brush.

GLOBE provides educators with the opportunity to implement one of Gardner's most important insights: that there are many ways to teach any concept or skill (Scherer, 1997). Most of the various learning styles are required of students participating in GLOBE. In a single learning activity on clouds, for example, students are asked to think linguistically, naturalistically, and spatially while observing and describing the appearance of clouds, and identifying ten major cloud types. They apply their logical-mathematical intelligence while estimating cloud height and while recording and organizing cloud data in their notebooks. All the while, students practice interpersonal intelligence as they work in small groups to accomplish their objectives. The bodily-kinesthetic learning style is practiced throughout, as this activity (like nearly all GLOBE activities) is a hands-on endeavor (GLOBE Teacher's Guide, 1997).

The environmental aspect of GLOBE makes it especially good at addressing naturalist intelligence, the ability to distinguish among, classify, and use features of the environment (Harvard Zero Project, 2000). In layman terms, the naturalist intelligence is having an "outstanding knowledge of the living world" (Meyer, 1998, p. 2). Fostering that knowledge inside a sterile classroom can be problematic, however, and that is where

GLOBE comes in. The program's outdoor orientation allows teachers to provide opportunities that encourage the development of the eighth intelligence. Activities like data collection from observation, grouping natural objects, designing experiments, conducting field studies, and recognizing natural cycles are elemental pieces of the GLOBE program, and are essential learning strategies in developing a naturalistic mindset (Meyer, 1998).

Technology

In spirit and practice, GLOBE draws from research and science education reform movements that employ inquiry and collaborative learning approaches. As GLOBE's Internet archives have grown- more than 5.7 million pieces of data have been added since the program began- it has increasingly focused on helping teachers engage students in collaboration and inquiry (Yarnall & Penuel, 2001). The inquiry method requires children to compare their own observations and discoveries with that of authentic science knowledge. "By reading and comparing this material," says Dyasi, "children join the larger scientific community on the topics they study" (2000, p 4). Joining that larger scientific community is what GLOBE is a primary objective of GLOBE, and technology is the vehicle that makes it happen.

The use of technology in the GLOBE program is a major contributing factor in its ability to contribute to student learning. Schulz-Hamsa (1998) argues that applying technology in unique ways in classrooms is essential to improving student achievement and in preparing them for a life in an increasingly technological world. In GLOBE, technology is not simply a "piece" in the program; it is the backbone of the entire enterprise. Technology is the tool that allows for student involvement in authentic science. Students enter the data they collect onto a website where scientists can use it for their studies. The GLOBE site is designed for instant student feedback. Visualization software set up by NASA and NOAA transforms the student data into dynamic, colorful maps. By adding to the worldwide database, students start to understand how earth systems work, and how all the components of the planet are interrelated. Student interest grows as they see how their data generates new findings about the earth (Hamil, 1998).

The GLOBE site also provides an open forum where students and scientists can share ideas and ask questions. GLOBE students in Washington State can compare their data sets to those of students from Australia, Monaco, or anywhere else there is a GLOBE school. Through GLOBEMAIL, an e-mail directory on the site, students can establish a dialogue with any other GLOBE school. The relationships formed through this communication, of course, have the potential to extend well beyond the bounds of science. Technology not only links students from around the world together; it provides a direct connection to the scientific community. If a student has a question about an unexpected result he/she found while conducting a soil investigation, for example, an expert in the field is just a click away (Jacobson and Jacobson, 1998).

GLOBE's use of technology goes beyond students entering data on an internet archive or emailing a scientist. Many of the program's learning activities and protocols call for students to utilize high tech instruments in their studies.

By implementing Geographic Information Systems (GIS) in remote sensing activities, GLOBE students can create dynamic visual representations of the data they collect. For example, a class in Ellensburg could superimpose the land cover data they've collected over a topographic map of the Yakima River Valley and then, in turn, overlay all of this onto a satellite image of the area.

GIS can help students do things only whimsically imagined by previous generations. Dusty old maps can become three-dimensional realities. Data points in logbooks can be connected to infrared satellite images. In fact, remote sensing and GIS can be used effectively at all grade levels. Primary students can develop a sense of place and appreciation for their world as seen from above. They can learn to use computers as tools, not just toys, and find satisfaction in their creations. In the process, they can also start to develop spatial skills, like mapping routes to school, and begin identifying physical features on the local landscape. Intermediate learners can create imagery as well as develop computer analysis and word processing skills. They can use GIS to recognize relationships and compare and contrast different geographic regions, identify physical features on a global level, and continue to grow in their understanding of spatial relationships. Students in the upper grades can develop advanced computer skills, manipulate data sets, and interpret biological, ecological, and socio-economic relationships. They can also test the accuracy of data, initiate and conduct local projects, and, ultimately, explore career possibilities (Hehr, 1998).

Some of the most complicated pieces of equipment that students have the opportunity to use in GLOBE are Global Positioning System (GPS) receivers. These hand-held devices receive data directly from a series of twenty-four satellites orbiting 20,200 kilometers above the earth. With a GPS receiver, students can determine their location, as measured in latitude and longitude, anywhere in the world to within thirty meters. Hence, they can determine the location of their school site on satellite photographs. (GLOBE Teacher's Guide, 1997).

Environmental Awareness

As these examples indicate, GLOBE's use of technology plays a large role in achieving the program's third goal of enhancing environmental awareness. GLOBE takes the environmentalist's creed of thinking globally and acting locally and applies it to a real world context. By taking hands-on measurements and entering them onto the database, children come to understand how their backyard is an important piece of the Earth's environment (Murphy and Coppola, 1997).

Assessing environmental awareness, however, is a tricky thing to do. The phrase is open to many interpretations and points of view. GLOBE is an environmental science program, so its definition of environmental awareness takes a scientific-cognitive perspective (Means et al., 1998).

Over the past few years, researchers have sought direct evidence of GLOBE students' understanding and ability to work with environmental data. Specifically, they have been "looking for evidence that students hold an integrated Earth systems understanding of environmental science (e.g., statements about environmental variables as interdependent, adaptive, and cyclical)" (Means et al., 1998).

In 1998, groups of elementary and middle school students from diverse backgrounds (and from both GLOBE and non-GLOBE classrooms) were asked to participate in an environmental awareness activity. The students were given a photograph of Glacier National Park and asked to describe what they inferred or perceived to be present in the picture. The student's responses were analyzed and then divided into different idea statements. Those which contained any kind of environmental inference (e.g., "that water must be cold," or "those valleys have a U shape") were further separated into "higher-level" or "descriptive" categories. Higher level responses were defined as statements that referred to five underlying ecological themes: adaptation, interdependence, cycles, ecosystems, and pollutants. Descriptive inferences were defined as statements that referred to the more cosmetic characteristics of the scene, without making references to any ecological ideas. After sifting through the environmental statements, the researchers found that the GLOBE student responses were far more likely to be of the higher-level category (seventy-seven percent) than their non-GLOBE counterparts (fifty-three percent). GLOBE students also needed less help in interpreting the image, suggesting that they required less contextual support to elicit environmental inferences than did non-GLOBE students. This research indicated that GLOBE students appear to be developing a deeper understanding of their planet as a result of participating in the program (Means, et al., 1998).

Researchers wanted to delve further into that notion, so in 1999 they conducted two different online assessments of students. The first test, as before, looked at environmental awareness, while the second required students to analyze data, write conclusions, and present evidence on a graph. The researchers tested students from high and average implementing GLOBE classrooms, as well as from some not involved in GLOBE. They chose a web-based format for the assessments because it allowed students to take part in realistic complex tasks, and it gave them the opportunity to use the kind of automated graphing tools used by scientists. Doing the assessments online also had the added benefit of allowing test administrators to collect data from a broader region than would have been possible if they had been given in a more traditional way (Means, et al., 2001).

The online assessment of environmental awareness was different from the 1998 study in that it asked students to view an image (this time, Mt. Hood) under two different conditions. In the first condition, the students were told to simply comment on the relationships they saw between the different elements in the picture. In the second condition, they were prompted to think about how the water cycle works in the environment. The two conditions allowed researchers to determine what kind of observations and ideas students could create on their own, and what they could generate when prompted to discuss their understanding of a particular concept. As before, the student responses were divided into the categories of descriptions and environmental inferences. Two key differences were found to exist between the GLOBE and non-GLOBE groups. First, GLOBE students made more references to the "big ideas" of environmental science in an unprompted situation than their non-GLOBE peers, strongly suggesting that GLOBE has a positive influence on students' environmental awareness. Second, GLOBE students also mentioned more phases of the water cycle than did non-GLOBE students, indicating that the program may have a positive influence on students' ability to describe specific aspects of an important earth system cycle. Of particular note here is that the cycle in question, water, is a commonly taught concept. Hence, it appears that GLOBE may help to nurture a richer understanding of how scientific processes operate in the natural world (Means, et. al, 2001).

The second part of the web based performance assessment measured students' skills in data analysis, decision making, and communication using environmental data. Students were asked to demonstrate their proficiency in these skills by determining a good site for the Winter Olympics using climate data. Basing their decisions on climate-related criteria set by the Olympic Committee, students had to decide which one of five cities would be the best site for a future Olympiad. The task required students to prepare a presentation for the Olympic Committee, announcing their site recommendation and graphically displaying the data that led them to that decision. When comparing the responses given by the three GLOBE groups on this complex performance assessment, the researchers found a positive correlation between the level of the GLOBE implementation and achievement on the test. This indicates that the more students are involved in the GLOBE program, the greater their ability to reason with environmental information (Means, et al., 2001).

Challenges to the Program

The nature of the partnership between scientists and students is touted as one of GLOBE's greatest attributes. It is also poses some of the greatest challenges to the successful implementation of the program. The best interests of the classroom and the field do not always intersect. For teachers, selective implementation of the protocols may make more sense in their classroom. They will utilize the atmosphere protocol for their unit on weather, but then stop taking measurements when the unit is done. For a scientist, these gaps in the data severely reduce the value of the research. Moreover, GLOBE's focus on data collection can limit other aspects of scientific inquiry. Programs with less of a stake in the production of new scientific knowledge have an easier time focusing on such skills as hypothesis development and data analysis (Means, 1998).

The structures of the school and those of the GLOBE program often come into conflict. If the data that students collect is to be useful to scientists, it must be collected regularly over a long period of time. Schools, however, are not mini-marts. They close for the weekends, holidays, and, of course, summer. "School vacations have always been the weak link for data collection within the GLOBE program," contends Brooks (2000). "Even active GLOBE schools often do not collect data on weekends or during extended holidays" (p.8).

To ensure their validity, GLOBE atmospheric measurements also need to be taken at the same *time* each day – at "solar noon" (middle of the day). This is a relatively wide window, and usually not that difficult to accommodate. However, some protocols call for measurements to be used for "ground-truth" validation of satellite data. In these instances, the opportunity to take measurements is restricted to the few minutes when the satellite is flying overhead (Brooks, 2000). In short, implementing the program to its fullest potential requires a great amount of time and schedule flexibility, things rarely found in public schools (Means, 1998).

The partnership scientists form with teachers and students is unlike any other relationship in their profession. In order to make it work effectively, scientists have to be willing to accept the fact that even the best teachers, with a high level of understanding, are undoubtedly less informed in a given field than are their other colleagues. Conversely, many scientists may not be especially adept in teaching or mentoring roles. Real partnerships with teachers and students require a great deal of patience and commitment of personal time. In addition to these concerns, scientists must recognize that students and teachers may not share the same level of enthusiasm for a particular project. Whereas a scientist may devote years of his or her life to a singular study, that same project may represent only a sliver of a student's or teacher's day (Brooks, 2000).

Scientists can also become frustrated by the apparent lack of regard teachers have for intellectual property. These professionals understandably develop a strong sense of ownership over their data, and it can be disheartening to see it being used carelessly. This issue may be more a matter of point of view than ethics, however. Schools are typically allowed unrestricted use of information gathered through GLOBE studies. In addition, "fair use" policies with concern to intellectual property in schools give educators a great deal of freedom in how they use information (Brooks, 2000).

Issues surrounding the technology component of GLOBE are another challenge facing the program. Many schools have little if any access to the internet, and teachers with minimal technology backgrounds can easily be intimidated by GLOBE's technical requirements. The data collected by students can be reported through other means, but as was stated earlier, the technological aspects GLOBE are major components in GLOBE's allure to students and the program's effectiveness (Means, 1998). Sending your data via the post office just doesn't have the same appeal as shooting it across cyberspace.

GLOBE is supposed to be a K-12 program, but primary (K-3) teachers have found that some of the protocols and learning activities sometimes require skills (such as the ability to work with fractions, or determining averages) that are developmentally inappropriate for their students. The GLOBE Program has recognized this as a weakness, and it has made efforts to develop activities for very young learners, but it is still a major stumbling block for some primary teachers. Other problems exist with concern to making GLOBE a successful endeavor. Finding a good data collection site for the different protocols can prove to be problematic, as can finding funds and obtaining the scientific equipment needed (Means, 1998).

A teacher's personal level of development should also be taken into account. An educator at the self-adequacy stage of his or her career, whose primary concern is making it through the school day, may not be able to take on the level of commitment, time and responsibility a program like GLOBE demands on an individual (Adams and Martray, 1981).

Successful Implementation of the Program

Although challenging to implement, the GLOBE program is still viewed as rewarding by its participants. Schools that have had success with GLOBE seem to exhibit some basic commonalties. First, they report having strong support from school administrators. Principals provide fiscal assistance for training, for transportation to data collection sites, and for purchasing equipment. The principals also give support by treating GLOBE as a special asset that sets their school apart from others (Means, et al., 2001).

Teachers in high-implementing GLOBE schools said that organizing data collection around local environmental issues was extremely beneficial to the success of the program. While GLOBE's scope is worldwide, it is best experienced when it is firmly anchored to community concerns. In Middleport, New York, for example, the elementary school is in close proximity to a coal-burning energy plant. So students studied the acidity of local rainwater. In Kinsburg, California, students observed ozone levels to record the flow of pollution from San Francisco to the San Joaquin Valley. Teachers also rely on creative classroom management, finding a variety of ways for students to participate in multiple aspects of scientific inquiry. Some schools have worked out data collecting rotations among different classrooms, while others have formed buddy systems between primary and intermediate grades (Means et al., 1996). Others have distributed teaching responsibilities among students, giving them a larger role in directing their own learning, and freeing up teachers to respond to the different needs and skills of the class (Means et al., 2001).

Finally, successful GLOBE teachers have expanded the program within their own schools by coming up with creative ways to involve other teachers in parts of GLOBE implementation. One way to create interest among colleagues is to show how GLOBE aligns with the Standards. With the heavy emphasis being given to accountability in schools, some teachers feel they have less latitude to incorporate GLOBE into their classrooms. Suffering from "Not-enough-time-in-the-day Syndrome," these teachers are not about to add yet another thing to their schedule, let alone a program as time consuming as GLOBE. They express concerns about aligning GLOBE with state and local curriculum standards, as well as finding time to plan for the program and use it in the classroom (Means, et al., 2001). These concerns would cease to exist however, if teachers could more easily recognize the congruent relationship GLOBE has with subject integration and the Standards. "The Standards should be used as much to determine what should be pruned out of the curriculum as what should be grafted in its place," says Bartels. "We cannot keep adding without taking away!" (2000, p. 5).

The GLOBE program can be an excellent vehicle for subject integration. The study of scientific phenomena in GLOBE is dependent upon the use of mathematical skills, and so the integration of these two subjects is virtually seamless. But GLOBE's potential for the infusion of disciplines goes beyond the realm of math and science. Reading, writing, and language skills are all a part of the required elements of the program, and there is almost unlimited possibility for the inclusion of other subjects as well (Means, et. al, 2001).

The international nature of GLOBE allows for the investigation of common themes and concerns across cultures. With GLOBEMAIL's "magic box," an engine that translates the written word into the six major global languages recognized by the UN, students can engage in a kind of communication that makes pen pal programs look pale in comparison. Social and historical events can be intertwined into GLOBE as well. For example, students in Walla Walla could use ground cover protocols to study the regeneration of plant life to make accurate maps of the Oregon Trail.

The driving force of standards-based education, of course, is the desire for greater academic achievement. To that end, the Standards provide clearly defined goals for students and teachers, outlining what students should know and be able to do (Stepanek, 1997). The Commission on Student Learning created four primary learning goals designed to "raise the bar" in Washington State. They are:

1. Read with comprehension, write with skill, and communicate effectively and responsibly in a variety of ways and settings.

2. Know and apply the core concepts and principles of mathematics; social, physical and life sciences; civics and history; geography; arts; and health and fitness.

3. Think analytically, logically, and creatively, and to integrate experience and knowledge to form reasoned judgements.

4. Understand the importance of work and how performance, effort and decisions directly effect career and educational opportunities (1997).

GLOBE is an excellent vehicle for attaining these goals. The GLOBE methodology and that espoused by national and state standards are one in the same. GLOBE is project based, and it engages students in relevant, hands-on investigations. "Because it is grounded in authentic science, the program provides a rich context for introducing challenging material early in students' schooling." (Means, 1998). GLOBE activities promote higher order thinking skills, and they lend themselves well to cooperative and multi-age groupings.

Summary

The research and literature summarized in Chapter II supported the following themes:

1. A positive association exists between implementation of the GLOBE program and increased student academic performance and environmental awareness.

2. Students are capable of collecting valid data for authentic scientific studies and contributing to greater scientific knowledge.

3. Teachers participating in the GLOBE program are more likely than their non-GLOBE counterparts to require higher-level tasks of their students.
4. The GLOBE program embodies features valued in education reform efforts and on math and science standards, such as the National Science Education Standards calling for the use of inquiry as a primary method of instruction.
5. Inquiry-based classrooms, while difficult to set up, improve student involvement and understanding.
6. Schools that have had success with the GLOBE program exhibit some basic commonalties, which include receiving strong administrative support, organizing data around local environmental issues, and expanding the program within their own schools.

CHAPTER III

PROCEDURES OF THE PROJECT

The purpose of this project was to develop a guide that aligned the Washington State Essential Learning Requirements (EALRs) with the Global Learning and Observations to Benefit the Environment (GLOBE) program for teachers in Washington state. To accomplish this purpose, a review of related current literature was conducted.

Chapter III contains background information describing:

1. Need for the project
2. Procedures of the project
3. Planned implementation and assessment of the project

Need for the Project

The need for this project was influenced by the following considerations:

1. The writer, Travis B. Peterson, an elementary certified teacher, took part in a GLOBE teacher-training seminar in the summer of 1998. During that time he came to recognize the program's utility in teaching science and math concepts to students and in helping teachers meet the standards set by the Washington State Essential Academic Learning Requirements.
2. With the start of the new school year, the writer began to implement GLOBE into his curriculum. Emboldened by some positive early experiences, he attempted to enlist other teachers into the program, but was met with resistance. His colleagues expressed concern in adding anything else to their already full curriculum, and were apprehensive about the inquiry-based, data-

intensive nature of the program. The writer determined that if staff members could clearly understand how GLOBE's approach to learning fit hand-in-glove with the Essential Learnings and could actually "lessen the load" by integrating subject material, then they would be more inclined to implement the program into their classrooms. To that end, the writer resolved that there was a need for a GLOBE Essential Learning Guide.

3. Following his admission to graduate school, the writer's review of literature and research related to the GLOBE program and inquiry-based learning further convinced him of the need to correlate the GLOBE program's learning activities and protocols to the Essential Learnings.
4. Undertaking this project coincided with the writer's graduate studies in Educational Administration at Central Washington University.

Procedures of the Project

To obtain related background information an Educational Resources Information Center (ERIC) computer search was conducted. Additionally, GLOBE program materials and the Washington State Essential Academic Requirements benchmarks for math and science were obtained and analyzed.

Planned Implementation and Assessment

It is the writer's intent to present this GLOBE Essential Learning Guide to GLOBE program coordinators in the state of Washington so that it can be inserted into the Teaching Guides of participating educators. The GLOBE Essential Learning Guide will also be made available on the "Educator's Corner" page of the GLOBE website at www.globe.gov/fsl/standards/index.pl.

Assessment of the GLOBE Essential Learning Guide will be an ongoing process and will take place starting shortly after implementation. GLOBE officials and participating teachers will review the guide and assess it for accuracy and ease of use. Surveys will be sent to participating GLOBE schools in Washington State. After the surveys are returned, the data will be analyzed and improvements and changes will be made accordingly. Internet users will also be able to provide immediate feedback on the guide by sending comments to the writer's email address, which will be attached to the document. The GLOBE Essential Learning Guide will be adjusted and enhanced as new learning activities and protocols are introduced to the GLOBE program, and as the state standards in math and science are altered.

CHAPTER IV

THE PROJECT

The GLOBE Essential Learning Guide developed for the purposes of this project was designed to assist teachers in WA State. The guide aligns the GLOBE program learning activities/protocols to the State of Washington's Essential Academic Requirements. The GLOBE Essential Learning Guide has been organized into seven (7) sections listed below:

Section 1: Implementation Guide

Section 2: Atmosphere

Section 3: Hydrology

Section 4: Land Cover

Section 5: Soil

Section 6: GPS

Section 7: Seasons

GLOBE ESSENTIAL LEARNING GUIDE

-For Educators in Washington State-

TABLE OF CONTENTS

IMPLEMENTATION - SCIENCE	Our Home Planet	Our Special Place
Human Biology		
Molecular basis of heredity		
Structure and organization of living things		
Components of the solar system and beyond		
Components and patterns of the earth system	X	
Physical /chemical changes		
Structure of matter		
Energy transfer and transformation		
Energy sources and kinds		
Systems	X	
1.2 recognizes the components, structure and organization of systems and the interconnections...		
Basis of biological diversity		
Nature and properties of earth materials		X
Wave behavior		
Motion of objects		
Properties and substances		X
1.1 uses properties to identify , describe, and categorize substances, materials, and objects...		
1. The student understands and uses scientific concepts and principles		

IMPLEMENTATION- SCIENCE	Our Home Planet	Our Special Place
1.3 understand how interactions within and among systems cause changes in matter and energy		
Nature of forces		
Forces to Explain Motion		
Processes and interactions in the earth system	x	
History and evolution of the earth		
Hydroshere/atmosphere		
Interactions in the solar system and beyond		
Life processes and the flow of matter and energy		
Biological Evolution		
Interdependence of life		
Environmental and resourse issues	x	
2. The student knows and applies the skills and processes of science/tech		
2.1 develop abilities necessary to do scientific inquiry		
Questioning		x
Designing and conducting investigations		x
Explanation		x
Modeling		x

IMPLEMENTATION- SCIENCE

IMPLEMENTATION- SCIENCE	Our Home Planet	Our Special Place
Careers and occupations using science, mathematics, and technology	X	
Relationship of science and technology	X	
All peoples contribute to science and technology		
3.2 know that science and technology are human endeavors, interrelated to each other, to society...		
Evolution of scientific ideas		
Evaluating methods of investigation		
Dealing with inconsistencies		
Limitations of science and technology		
Intellectual honesty		
3.1 understand the nature of inquiry		
3. The student understands the nature and contexts of science and technology		
Evaluating potential solutions		
Designing and testing solutions		
Identifying problems	X	
2.2 apply science knowledge and skills to solve problems or meet challenges		
Communication		X

IMPLEMENTATION- MATH	Our Home Planet	Our Special Place
1. The student understands and applies the concepts and procedures of mathematics		
1.1 understand and apply concepts and procedures from number sense		
number and numeration		
computation		
estimation		
1.2 understand and apply concepts and procedures from measurement		
attributes and dimensions		
approximation and precision		
systems and tools		
1.3 understand and apply concepts and procedures from geometric sense		
properties and relationships		
locations and transformations		
1.4 understand and apply concepts and procedures from probability and statistics		
probability		
statistics		
prediction and inference		
1.5 understand and apply concepts and procedures from algebraic sense		
patterns	X	
representations		
operations		

P7

IMPLENTATION- MATH	Our Home Planet	Our Special Place
2. The student uses mathematics to solve problems		
2.1 investigate situations	X	X
2.2 formulate questions and define the problem	X	
2.3 construct solutions		
3. The student uses mathematical reasoning		
3.1 analyze information	X	X
3.2 predict results	X	X
3.3 draw conclusions and verify results		X
4. The student communicates knowledge and understanding everyday and mathematical language		
4.1 gather information		X
4.2 organize and interpret information		X
4.3 represent and share information	X	X
5. The student understands how math ideas connect within math, to other subjects areas, and to life		
5.1 relate concepts and procedures within mathematics		
5.2 relate mathematical concepts and procedures to other disciplines	X	X
5.3 relate mathematical concepts and procedures to real-life situations	X	

ATMOSPHERE- SCIENCE	Cloud Watch	Land, Water, Air	Thermometer	Instrument Shelter	Cloud Cover	Observing/Describing	Protocols
Human Biology							
Molecular basis of heredity							
Structure and organization of living things							
Components of the solar system and beyond							
Components and patterns of the earth system	X	X			X		X
Physical /chemical changes	X	X	X				X
Structure of matter							
Energy transfer and transformation		X	X	X			X
Energy sources and kinds		X	X	X			X
Systems	X	X					
1.2 recognizes the components, structure and organization of systems and the interconnections...							
Basis of biological diversity							
Nature and properties of earth materials	X	X			X	X	X
Wave behavior							
Motion of objects							
Properties and substances		X				X	X
1.1 uses properties to identify , describe, and categorize substances, materials, and objects...							
1. The student understands and uses scientific concepts and principles							

ATMOSHERE - SCIENCE

	Cloud Watch	Land, Water, Air	Thermometer	Instrument Shelter	Cloud Cover	Observing/Describing	Protocols
1.3 inderstand how interactions within and among systems cause changes in matter and energy							
Nature of forces							
Forces to Explain Motion							
Processes and interactions in the earth system	X						X
History and evolution of the earth							
Hydroshere/atmosphere	X	X	X	X		X	X
Interactions in the solar system and beyond							
Life processes and the flow of matter and energy							
Biological Evolution							
Interdependence of life							
Environmental and resourse issues							
2. The student knows and applies the skills and processes of science/tech							
2.1 develop abilities necessary to do scientific inquiry							
Questioning		X	X	X	X		
Designing and conducting investigations		X	X	X			X
Explanation			X	X			
Modeling					X		

ATMOSPHERE-SCIENCE	Cloud Watch	Land, Water, Air	Thermometer	Instrument Shelter	Cloud Cover	Observing/Describing	Protocols
Careers and occupations using science, mathematics, and technology							X
Relationship of science and technology			X				X
All peoples contribute to science and technology			X				X
3.2 know that science and technology are human endeavors, interrelated to each other, to society...							
Evolution of scientific ideas	X						
Evaluating methods of investigation			X	X			X
Dealing with inconsistencies				X			
Limitations of science and technology							
Intellectual honesty							X
3.1 understand the nature of inquiry							
3. The student understands the nature and contexts of science and technology							
Evaluating potential solutions				X			
Designing and testing solutions				X			
Identifying problems				X			
2.2 apply science knowledge and skills to solve problems or meet challenges							
Communication		X		X	X	X	X

ATMOSPHERE- MATH	Cloud Watch	Land, Air, Water	Thermometer	Instrument Shelter	Cloud Cover	Observing/Describing	Protocols
1. The student understands and applies the concepts and procedures of mathematics							
1.1 understand and apply concepts and procedures from number sense							
number and numeration					X	X	X
computation					X		
estimation				X	X	X	X
1.2 understand and apply concepts and procedures from measurement							
attributes and dimensions			X	X			
approximation and precision		X	X		X		X
systems and tools							
1.3 understand and apply concepts and procedures from geometric sense							
properties and relationships							
locations and transformations							
1.4 understand and apply concepts and procedures from probability and statistics							
probability							
statistics	X	X			X		X
prediction and inference	X			X	X		
1.5 understand and apply concepts and procedures from algebraic sense							
patterns	X	X					X
representations							
operations							

ATMOSPHERE- MATH	Cloud Watch	Land, Air, Water	Thermometer	Instrument Shelter	Cloud Cover	Observing/Describing	Protocols
5.3 relate mathematical concepts and procedures to real-life situations	X		X	X	X	X	X
5.2 relate mathematical concepts and procedures to other disciplines	X	X	X	X	X	X	X
5.1 relate concepts and procedures within mathematics							
5. The student understands how math ideas connect within math, to other subjects areas, and to life							
4.3 represent and share information		X		X	X		X
4.2 organize and interpret information	X		X	X	X	X	
4.1 gather information	X	X	X	X	X	X	X
4. The student communicates knowledge and understanding everyday and mathematical language							
3.3 draw conclusions and verify results		X					
3.2 predict results	X			X			
3.1 analyze information	X	X	X	X	X	X	X
3. The student uses mathematical reasoning							
2.3 construct solutions	X	X	X	X			
2.2 formulate questions and define the problem			X	X			
2.1 investigate situations	X	X	X	X			
2. The student uses mathematics to solve problems							

HYDROLOGY - SCIENCE	Water balance	Macroinvertabrates	Water everywhere	Predicting protocol	pH game	Water detective	Model watershed	Water Walk	Protocols
Human Biology									
Molecular basis of heredity									
Structure and organization of living things									
Components of the solar system and beyond									
Components and patterns of the earth system	X		X			X	X	X	X
Physical /chemical changes	X								X
Structure of matter						X			
Energy transfer and transformation									X
Energy sources and kinds									X
Systems		X					X		X
1.2 recognizes the components, structure and organization of systems and the interconnections...									
Basis of biological diversity		X							
Nature and properties of earth materials	X		X	X	X	X	X	X	X
Wave behavior									
Motion of objects								X	
Properties and substances					X	X		X	X
1.1 uses properties to identify , describe, and categorize substances, materials, and objects...									
1. The student understands and uses scientific concepts and principles									

HYDROLOGY - SCIENCE	Water balance	Macroinvertabrates	Water everywhere	Predicting protocol	pH game	Water detective	Model watershed	Water Walk	Protocols
Careers and occupations using science, mathematics, and technology									X
Relationship of science and technology			X	X					X
All peoples contribute to science and technology	X	X	X	X					X
3.2 know that science and technology are human endeavors, interrelated to each other, to society...									
Evolution of scientific ideas									
Evaluating methods of investigation	X	X	X			X	X		
Dealing with inconsistencies	X	X	X		X	X			
Limitations of science and technology	X		X						
Intellectual honesty			X	X	X			X	
3.1 understand the nature of inquiry	X		X	X	X	X			X
3. The student understands the nature and contexts of science and technology									
Evaluating potential solutions						X			
Designing and testing solutions						X			
Identifying problems					X	X		X	
2.2 apply science knowledge and skills to solve problems or meet challenges									
Communication	X		X	X			X	X	X

HYDROLOGY - SCIENCE	Water balance	Macroinvertabrates	Water everywhere	Predicting protocol	pH game	Water detective	Model watershed	Water Walk	Protocols
Modeling	x	x	x				x	x	
Explanation			x		x	x			
Designing and conducting investigations	x	x	x	x	x	x			x
Questioning	x		x		x	x		x	
2.1 develop abilities necessary to do scientific inquiry									
2. The student knows and applies the skills and processes of science and technology									
Environmental and resourse issues				x					x
Interdependence of life		x							x
Biological Evolution									
Life processes and the flow of matter and energy		x							x
Interactions in the solar system and beyond									
Hydroshere/atmosphere	x		x	x	x			x	x
History and evolution of the earth							x		
Processes and interactions in the earth system	x				x		x	x	x
Forces to Explain Motion							x		
Nature of forces							x		
1.3 inderstand how interactions within and among systems cause changes in matter and energy									

HYDROLOGY - MATH	Water balance	Macroinvertabrates	Water everywhere	Predicting protocol	pH game	Water detective	Model watershed	Water Walk	Protocols
1. The student understands and applies the concepts and procedures of mathematics									
1.1 understand and apply concepts and procedures from number sense									
number and numeration	X	X	X	X	X	X			X
computation	X	X	X	X		X			X
estimation									
1.2 understand and apply concepts and procedures from measurement									
attributes and dimensions	X	X	X	X	X				X
approximation and precision	X	X	X	X					X
systems and tools	X	X	X	X	X		X		X
1.3 understand and apply concepts and procedures from geometric sense									
properties and relationships							X		
locations and transformations							X		
1.4 understand and apply concepts and procedures from probability and statistics									
probability									
statistics	X	X	X	X	X	X			X
prediction and inference	X	X	X		X		X		
1.5 understand and apply concepts and procedures from algebraic sense									
patterns								X	
representations									
operations									

HYDROLOGY - MATH	Water balance	Macroinvertabrates	Water everywhere	Predicting protocol	pH game	Water detective	Model watershed	Water Walk	Protocols
5.3 relate mathematical concepts and procedures to real-life situations	X	X	X	X	X	X	X	X	X
5.2 relate mathematical concepts and procedures to other disciplines	X	X	X	X	X	X	X	X	X
5.1 relate concepts and procedures within mathematics	X		X						
5. The student understands how math ideas connect within math, to other subjects areas, and to life									
4.3 represent and share information	X	X	X		X			X	
4.2 organize and interpret information	X	X	X		X	X		X	
4.1 gather information	X	X	X	X	X	X	X	X	X
4. The student communicates knowledge and understanding everyday and mathematical language									
3.3 draw conclusions and verify results	X		X		X		X		
3.2 predict results	X	X	X			X	X	X	
3.1 analyze information	X	X	X	X	X	X	X	X	X
3. The student uses mathematical reasoning									
2.3 construct solutions	X		X			X	X		
2.2 formulate questions and define the problem	X		X		X		X	X	
2.1 investigate situations	X		X		X	X	X	X	
2. The student uses mathematics to solve problems									

SOIL- SCIENCE	Data Game	Particle Size	The Great Decomposer	Soils as Sponges	Soil and my backyard	Mud Pies to Bricks	Just Passing Through	Protocols
Human Biology								
Molecular basis of heredity								
Structure and organization of living things								
Components of the solar system and beyond								
Components and patterns of the earth system		X	X	X	X	X	X	
Physical /chemical changes			X	X			X	
Structure of matter		X						X
Energy transfer and transformation								
Energy sources and kinds								
Systems								
1.2 recognizes the components, structure and organization of systems and the interconnections...								
Basis of biological diversity			X					X
Nature and properties of earth materials		X	X	X	X	X	X	X
Wave behavior								
Motion of objects								
Properties and substances		X	X	X	X	X	X	X
1.1 uses properties to identify , describe, and categorize substances, materials, and objects...								
1. The student understands and uses scientific concepts and principles								

SOIL-SCIENCE	Data Game	Particle Size	The Great Decomposer	Soils as Sponges	Soil and my backyard	Mud Pies to Bricks	Just Passing Through	Protocols
1.3 inderstand how interactions within and among systems cause changes in matter and energy								
Nature of forces								
Forces to Explain Motion								
Processes and interactions in the earth system			X		X	X	X	
History and evolution of the earth								
Hydroshere/atmosphere							X	
Interactions in the solar system and beyond								
Life processes and the flow of matter and energy			X					
Biological Evolution								
Interdependence of life								
Environmental and resourse issues			X					X
2. The student knows and applies the skills and processes of science and technology								
2.1 develop abilities necessary to do scientific inquiry								
Questioning			X		X	X	X	
Designing and conducting investigations			X	X	X	X	X	X
Explanation			X	X		X	X	
Modeling								

SOIL-SCIENCE	Data Game	Particle Size	The Great Decomposer	Soils as Sponges	Soil and my backyard	Mud Pies to Bricks	Just Passing Through	Protocols
Communication			X	X	X		X	X
2.2 apply science knowledge and skills to solve problems or meet challenges								
Identifying problems								
Designing and testing solutions								
Evaluating potential solutions								
3. The student understands the nature and contexts of science and technology								
3.1 understand the nature of inquiry								
Intellectual honesty								X
Limitations of science and technology								
Dealing with inconsistencies								
Evaluating methods of investigation			X	X		X	X	X
Evolution of scientific ideas			X	X		X	X	
3.2 know that science and technology are human endeavors, interrelated to each other, to society…								
All peoples contribute to science and technology								X
Relationship of science and technology		X					X	X
Careers and occupations using science, mathematics, and technology								X

SOIL- MATH	1. The student understands and applies the concepts and procedures of mathematics	1.1 understand and apply concepts and procedures from number sense	number and numeration	computation	estimation	1.2 understand and apply concepts and procedures from measurement	attributes and dimensions	approximation and precision	systems and tools	1.3 understand and apply concepts and procedures from geometric sense	properties and relationships	locations and transformations	1.4 understand and apply concepts and procedures from probability and statistics	probability	statistics	prediction and inference	1.5 understand and apply concepts and procedures from algebraic sense	patterns	representations	operations
Data Game			X	X	X		X	X	X		X				X				X	X
Particle Size			X	X	X		X	X	X		X								X	X
The Great Decomposer																X				
Soils as Sponges			X	X	X		X	X	X						X	X				X
Field View															X					
Soil in my Backyard																				
From Mud Pies to Bricks			X				X	X	X		X				X					
Just Passing Through			X	X			X	X	X						X	X				
Protocols			X	X				X	X						X					

SOIL- MATH	Data Game	Particle Size	The Great Decomposer	Soils as Sponges	Field View	Soil in my Backyard	From Mud Pies to Bricks	Just Passing Through	Protocols
2. The student uses mathematics to solve problems									
2.1 investigate situations	X	X	X	X	X	X	X	X	X
2.2 formulate questions and define the problem					X			X	
2.3 construct solutions	X							X	
3. The student uses mathematical reasoning									
3.1 analyze information	X	X	X	X	X	X	X	X	
3.2 predict results			X	X	X		X	X	
3.3 draw conclusions and verify results	X		X	X	X		X	X	
4. The student communicates knowledge and understanding everyday and mathematical language									
4.1 gather information	X	X	X	X	X	X	X	X	X
4.2 organize and interpret information	X	X	X	X	X	X	X	X	X
4.3 represent and share information	X		X			X	X		X
5. The student understands how math ideas connect within math, to other subjects areas, and to life									
5.1 relate concepts and procedures within mathematics	X			X				X	
5.2 relate mathematical concepts and procedures to other disciplines	X	X	X	X	X	X	X	X	X
5.3 relate mathematical concepts and procedures to real-life situations	X								X

G. COVER- SCIENCE	Seasonal Changes	Site Seeing	Discovery Area	Some Like it Hot	Odyssey of the Eyes	What's the Difference?	How Accurate is it?	Leaf Classification	Protocols
Human Biology									
Molecular basis of heredity	X						X		
Structure and organization of living things	X								
Components of the solar system and beyond									
Components and patterns of the earth system	X	X	X	X	X	X			X
Physical /chemical changes	X	X		X					X
Structure of matter				X					X
Energy transfer and transformation		X		X					
Energy sources and kinds		X		X					
Systems	X	X	X						X
1.2 recognizes the components, structure and organization of systems and the interconnections...									
Basis of biological diversity	X	X	X		X		X	X	X
Nature and properties of earth materials		X	X	X	X	X		X	
Wave behavior									
Motion of objects									
Properties and substances					X	X	X		
1.1 uses properties to identify , describe, and categorize substances, materials, and objects...									
1. The student understands and uses scientific concepts and principles									

G. COVER- SCIENCE	Seasonal Changes	Site Seeing	Discovery Area	Some Like it Hot	Odyssey of the Eyes	What's the Difference?	How Accurate is it?	Leaf Classification	Protocols
Modeling		X		X	X	X	X	X	X
Explanation		X	X	X	X	X	X		X
Designing and conducting investigations		X		X		X	X		X
Questioning			X	X		X			X
2.1 develop abilities necessary to do scientific inquiry									
2. The student knows and applies the skills and processes of science and technology									
Environmental and resourse issues	X								X
Interdependence of life		X	X						X
Biological Evolution									
Life processes and the flow of matter and energy	X	X							X
Interactions in the solar system and beyond							X		
Hydroshere/atmosphere		X				X			X
History and evolution of the earth									
Processes and interactions in the earth system			X						
Forces to Explain Motion									
Nature of forces									
1.3 inderstand how interactions within and among systems cause changes in matter and energy									

G. COVER- SCIENCE	Seasonal Changes	Site Seeing	Discovery Area	Some Like it Hot	Odyssey of the Eyes	What's the Difference?	How Accurate is it?	Leaf Classification	Protocols
Communication	X		X	X	X	X	X	X	X
2.2 apply science knowledge and skills to solve problems or meet challenges									
Identifying problems			X			X	X		X
Designing and testing solutions							X		X
Evaluating potential solutions			X			X	X		X
3. The student understands the nature and contexts of science and technology									
3.1 understand the nature of inquiry									
Intellectual honesty						X	X		X
Limitations of science and technology		X						X	
Dealing with inconsistencies						X			X
Evaluating methods of investigation		X		X			X		X
Evolution of scientific ideas		X		X		X	X		X
3.2 know that science and technology are human endeavors, interrelated to each other, to society...									
All peoples contribute to science and technology				X					X
Relationship of science and technology			X	X	X				X
Careers and occupations using science, mathematics, and technology			X						X

G. COVER- MATH	Seasonal Changes	Site Seeing	Discovery Area	Some Like it Hot	Odyssey of the Eyes	What's the Difference?	How Accurate is it?	Leaf Classification	Protocols
1. The student understands and applies the concepts and procedures of mathematics									
1.1 understand and apply concepts and procedures from number sense									
number and numeration							X		X
computation							X		X
estimation					X				X
1.2 understand and apply concepts and procedures from measurement									
attributes and dimensions				X			X		X
approximation and precision				X	X		X		X
systems and tools				X		X	X		X
1.3 understand and apply concepts and procedures from geometric sense									
properties and relationships				X	X		X		
locations and transformations				X					
1.4 understand and apply concepts and procedures from probability and statistics									
probability									
statistics						X	X	X	X
prediction and inference			X	X					
1.5 understand and apply concepts and procedures from algebraic sense									
patterns						X	X	X	
representations						X			
operations						X	X		X

G. COVER- MATH	Seasonal Changes	Site Seeing	Discovery Area	Some Like it Hot	Odyssey of the Eyes	What's the Difference?	How Accurate is it?	Leaf Classification	Protocols
5.3 relate mathematical concepts and procedures to real-life situations			X	X					X
5.2 relate mathematical concepts and procedures to other disciplines	X	X	X	X	X	X	X	X	X
5.1 relate concepts and procedures within mathematics			X			X	X		
5. The student understands how math ideas connect within math, to other subjects areas, and to life									
4.3 represent and share information		X	X	X	X		X	X	X
4.2 organize and interpret information	X	X	X	X	X	X	X	X	X
4.1 gather information	X	X	X	X		X	X	X	X
4. The student communicates knowledge and understanding everyday and mathematical language									
3.3 draw conclusions and verify results			X	X		X	X		X
3.2 predict results			X	X		X	X		
3.1 analyze information		X	X	X	X		X	X	X
3. The student uses mathematical reasoning									
2.3 construct solutions			X			X	X	X	
2.2 formulate questions and define the problem			X	X		X	X	X	
2.1 investigate situations		X	X	X		X	X	X	
2. The student uses mathematics to solve problems									

GPS- SCIENCE	Celestial Navigation	Working with Angles	Relative and Absolute	The Right Answer	Protocols
Human Biology					
Molecular basis of heredity					
Structure and organization of living things					
Components of the solar system and beyond	X				
Components and patterns of the earth system		X			
Physical /chemical changes					
Structure of matter					
Energy transfer and transformation					
Energy sources and kinds					
Systems	X				
1.2 recognizes the components, structure and organization of systems and the interconnections...					
Basis of biological diversity					
Nature and properties of earth materials					
Wave behavior					
Motion of objects			X		
Properties and substances					
1.1 uses properties to identify , describe, and categorize substances, materials, and objects...					
1. The student understands and uses scientific concepts and principles					

GPS- SCIENCE	Celestial Navigation	Working with Angles	Relative and Absolute	The Right Answer	Protocols
Modeling			X	X	
Explanation				X	
Designing and conducting investigations	X				X
Questioning			X		
2.1 develop abilities necessary to do scientific inquiry					
2. The student knows and applies the skills and processes of science and technology					
Environmental and resourse issues					
Interdependence of life					
Biological Evolution					
Life processes and the flow of matter and energy					
Interactions in the solar system and beyond	X				
Hydroshere/atmosphere					
History and evolution of the earth					
Processes and interactions in the earth system					
Forces to Explain Motion					
Nature of forces					
1.3 inderstand how interactions within and among systems cause changes in matter and energy					

GPS - SCIENCE	Celestial Navigation	Working with Angles	Relative and Absolute	The Right Answer	Protocols
Communication	X		X	X	X
2.2 apply science knowledge and skills to solve problems or meet challenges					
Identifying problems			X	X	
Designing and testing solutions					
Evaluating potential solutions			X	X	
3. The student understands the nature and contexts of science and technology					
3.1 understand the nature of inquiry					
Intellectual honesty					X
Limitations of science and technology				X	
Dealing with inconsistencies				X	
Evaluating methods of investigation				X	X
Evolution of scientific ideas					
3.2 know that science and technology are human endeavors, interrelated to each other, to society...					
All peoples contribute to science and technology	X			X	X
Relationship of science and technology	X			X	X
Careers and occupations using science, mathematics, and technology					X

GPS- MATH	Celestial Navigation	Working with Angles	Relative and Absolute	The Right Answer	Protocols
operations	X	X	X	X	X
representations	X	X			X
patterns					
1.5 understand and apply concepts and procedures from algebraic sense					
prediction and inference					
statistics	X	X		X	X
probability					
1.4 understand and apply concepts and procedures from probability and statistics					
locations and transformations	X		X		X
properties and relationships	X		X		X
1.3 understand and apply concepts and procedures from geometric sense					
systems and tools	X	X	X	X	X
approximation and precision	X	X	X	X	X
attributes and dimensions	X	X	X	X	X
1.2 understand and apply concepts and procedures from measurement					
estimation		X		X	X
computation	X	X	X	X	X
number and numeration	X	X	X	X	X
1.1 understand and apply concepts and procedures from number sense					
1. The student understands and applies the concepts and procedures of mathematics					

GPS- MATH	Celestial Navigation	Working with Angles	Relative and Absolute	The Right Answer	Protocols
5.3 relate mathematical concepts and procedures to real-life situations	X	X	X	X	X
5.2 relate mathematical concepts and procedures to other disciplines	X	X	X	X	X
5.1 relate concepts and procedures within mathematics	X	X	X	X	X
5. The student understands how math ideas connect within math, to other subjects areas, and to life					
4.3 represent and share information	X				X
4.2 organize and interpret information	X	X	X	X	X
4.1 gather information	X	X	X	X	X
4. The student communicates knowledge and understanding everyday and mathematical language					
3.3 draw conclusions and verify results			X	X	
3.2 predict results					
3.1 analyze information	X	X	X	X	X
3. The student uses mathematical reasoning					
2.3 construct solutions				X	
2.2 formulate questions and define the problem			X	X	
2.1 investigate situations	X			X	X
2. The student uses mathematics to solve problems					

SEASONS- SCIENCE	Sharing seasonal markers	Reg. Temp. patterns	Seasonal patterns	What we can learn about	Protocols
Human Biology					
Molecular basis of heredity					
Structure and organization of living things					
Components of the solar system and beyond					
Components and patterns of the earth system					
Physical /chemical changes	×			×	×
Structure of matter					
Energy transfer and transformation					
Energy sources and kinds					
Systems	×	×	×	×	×
1.2 recognizes the components, structure and organization of systems and the interconnections…					
Basis of biological diversity	×		×	×	×
Nature and properties of earth materials					
Wave behavior					
Motion of objects					
Properties and substances					
1.1 uses properties to identify , describe, and categorize substances, materials, and objects…					
1. The student understands and uses scientific concepts and principles					

SEASONS- SCIENCE	Sharing seasonal markers	Reg. Temp. patterns	Seasonal patterns	What we can learn about	Protocols
Modeling	X	X	X	X	
Explanation		X	X		X
Designing and conducting investigations		X	X	X	X
Questioning		X	X		X
2.1 develop abilities necessary to do scientific inquiry					
2. The student knows and applies the skills and processes of science and technology					
Environmental and resourse issues				X	
Interdependence of life		X		X	X
Biological Evolution					
Life processes and the flow of matter and energy		X			X
Interactions in the solar system and beyond					
Hydroshere/atmosphere	X	X	X		
History and evolution of the earth					
Processes and interactions in the earth system		X		X	
Forces to Explain Motion					
Nature of forces					
1.3 inderstand how interactions within and among systems cause changes in matter and energy					

SEASONS - SCIENCE	Sharing seasonal markers	Reg. Temp. patterns	Seasonal patterns	What we can learn about	Protocols
Careers and occupations using science, mathematics, and technology					X
Relationship of science and technology	X	X	X	X	X
All peoples contribute to science and technology	X		X		X
3.2 know that science and technology are human endeavors, interrelated to each other, to society...		X	X		
Evolution of scientific ideas					
Evaluating methods of investigation		X	X		X
Dealing with inconsistencies					
Limitations of science and technology			X		
Intellectual honesty		X	X		X
3.1 understand the nature of inquiry					
3. The student understands the nature and contexts of science and technology					
Evaluating potential solutions					
Designing and testing solutions					
Identifying problems					
2.2 apply science knowledge and skills to solve problems or meet challenges					
Communication	X	X	X	X	X

SEASONS- MATH	Sharing seasonal markers	Reg. Temp. patterns	Seasonal patterns	What we can learn about	Protocols
operations		X	X		X
representations					
patterns	X	X	X	X	X
1.5 understand and apply concepts and procedures from algebraic sense					
prediction and inference					
statistics		X	X	X	X
probability					
1.4 understand and apply concepts and procedures from probability and statistics					
locations and transformations		X	X		
properties and relationships		X			X
1.3 understand and apply concepts and procedures from geometric sense					
systems and tools	X	X	X		X
approximation and precision		X	X		X
attributes and dimensions	X	X	X	X	X
1.2 understand and apply concepts and procedures from measurement					
estimation					
computation		X	X		X
number and numeration		X	X	X	X
1.1 understand and apply concepts and procedures from number sense					
1. The student understands and applies the concepts and procedures of mathematics					

SEASONS- MATH	Sharing seasonal markers	Reg. Temp. patterns	Seasonal patterns	What we can learn about	Protocols
2. The student uses mathematics to solve problems					
2.1 investigate situations		X	X	X	X
2.2 formulate questions and define the problem			X		
2.3 construct solutions			X		
3. The student uses mathematical reasoning					
3.1 analyze information	X	X	X	X	X
3.2 predict results			X		
3.3 draw conclusions and verify results	X		X		
4. The student communicates knowledge and understanding everyday and mathematical language					
4.1 gather information		X	X	X	X
4.2 organize and interpret information	X	X	X	X	
4.3 represent and share information		X	X	X	X
5. The student understands how math ideas connect within math, to other subjects areas, and to life					
5.1 relate concepts and procedures within mathematics		X	X		X
5.2 relate mathematical concepts and procedures to other disciplines	X	X	X	X	X
5.3 relate mathematical concepts and procedures to real-life situations	X	X	X	X	X

Chapter V

Summary, Conclusions, and Recommendations

Summary

The purpose of this project was to develop a guide that aligned the Washington State Essential Academic Learning Requirements (EALRs) with the Global Learning and Observations to Benefit the Environment (GLOBE) program for teachers in Washington State. To accomplish this purpose, a review of related current literature was conducted. Additionally, related information/materials from selected sources were obtained and analyzed.

Conclusions

Conclusions reached as a result this study were:

1. A positive association exists between implementation of the GLOBE program and increased student academic performance and environmental awareness.
2. Because the GLOBE program embodies features valued in education reform efforts and on math and science standards, it can be used effectively to reach education goals, such as teaching the methods of inquiry to students.
3. A GLOBE Essential Learning Guide can help clarify the congruent relationship between the state standards and the GLOBE program protocols/ learning activities.
4. The GLOBE program must become more "user friendly" if it is to become more widely used, especially in elementary schools. Schools that have had success with the GLOBE program exhibit some basic commonalties, which include receiving

strong administrative support, organizing data around local environmental issues, and expanding the program within their own schools.

Recommendations

As a result of this project, the following recommendations have been suggested.

1. Submit the GLOBE Essential Learning Guide to GLOBE program coordinators for inclusion into the GLOBE Teaching Guide for the 2002-03 school year.
2. Post the GLOBE Essential Learning Guide onto the program's website for immediate use by teachers.
3. Teachers from other states seeking to align their state's education standards to GLOBE program learning activities/protocols may wish to adapt the guide developed for this project or undertake further research on this subject to meet their unique needs
4. Design and implement more GLOBE learning activities that are developmentally appropriate for young learners.
5. The sponsorship of this program and the political ramifications resulting from it must be recognized. GLOBE will be best utilized when it is used as a learning and research tool, not a political one.

REFERENCES

Ash, D., (2000). Foundations: Inquiry Thoughts, Views, and Strategies for the K-5 Classroom: A Monograph for Professionals in Science, Mathematics, and Technology Education. The Process Skills of Inquiry. National Science Foundation. The Division of Elementary, Secondary and Informal Education, 2, 2000.

Adams, R.D., & Martray, C. (1981). Teacher development: A study of factors related to teacher concerns for pre, beginning, and experienced teachers. Paper presented at the annual meeting of the American Educational Research Association, Los Angeles, April.

Bartels, D.M., (2000). Foundations: Inquiry Thoughts, Views, and Strategies for the K-5 Classroom: A Monograph for Professionals in Science, Mathematics, and Technology Education. An Introduction to the National Science Standards. National Science Foundation. The Division of Elementary, Secondary and Informal Education, 2, 2000.

Brooks, D. R., (2000). Spacecraft-based Earth Science in the 21st Century: Opportunities and Challenges for Student/Teacer/Scientist Partnerships. Paper presented at the Workshop on Environmental Education at the School Level in the Field of Air Quality, Santorini, Greece.

Bybee, R.W., & McInerney, J.D. (1995). Redesigning the Science Curriculum: A Report on the Implications of Standards and Benchmarks for Science Education (Report No. SE 060 766) Colorado Springs, CO: Biological Services Curriculum Study. (ERIC Document Reproduction Service No. ED 433 179)

Christensen, M.(1995). Critical Issue: Providing Hands-On, Minds-On, and Authentic Learning Experiences in Science. North Central Regional Educational Laboratory. Directory: www.nwrel.org/msec/pub.html

Dewey, J. (1938). Experience and Education. New York: Macmillan.

Dow, P.(2000). Foundations: Inquiry Thoughts, Views, and Strategies for the K-5 Classroom: A Monograph for Professionals in Science, Mathematics, and Technology Education. Why Inquiry? A Historical and Philosophical Commentary. National Science Foundation. The Division of Elementary, Secondary and Informal Education, 2, 2000.

Dyasi, H.(2000). Foundations: Inquiry Thoughts, Views, and Strategies for the K-5 Classroom: A Monograph for Professionals in Science, Mathematics, and Technology Education. What Children Gain by Learning through Inquiry. National Science Foundation. The Division of Elementary, Secondary and Informal Education, 2, 2000.

Edwards, C.H.(1997). Promoting Student Inquiry. The Science Teacher, 64 (7), 18, 20-21.

Finarelli, M. (1998). GLOBE: A Worldwide Environmental Science and Educational Partnership. Journal of Science Education and Technology, 7 (1), 77-84

GLOBE Teachers Guide (1997). Washington, D.C.: GLOBE Press

Highlights from the GLOBE Year 3 Evaluation (1998). [On-line] GLOBE Resource Room. Directory: www.globe.gov/sda-bin/wt-ghp/y3eval+L(er

Hamil, B. (1998). Hands-On Scientific Research: Conducting GLOBE Project Protocol Training in Oktibbeha County (Report No. SP 038 315). New Orleans, LA: Educational Research Association. (ERIC Document Reproduction Services No. ED 428 034)

Harvard Project Zero (1999). Theory of Multiple Intelligences [On-Line] Project SUMIT: Schools using Multiple Intelligence Theory. Directory: www.

Hehr, L.H. (1998). Remote Sensing, GIS, and the K-12 Education. NCRI News, 1-3.

Jacobson, M.J. & Jacobson, P.C. (1998). Lessons Learned and Lessons To Be Learned: An Overview of Innovative Network Learning Environments (Report No. IR 029 337) Frieberg, Germany: Educational Multimedia and Hypermedia & World Conference on Telecommunications. (ERIC Document Reproduction Service No. ED 428 676)

Jarrett-Weeks, J. & Stepanek, J. (2001), Student Scientists Team Up with the Pros. Portland, OR: Northwest Regional Educational Laboratory.

LaHart, V. (1998). Measuring up with GLOBE: A profile of a teacher-friendly international monitoring program. Green Teacher, 55, 20-22

Larsen-Becker, M., Congalton, R.G., Budd, R., & Fried, A. (1998). A GLOBE Collaboration to Develop Land Cover Data Collection and Analysis Protocols. Journal of Science Education and Technology, 7 (1), 85-95

Means, B. (1998). Melding Authentic Science, Technology, and Inquire-Based Teaching; Experiences of the GLOBE Program. Journal of Science Education and Technology, 7 (1), 87-104

Means, B., Korbak, C., Lewis, A., Michalchik, V., Penuel, W.R., Rollin, J., Yarnall, L.(2001). GLOBE Year 5 Evaluation: Classroom Practices. Melno Park, CA: SRI International

Means, B., Coleman, E., & Lewis, A. (1998). GLOBE Year 3 Evaluation: Implementation and Progress. Melno Park, CA: SRI International

Means, B., Coleman, E., Lewis, A., Quellmalz, E., Marder, C., & Valdes, K. (1996). GLOBE Year 2 Evaluation: Implementation and Progress. Melno Park, CA: SRI International

Meyer, M. (1998). Learning and Teaching Through the Naturalist Intelligence. Seattle, WA: New Horizons for Learning.

Moran, J.B. (2000). Multiple Intelligences. Dr. Chordate Sings! Science meets music for an education in fun. [On-Line] Directory: www.tranquility.net/~scimusic/MI.html

Murphy, A.P., & Coppola, Ralph K. (1997). GLOBE: A Science/Education Partnership Program (Report No. SE 060 609) Chicago, IL: Paper presented at the annual meeting of the American Educational Research Association. (ERIC Document No. ED 414 155)

National Research Council. (1996). National Science Education Standards. Washington, D.C.: National Academy Press.

Plato, K. (1995). History of Education Reform in Washington State: The Transition to a Performance-Based, Student Learning Education System (Report No. EA 026 692) Olympia, WA: Washington Office of the State Superintendent of Public Instruction. (Eric Document Reproduction Service No. ED 428 034)

Pyke, T.N., Jr. (1995). GLOBE Partnership Launched: Kids and scientists are collaborating worldwide. EPA Journal, 14-16

Quellmalz, E., Schank, P., Hinjosa, T., & Padilla, C. (1999). Performance Assessment Links in Science (PALS). ERIC/AE Digest (Report No. TM 030 339) Washington, D.C.: ERIC Clearinghouse on Assessment and Evaluation. (ERIC Document Reproduction Service No. ED 435 708)

Roebuck, K.I., & Warden, M.A. (1998). Searching for the Center on the Mathematics-Science Curriculum. School Science and Mathematics, 98, (6) 328-333

Ross, M.E. (1997). Scientists at Play. Science and Children, 35-38

Schmidt, W.H., McKnight, C.C., & Raizen, S.A. (1997). A splintered vision: An investigation of U.S. science and mathematics education. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Scherer, M. (1997). Perspectives/ Martian Chronicles. Educational Leadership, 55, (1) 1-3.

Schulz-Hamsa, I. (1998). Inclusion and Technology: A marriage of Convenience for Educational Leaders. Technology and Teacher Education Annual. Charlottesville, VA: Association for the Advancement of Computing in Education

Singletary, T.J., & Jordan, J.R. (1996). Exploring the GLOBE. The Science Teacher, 36-40.

Stepanek, J. (1997). Science and Mathematics Standards in the Classroom: It's Just Good Teaching (Report No. SE 060 766) Portland, OR: Northwest Regional Educational Laboratory. (ERIC Document Reproduction Service No. ED 413 189)

Washington State Commission on Student Learning (1997). Essential Academic Learning Requirements: Technical Manual (Available from the Commission on Student Learning, Old Capitol Building, Room 222, P.O. Box 47220, Olympia, WA 98504-7220)

Yarnall, L., & Penuel, W.R. (2001). Structuring Group Learning within a Web-based Science Inquiry Program. Center for Technology in Learning. Melno Park, CA: SRI International