Summer 2004

# Proposal for an Elemenatry Science Curriculum Outline to Help K-4 Teachers Prepare Students to Take the 5th Grade Science WASL

Cindy D. Williams

ABSTRACT

PROPOSAL FOR AN ELEMENTARY SCIENCE CURRICULUM OUTLINE TO HELP K-4 TEACHERS PREPARE STUDENTS TO TAKE THE 5TH GRADE SCIENCE WASL

by

Cindy D. Williams

July 2004

With a statewide pilot of the 5th grade science Washington Assessment of Student Learning (WASL) in the spring of 2003, all elementary schools were trying to prepare their students to meet the standards. At this time, the only resources schools had for preparation was a glimpse of the first criterion-referenced assessment, the Essential Academic Learning Requirements (EALRs), Grade level Expectations (GLEs) and a "release booklet" of sample items distributed to 5th grade science teachers.

Educators knew that the best curriculum built on the previous year's knowledge which spiraled throughout the curriculum. At this time there were no curriculums designed starting with the first three EALRs in science from the kindergarten level and building up to the 5th grade. Another important factor in successful learning was to break down common terminology. All staff must commit to using a consistent science vocabulary with their students which was aligned with the assessment. This would assist the students' understanding and competence with the assessment. Additionally,

the assessment format needed to be practiced by the students in order for them to achieve optimum success.

In order for elementary schools to make science the "new basic" teachers will require three important criteria. First, teachers must be provided a science curriculum that deliberately emphasized themes in the state assessment of systems, inquiry, and design. With such a resource, lesson plans could be aligned to the EALRs and follow the WASL format. Secondly, teachers needed to utilize a common vocabulary consistent throughout the grade levels and taught across the curriculum including during spelling. Thirdly, K-4 teachers needed an opportunity to see the 5th grade scenarios, so they could create unit assessments which closely mirror the science WASL at 5th grade level.

# TABLE OF CONTENTS

Page

# TABLES

# CHAPTER 1

# INTRODUCTION

## Background of the Project

"The important thing is to not stop questioning" Albert Einstein

Science is the new basic. It is not just for future physicists or doctors. All students need basic science literacy to feel in charge of their world and to have a sense of how their world all fits together. But basic science literacy means more than just understanding key scientific concepts. It also means having the critical thinking skills to solve complex problems and the ability to scrutinize information. Students with science literacy can research, investigate and question the world around them (National Research Council, 1996). For students to acquire these skills, they must have teachers who realize their changing role as facilitators of science literacy. They must work hard everyday to make their teaching more closely reflect state and national science standards, understand inquiry-based teaching-learning process, and know how children learn. Part of this hard work includes the teachers' realization of the power of writing both for themselves and for their students, allowing the students to have a real voice in the classroom, helping students make connections between their activities in the classroom and the real world of today and tomorrow (Manning, Manning, & Long, 1994).

In addition, John Dewey stressed that the curriculum should not be a series of subjects isolated from the everyday lives of children and young people. The teachers must practice continual and sympathetic observation of student's interests if they hope to enter into the child's work (Dewey, 1910). In the science classroom, students are more often asked to simply memorize the terms scientists have used to conceptualize problems. The student's task is to accept and understand the scientists' ideas. As students progress through the school program, science learning becomes less and less a personal experience. This often leaves students with the task of memorizing scientists' language and ideas without understanding the processes of thinking that have brought these ideas into existence (Shapiro, 1994).

The experiential approach to learning, although it leads to a learner's deeper understanding, creates a dilemma within the current culture of teaching. Every child learns best when they are finding out about something that interests them. That concept is juxtaposed against a culture in which students are compelled by law to attend school and are expected to comply and conform while in the charge of teachers who are responsible for large numbers of them. There is an implicit conflict between teachers' responsibility for control and their responsibility for student's learning. One approach treats pupils as receivers and the other treats them as makers (Duckworth, 1987). Learning is not a matter of acquiring new information and storing it on top of the information we already have. Learning is a matter of coming across something unexpected, something that can't easily be explained by those theories we have already developed. To resolve that conflict, we have to change what we previously believed (Kohn, 1999).

Purpose of the Project

With the mandate to meet the new federal and state standards, elementary teachers are under pressure from administrators to teach toward the goal of high-test scores. The elementary teacher is required to become familiar with four content areas of the Washington Assessment of Student Learning: reading, writing, math, and now, science. Elementary teachers are expected to be experts in seven subjects with little content training in college. While teachers want to do their best for their students, they seldom have the training or the time to do each subject justice. Rather than deeper understanding, only superficial knowledge is achieved as teachers attempt to "cover" the curriculum (Deal & Sterling, 1997).

The National Science Education Standards (NSES) and Benchmarks for Science Literacy have outlined what knowledge and skills a scientifically literate high school graduate should have. The national standards describe what all students should achieve by the time they reach three benchmarks between kindergarten and 12$^{th}$ grade. For science in Washington State this occurs at the 5$^{th}$ grade, 8$^{th}$ grade, and 10$^{th}$ grade. While elementary teachers have little formal training in more than the basics of reading and writing, they are now faced with adapting and aligning four separate areas. For the elementary teacher without a science background, this is all overwhelming. When you hear someone say that schools need to "raise standards," that represents a vertical shift; a claim that students ought to know more, do more, perform better. To get to higher performance, students need to stay focused on the task itself, and students stay to the task when it matters to them (Kohn, 1999).

Although the expectations for teaching science literacy among elementary teachers have increased significantly, the resources and training available to them have not. Teachers have been put in the position of creating curricula and lesson plans on their own, with little or no training, support, or collaboration time. There is a significant need for a kindergarten through fourth grade lesson design that is aligned to the Washington Essential Academic Learning Regulations (EALRs), follows the WASL format, uses common vocabulary, and provides an inquiry-based environment.

The purpose of this project is to provide resource materials that will support Kindergarten through 4th grade teachers in implementing and facilitating science literacy in their classrooms.

## Significance of the Project

There are multiple problems inherent with each teacher addressing the fifth grade science WASL in their own manner. First, the time element involved with designing each lesson is formidable. Although the time spent on this endeavor is valuable it is also time away from the needs of the students. In addition, realignment of the EALRs themselves with national science standards is a difficult job and one best completed by a committee of representatives, from each grade level to assure that all benchmarks are met.

Another problem the elementary teachers face is finding the time in the day to teach science. The elementary schools that responded to questionnaires, asking about the time and emphasis that science has in the elementary classroom, admitted science has taken a back seat to reading, writing and mathematics since the test of the early years or 4th grade WASL has come about. According to a survey conducted by the curriculum team of a rural Washington school district in the fall of 2003, the majority of educators teaching kindergarten through fourth grade set aside 30 minutes a day for science two quarters out of the year. The science, social studies, and health units alternate into that 30-minute block of time. Additionally, each elementary teacher has a different level of comfort with science. As a result, the likelihood that science will be stressed in one room, yet over looked in another will not only inadequately prepare children, it also creates inequity among children. This implicates the need for teacher training. In education there are many techniques that must be learned and practiced. However, the essence of science is the drive to discover. The teacher must know how to spark the interest in the students to keep reading, to invent, to explain and to make meaning out of what they observe. Science is not just the ability to recite facts and master laboratory procedures (Kohn, 1999 ).

Another potentially significant outcome of this project is to create a highly student-centered science program that integrates reading and writing skills, builds from kindergarten to fourth grade, and is designed to help fifth graders meet the standards on the science WASL. In addition the materials gathered through this project could provide the basis or foundation for teacher training and focus for their collaboration.

Definition of Terms

The following terms have been added to help clarify any misunderstanding of terms.

Benchmark: A point in time, which may be used to measure student progress. Designed to help educators organize and make sense of a complex process of interaction between the student, the teacher, and the learning process.

Certificate of Mastery: The law, which states the students at about the age of 16, shall be eligible to receive the certificate, which in the state of Washington is generally the 10th grade.

Design: The knowledge and skills of science are applied by designing solutions to human problems or challenges. Students use *design* processes to develop and test scientific solutions to these problems. In addition, students recognize that science and technology are human endeavors, interrelated to each other, to society, and to the workplace.

Essential Academic Learning Requirement (EALR): A statement of what students should know and be able to do at the completion of their K-12 education. These statements are purposefully broad and are intended to serve as guideposts to school districts and give teachers flexibility in designing curriculum, teaching strategies, and planning instruction.

Inquiry: The knowledge and skills necessary to investigate systems are focused upon scientific *inquiry*. Students ask questions and plan valid scientific investigations to answer their questions. In addition, students demonstrate an understanding of the nature of science *inquiry*.

Investigation: An integrated science process that incorporates manipulating materials and recording data. This incorporates the basic processes of observing, classifying, measuring, communicating, inferring, predicting, and using space/time relationships.

Nature journaling: An opportunity for children to use their writing skills while observing things in nature.

Science literacy: The reading and writing of science using scientific terminology in the correct context.

Child-centered: The emphasis of learning is developmentally appropriate and provides a consistent learning environment which nurtures autonomy and curiosity on what the child is able to fully understand from their interaction with supplies and investigations.

Systems: The essential concepts and principles of the physical, earth, space, and life sciences are organized and interwoven by the theme of *systems*. Students connect these systems with the understanding of inputs, outputs, and transfers of matter, energy, and information. What science has learned about the universe is described as the properties, structure, and changes in *systems*.

## Project Overview

Chapter One explains the importance for science to become the new basic in the elementary classroom. It tells how all students need basic science literacy to feel in charge of their world and to have a sense of how their world all fits together. Chapter One goes on to explain that basic science literacy means having the critical thinking skills to solve complex problems and the ability to scrutinize information. Students with science literacy can research, investigate and question the world around them (National Research Council, 1996). For students to acquire these skills, they must have teachers who realize their changing role as facilitators of science literacy.

Chapter Two outlines the seven science content areas defined by the National science Education Standards (NSES) and the Benchmarks for Science Literacy. It describes what all students should achieve by the time they reach three or four milestones between kindergarten and $12^{th}$ grade, and it points out that the Benchmarks for Science Literacy was determined to be a tool for developing curriculum, not for offering a standard curriculum. Next it shows that the research supports the importance of inquiry teaching and learning which changes the role of the teacher without providing the support teachers need to be effective.

Chapter Three outlines the purpose of this project which is to: 1) demonstrate a sample lesson design, using existing grade level units, which focuses on the themes in the state assessment of Systems, Inquiry and Design; 2) assign the list of scientific vocabulary appropriate to each grade level; and 3) demonstrate unit assessment appropriate to each grade level that practice the Washington Assessment of Student Learning (WASL) format.

Chapter Four discusses the finding of the Science Curriculum Committee of a rural Washington state school district. It gives examples of an inquiry-based science approach to Kindergarten through fourth grade teachers that will connect each grade level with increasing difficulty, assign vocabulary to be taught at each grade level, and give a template for an assessment that mirrors the Science WASL at fifth grade.

Chapter Five summarizes the importance of science literacy for all students to feel in charge of their world and to have a sense of how their world all fits together. This chapter also expresses the need for elementary teachers to change the way they view science as a subject that will only be taught when time allows. Teachers need to see science as the new basic. Teachers require training in how to spark the interest in the students to keep reading, to invent, to explain, and to make meaning out of what they observe. Teachers require the opportunity to experience a highly child-centered science program that integrates reading and writing skills.

# CHAPTER 2

# REVIEW OF LITERATURE

## Standards for Science Literacy

*The terms and circumstances of human existence can be expected to change radically during the next human life span. Science, mathematics, and technology will be at the center of that change—causing it, shaping it, responding to it. Therefore, they will be essential to the education of today's children for tomorrow's world.*
*Science for All Americans (SFAA)*

What knowledge and skills should a scientifically literate high school graduate have? Scientists, teachers, and education researchers asked this question and received reactions and comments from thousands of their colleagues during the development of the *National Science Education Standards* (NSES) and the *Benchmarks for Science Literacy*. Both documents recommend essentially the same content, processes, and principles. The *NSES* organizes science content into seven areas: Scientific Inquiry, Life Science, Physical Science, Earth and Space Science, Science and Technology, Science in Personal and Social Perspectives, History and Nature of Science, and Unifying Concepts and Processes.

National standards describe what all students should achieve by the time they reach three or four milestones between kindergarten and 12$^{th}$ grade. These examples from the *NSES* illustrate the milestones for the development of a life science concept:

**Grades K-4:** All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants.

**Grades 5-8:** For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs.

**Grades 9-12:** Energy flows through ecosystems in one direction from photosynthetic organisms to herbivores, to carnivores and decomposes.

This organization is based on a combination of factors including cognitive development theory, the classroom experience of teachers, and the organization of schools. It is not necessarily a recommendation of how the curriculum that is delivered to students should be organized (NRC, 1996).

*Science for all Americans*, called Project 2061, started in 1985 and was published in 1989. Years later, a companion report called, *Benchmarks for Science Literacy,* answers the question of what constitutes adult science literacy, recommending what all students should know and be able to do in science, mathematics, and technology by the time they graduate from high school (AAAS, Project 2061, 1989).

The publication in 1993 of *Benchmarks for Science Literacy,* which included Phase II of Project 2061,was determined to be a tool for developing curriculum, not for offering a standard curriculum. The vision for this phase of Project 2061, was that 1) an identifiable common core of learning in science, mathematics, and technology would focus on science literacy as its main goal, 2) all students would have wide-ranging learning experiences, 3) teachers would have primary responsibility for planning and implementing curriculum, and 4) the school environment would support literacy goals and the curriculum to achieve them (AAAS, 1993).

The research reviewed supports the importance of inquiry teaching and learning. National Science Education Standards say science teachers must "plan an inquiry-based program," "focus and support inquiries," and "encourage and model the skills of scientific inquiry" (National Research Council, 2000). Teachers should experience scientific inquiry themselves in professional development, where their instructors model the role of teacher as facilitator of learning. Learning how to support student learning through skillful questioning strategies requires ongoing professional development, discussion among peers, and personal reflection. Examination of student work is essential to gather insights into students' thinking processes and understanding of scientific inquiry.

## Classroom Implications

*In a certain sense every experience should do something to prepare a person for later experiences of a deeper and more expansive quality. That is the very meaning of growth, continuity, reconstruction of experience. John Dewey*

In a standards-based curriculum, teachers design learning experiences to enable all their students to reach the level of understanding or skill described by applicable standards. Given the diverse backgrounds and interests of students in any classroom, teachers are challenged to present the content in an engaging and accessible manner and to make frequent assessments of the students' understanding (Harlen, 1988).

Research on how children learn has brought to light common misconceptions in several science content areas. These incomplete and incorrect understandings make sense to children and can be difficult to overcome and replace with a scientifically correct explanation. Telling or showing rarely changes the student's misconception. The best solution is an interaction between the student and a phenomenon or investigational result that directly challenges inaccurate thinking. A classroom environment in which students explain their thinking and are challenged to provide evidence for their explanations also helps students produce sound conclusions (Healy, 1990).

Children and teachers need to be actively engaged in the learning process. As designers of their learning, dynamic collaboration between adult and child produces thoughtful curriculum. Thinking required for life-long inquiry becomes embedded in relevant contexts; skills and concepts are developed, in the strongest sense, through the pursuit of one's own questions. Risk taking spurs breakthroughs as adults and children turn frustrated attempts into success. Curiosity and persistence are vital in pursuing future challenges (Dunn & Larson, 1990).

A child-centered approach to learning envelops the notion that interest, curiosity, and a sense of adventure and discovery are the seeds that develop into meaningful learning. In the process of investigation and understanding their world, a child considers complex interrelationships of perspective, experience, and meaning. Each individual experience has immediate purpose and value; more importantly, the accumulation of such experience forms a base for future attitudes and understanding. This natural process of learning, and the resulting change, is not prescribed, but discovered (Dunn & Larson, 1990, p.10).

## Role of the Teacher

For many teachers, science is conceptualized as specific information to be taught to young children. Science then becomes relegated to children following directions from a science textbook for 20 minutes twice a week, when the science teacher comes once a week, or to the presence of a discovery table on which sit increasingly dusty seed pods and seashells. Or perhaps science in the curriculum has somehow been pushed to the bottom of the priority list because teachers do not feel qualified to teach science (Chaille & Britain, 1997).

Few elementary school teachers have even a rudimentary education in science and mathematics. Unfortunately, such deficiencies have long been tolerated by the institutions that prepare teachers, the public bodies that license them, the schools that hire them and give them their assignments, and even the teaching profession itself (AAAS, 1989).

In science class, students always seem to have more questions than teachers can answer. Before answering any more questions, perhaps teachers should pause and ask themselves if they *should* answer them. *The National Science Education Standards* (National Research Council 1995) recommends that instead of imparting knowledge, the teacher's role is to help students develop the skills, values, and attitudes that facilitate a scientific understanding of the natural world. "Inquiry into authentic questions generated from student experiences is the central strategy for teaching

The teachers' response then, in this negotiated curriculum, is to pose situations in which the child will ask questions and then engage in experiences likely to encompass answers. Other children or adults are often engaged in problem solving as the children ask questions, talk through a problem, request assistance, or proudly proclaim achievement (Dunn & Larson, 1990).

What a teacher must do is to acknowledge the learners' thoughts and find ways to take them further. This applies whether she agrees with the learner or not, and whether she thinks she has something to learn from this learner or not…teachers should be "practitioners of reflective intervention." who help students reflect-in-action on their own learning practice (Fosnot, 1989).

## Support Teachers Need

To increase teachers' effectiveness in facilitating science literacy, they need materials, time for collaboration, time to reflect, and resources. Teachers clearly need science materials. Commercially developed science kits can answer this need. The materials in the kit and the guide provide a catalyst to start the teacher thinking about each unit provided in the specific kit. As the teachers read the guide they reflect on science, children, and learning. Teachers can have a dialog with other teachers using the guide and from this conversation science understanding grows. Just as children think better when their hands are in science, teachers often find it easier to plan when there is a published plan and materials in their hands with which to react. In this sense the science can come from the kit. On the other hand, if teachers insist that the students do precisely what the kit prescribes them to do, the students would need to put away their questions and curiosities. If the guide is followed as it is written the children would have few opportunities to practice science (Saul & Reardon, 1993). Child-centered science inquiry allows for a developmentally appropriate and consistent learning environment which nurtures autonomy and curiosity. This approach enhances and integrates any science program topics and naturally incorporates the use of writing, reading, and mathematical skills. Students conduct their own investigations based on their own questions. In this child-centered approach, children learn science content while experiencing what it means to investigate, and how to answer their own questions in a scientific setting (Orrell, 1997). Science is a process of inquiry and investigation. It is a way of thinking and acting, not just a body of knowledge to be acquired by memorizing facts and principles. Children learn through their own activity. As apprenticing scientists, they learn about their world by observing, describing, questioning, and searching for answers. Through direct experience with the plants, animals, and objects that surround them, children can begin thinking scientifically and drawing conclusions from firsthand observations, rather than relying primarily on books, lectures, or films for information (Doris, 1991).

Culturally diverse students, who typically perform less well on standard measures of academic achievement than do their English-speaking peers, have shown success in science when the teacher sees science has a creative enterprise. “Science is not a discipline that urges us to read, memorize, and recite. Science encourages us to use our intellect to solve real world problems. Children actively engaged in learning science should be engaged in problem solving" (Barba, 1998, p. 7).

Inquiry-based laboratory investigations conducted in small cooperative groups proportionally benefit culturally diverse students and white females. Additionally, research has shown that inquiry or discovery learning activities emphasizing science processes enhance the intellectual development of students. In using child-centered inquiry-based science, teachers are providing equity in science education.

Teachers need time to collaborate and share ideas and materials with other teachers and scientists. This also provides an opportunity to reinforce common science vocabulary terms, which are available to the classroom teacher. The list of scientific vocabulary identifies concepts and processes described in the science EALRs which all fifth grade students should know without explanation. The science curriculum should build in-depth understanding of these concepts and processes using many instructional activities and other supporting terms. (North Central ESD, 2003) (See Table 1).

TABLE 1

## 5TH GRADE SCIENTIFIC VOCABULARY SUMMARY

The following terms are a summary of the vocabulary that may be used on the Science WASL without definitions. More terms may be used with definitions or examples as noted in the item specifications. The plural form of all these words is assumed useable. However, other forms of these words are not accepted unless specified. Every word from a lower grade level may be used at a higher-grade level.

Terms that build through the grade levels are listed below, and appears in the Science WASL, with the higher-grade item in parenthesis. For example:

Variable kept the same (controlled)
Variable changed (manipulated)
Variable determined by other variables (dependent)

This list of scientific vocabulary identifies concepts and processes described in the science EALRs that all fifth grade students should know without explanation. These are not meant to be exclusive terms used in the science curriculum. The science curriculum should build in-depth understanding of these concepts and processes using many instructional activities and other supporting terms.

**A**
air
amount
amount of time

**B**
balance scale
bone
brain

**C**
cause
centimeter (cm)
cell
characteristic
chart
classify

climate
color
conclude
conclusion
condensation
condense
consumer
continent
cycle

**D**
data

decomposer
depend
describe
design
direction

**E**
Earth

earthquake
echo
effect
egg
electrical
electricity
energy
energy of motion
erosion
eruption
evaporate

**F**
fair test
feet
flower
food

**G**
(Table 1 continued)

(Table 1 continued)

food chain
force
forest
fossil remains
fossil
freeze
function

**I**
identify
inch (in)
inclined plane
invent
invention
investigation
inherited

**N**
nonliving
nutrient

**O**
object
observe
observation
ocean
orbit (revolve)
orbit (revolution)
organism
organize
ounce
oxygen

**S**
sea
seed
shape
size
skeleton
soil

evaporation
event
explain
explanation

**H**
habitat
hand lens
hardness
heart
heat energy

**L**
lake
leaf
learned (acquired)
lever
liquid
liter (L)
living
lung

**P**
part
pattern
picture
pitch
plan
planet
pound
precipitation
predict
prediction
problem
procedure
process
producer
property
pull
pulley

gas
glacier
grain
gram
graph
grassland
gravity

**J**

**K**
kilogram (kg)
kilometer (km)

**M**
machine
magnetic
magnifying glass
material
melt
meter (m)
mile (mi.)
milliliter (ml)
model
molecule
Moon
mountain
muscle

**Q**
question

**R**
rate
report
reproduce
reproduction
result
river
root

(Table 1 continued)

(Table 1 continued)
solid
solve
sort
sound
special
speed
spin (rotate)
spring scale
sprout
state of matter
stem
stored energy
stream
strength
structure
substance
summary
Sun
system

push

**U**

**V**
vapor
variable
variable changed
(manipulated)
variable kept the
same (controlled)
vibration
volcano

**X**

**Y**
yard

**T**
table
temperature
texture
thaw
thermometer
tool

**W**
waste
water
weather
weight
wind

**Z**

# CHAPTER 3

## METHODOLOGY

### Introduction

The purpose of this project was to 1) demonstrate a sample lesson design, using existing kindergarten through fourth grade units, which focuses on the themes in the state assessment of systems, inquiry and design. 2) assign the list of scientific vocabulary appropriate to each grade level, 3) Demonstrate unit assessments appropriate to each grade level that practice the Washington Assessment of Student Learning (WASL) format.

### Methods

Research and related literature were procured from textbooks, science workshops the author attended, Internet web sites, government publications, periodicals and Science Curriculum Committee work. The author began attending meetings in a rural Washington State school district designed to adopt science curriculum. This committee was consisted of one teacher from each grade level, kindergarten through fourth grade, from two different elementary schools and equal representation of grade levels fifth grade through twelfth grade.

Through the discussions at the meetings, speaking with the author's building principal and reading of the literature, it was evident that as a whole, the school district was ill prepared to jump into ordering materials. It was suggested the school district receive training on the EALRs from a North Central Educational Service District staff member, who was also a well-known science teacher in the area.

The Educational Science Specialist met with the Science Curriculum Committee in November of 2003 and led the committee through background and discussion on inquiry and testing, EALRs Draft 3b, External evaluation of EALRs document, colored EALRs document, and WASL – general characteristics and vocabulary and influences on an adoption.

It was also recommended by the science committee to bring in Pat Orrell, Science Education Specialist Developmental Designs, to get the science committee members on the same page with science inquiry according to the National Science Standards. Next, Pat Orrell had each grade level write on index cards the science units that were presently being taught at each grade level and check to see how well they fit into the three science areas of life science, physical science, and earth science. As the index cards were laid out across the gym floor from kindergarten to twelfth grade, it became clear which units were heavily taught and which areas were in need of support. The dialog between the teachers from different grade levels and different buildings was invaluable to all present. This activity and the start of communication between educators brought to light the holes in the curriculum from K-12 and helped the committee to see that the job ahead was much greater than ordering science kits.

The district science committee continued to meet monthly, and set up inquiry-based science workshops, run by local teachers who had attended formal training. The workshops were offered three times to give optimum opportunity for all teachers to attend at least one session. Additional incentives for all teachers to attend workshop sessions included curriculum rate pay, receiving classroom science materials to implement the workshop activities in the classroom, and collaboration time with other district staff members.

The curriculum committee felt these workshops were beneficial to facilitate change in the way that science was approached. The presenters were instructed to emphasize the use of the WASL including general characteristics and vocabulary, child-directed learning, journaling, and to integrate language and reading with science as well as connecting concepts of the science units across the school year.

It was estimated the inquiry-based science workshops were 90% attended by district staff members and opened up the discussion that was necessary for change.

## Review of Literature

The research reviewed in Chapter 2 supported the importance of inquiry teaching and learning. The National Science Education Standards indicated science teachers must plan, encourage and model an inquiry-based program that will focus and support student generated investigations (National Research Council, 2000).

## Personal Experience

The author had been a practicing elementary teacher as well as an early childhood educator in private industry prior to becoming a public educator. It was this experience and knowledge of how children learn that influenced the review of literature and recommendations that followed in Chapter 5.

The author's familiarity and experience with the Washington Assessment of Student Learning for fourth grade students in the areas of reading, math, listening and writing, increased the desire and need to prepare students for the challenges of the Science WASL.

The request that the author hold a position on the district Science Curriculum Committee increased the need to train and educate teachers in a systematic way so that they could prepare their students. This was approached by designing a learning experience for inquiry that included specific learning goals, teaching strategies that provided opportunities for students to learn and assessment strategies that provided the best evidence to ensure students had met the learning goal.

As a result, lessons and vocabulary were developed and disseminated to all kindergarten through fourth grade teachers. In addition planning took place for further professional development and collaboration opportunities.

# CHAPTER 4

# THE PROJECT

## Introduction

"How can students become familiar with and understand scientifically rich vocabulary?" "How can the classroom teacher effectively help prepare students to take the 5th grade Science WASL?" and "How can a school district influence teachers to adapt their science lessons to include inquiry based education?" These are the driving questions that influenced the author's interest in pursuing this project.

Washington state released the list of 5th Grade Scientific Vocabulary Summary (Table 1) to clarify the concepts and processes described in the science EALRs, which all fifth grade students should know without explanation. This cut the work for the school districts down from needing to gather all unfamiliar terms that appear on the 5th grade WASL to organizing a system of assigning terms to grade levels. The author opened the discussion of teaching the 180 scientific words to the staff of a rural elementary. It was decided that each grade level would highlight the terms they were presently teaching. Next it was necessary to assign the remaining terms to the proper GLE and unit that they naturally belonged with. The author would insert the scientific terms to the appropriate spelling list of each grade level. The author would also present the assigned list at the start of each new school year and periodically to remind the staff of the importance of using common terminology. One example of the need of common terminology was the fact that *experiment* did not even make the list. The new term was *investigation*. If a school district continued to refer to the science labs as *experiments,* their students would be at a disadvantage when the 5th grade WASL used the term *investigation.*

As an elementary classroom teacher the author experienced first-hand the next two questions. Teachers wanted to assist in the preparation for the 5th grade Science WASL, but at this time few educators had even laid eyes on the actual test. Teachers did not know where to begin. The National Science Education Standards (NSES) and Benchmarks for Science Literacy outlined what knowledge and skills a scientifically literate high school graduate should have. Breaking these skills down and assigning them to each grade level was a huge job that the individual teacher might not be capable of undertaking alone. Although the expectations for teaching science literacy among elementary teachers had increased significantly, the resources and training available to them had not. Teachers had been put in the position of creating curricula and lesson plans on their own, with little or no training, support, or collaboration time. The author saw the significant need for a kindergarten through fourth grade lesson design that was aligned to the Washington Essential Academic Learning Requirements (EALRs) and met all General Learning Expectations (GLEs). The author felt that once teachers saw the format that would facilitate student preparation for the 5th grade WASL, adapting more lessons would be forthcoming.

The project was aligned with the GLEs, tied in journaling (Science Writing Notebooks), followed the WASL format, and encouraged inquiry learning.

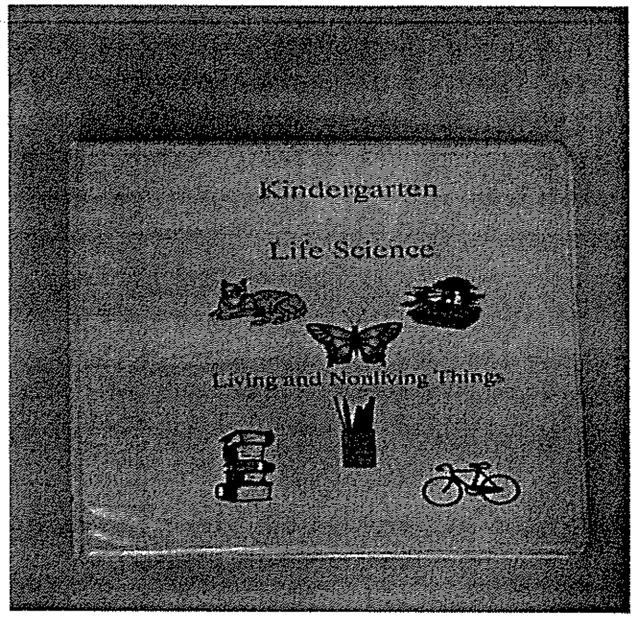
The following samples are in accordance with the Central Washington University Graduate Handbook, which states that in the case of a **Project Study** that does not fit the standard format of the written report it shall be submitted separately and a written description, with visual illustration may comprise Chapter 4.

The project includes a sample unit for each grade level including a student Science Writing Notebook.

Kindergarten

Life Science

Living and Nonliving Things




GLEs: 1.1.1, 1.1.6, 1.2.6, 1.3.8, 1.3.10, 2.1.2, 2.1.4, 2.1.5, 2.2.2,

Classifying living and nonliving things.

Start and finish with **K-W-L Chart**. K- what I know, W- what I want to find out (what I wonder) and L- what I learned. The students are familiar with this chart all across the curriculum. The parents are involved with a **Home Connection** activity that has the students classifying living and nonliving items on a **T-Chart.** The children will analyze and conclude what makes an item living or nonliving through large group, small group and individual activities. These activities include many different ways to classify and sort items by comparing and contrasting traits. The students will visually see differences between items when placing them in appropriate categories on different charts. The kindergarten class will be using these classifying charts across the curriculum such as t-charts, venn diagrams, and block style charts. After each activity the student will have an opportunity to reflect on their performance through a checklist with happy or frowning faces. They later will learn to evaluate their group performance and use a similar checklist. The student's activities and assessments have been bound into one folder called their Science Writing Notebooks (SWN). The SWN will enhance organization for teachers, allowing for review, assessing student understanding as the unit progresses, and clarifying meaning of what was taught for the parents. The parents will get more meaning from the combined activities then each individual activity sent home at a different time.

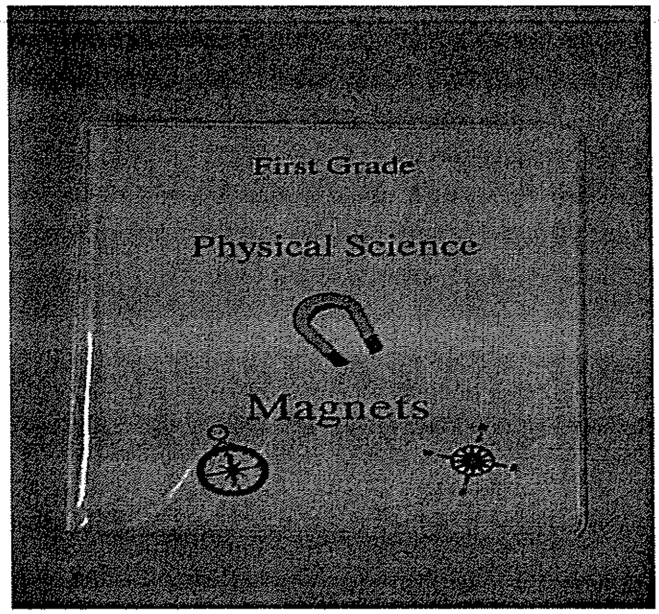
All scientific terms have been typed in bold to help assist the teacher in using the scientific vocabulary and to remind them to check for understanding with their class.

The teachers each have a binder of the activities and their lesson plans set up step by step. All activities that appear in the student Science Writing Notebook also appear in the teacher's binder. These pages have been labeled SWN or Large Poster so the teacher knows where to direct the students. The highlighter can be seen on the original, but will not show up when needed to be copied. In the back of the teacher binder they have a complete set of originals to be copied for the student's Science Writing Notebooks. The teachers also have a place to reflect on the unit and write themselves notes for next year.

First Grade

Physical Science

Magnets



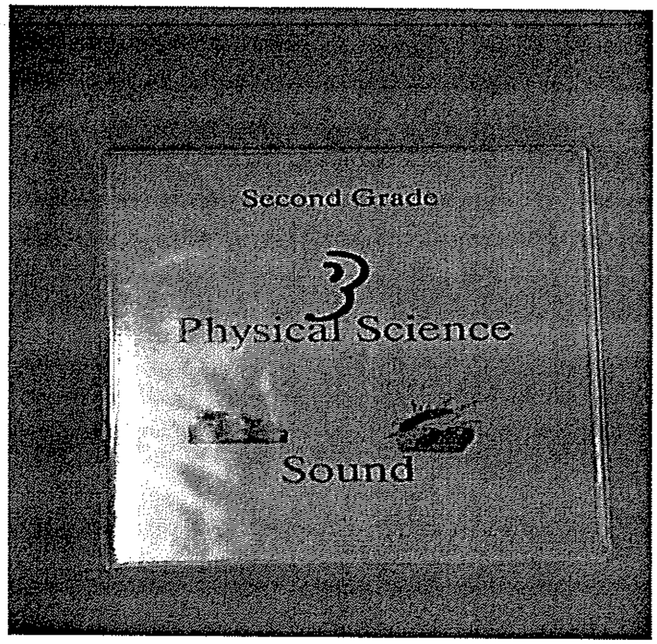

GLEs: 1.1.1, 1.1.2,1.2.2, 1.3.1, 1.3.2, 2.1.1, 2.1.2, 2.1.3, 2.1.5, 2.2.1, 2.2.2, 2.2.5, 3.1.1, 3.1.2, 3.2.1, 3.2.2, 3.2.3,

Start and finish with **K-W-L Chart**. K- what I know, W- what I want to find out (what I wonder) and L- what I learned. The students are familiar with this chart all across the curriculum. Lesson #1 students learn to classify objects that are attracted by magnets and objects that are not attracted by magnets. Magnetic attraction is one means of classifying everyday objects. Giving children labels can help them visualize the concept. Lesson #1: Uses labels with "international symbols" for attracted by magnets (a magnet) and not attracted by magnets (a diagonal line through a magnet). Give each child a group of items to test and a set of labels. Children will compare their results. Lesson #2: Children will infer that magnetic force can pass through air and certain materials, making it possible to move objects without touching them. Children will infer that the strength of the magnet being used and the thickness of the material will affect the magnetic force on an object. Lesson #3: Children will compare the strengths of various magnets and various parts of a magnet. Through this activity children will infer that magnets have different amounts of strength and the size of a magnet is not always an indication of its strength; magnetic force is greatest at the ends (poles) of a magnet. Lesson #4: Children will recognize that a magnet has two poles (north-seeking and south-seeking). The poles of two magnets always act in the same way when they are brought near each other: They will observe that like poles of magnets repel each other and that unlike poles of magnets attract each other. Lesson #5: Children will describe the shapes of various magnetic fields by investigating with iron filings that show evidence of a magnetic field. Lesson #6: Children will demonstrate and describe how to make temporary magnets by stroking an object with a magnet to line up the magnetic domains within the objects. Lesson #7: Children will explain that a compass helps people find out which way is north. Then they will compare the poles of a magnet to the needle of a compass after floating a bar magnet in water and observing how it acts like a compass by turning until its north-seeking pole points to the earth's magnetic north pole.

Second Grade

Physical Science

Sound



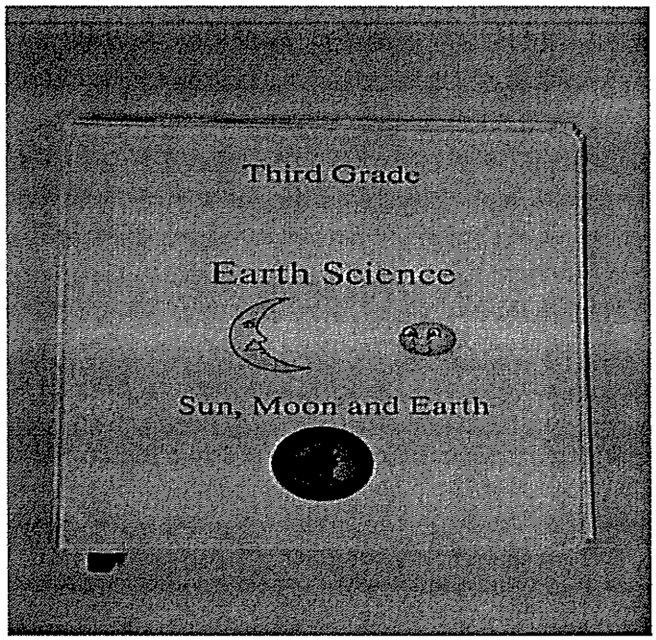

GLEs: 1.1.3, 2.1.1, 2.1.2, 2.1.3, 2.1.5, 2.2.1, 2.2.2, 2.2.3, 2.2.5, 3.1.1, 3.2.1, 3.2.3,

Start and finish with **K-W-L Chart**. K- what I know, W- what I want to find out (what I wonder) and L- what I learned. The students are familiar with this chart all across the curriculum. Students will discover that sound is another kind of energy that moves in waves. Some sounds are natural, such as thunder. Other sounds are produced by the activities of people, such as the roar of a jet engine or the hammering of a jackhammer. Vibrations cause all sounds. Two properties of sound are volume and pitch. The louder a sound is, the more energy it has. The number of vibrations determines pitch, or waves, produced each second. Low-pitched sounds, such as a car engine, produce long waves. High-pitched sounds, such as a whistle, produce shorter waves. Regardless of the volume or the pitch, all sounds are in motion and move at the same speed in the same medium. Lesson #1: As students learn that sound waves move through the air, they will be able to observe how sound moves, and explain how some animals make sound. Lesson #2: Students will describe sounds and vibrations. Students will observe that sounds are caused by vibrational motion. Students will explain that sound energy, which is caused by vibrational motion, moves through matter in waves. Lesson #3: Students will observe that sounds can be described and compared by their pitch and volume. Students will observe the sounds that different vibrations produce. They will describe how the pitch of a sound can be changed, and they will identify the loudness of a sound as its volume. Students will construct sound-making devices. Lesson #4: As students learn that volume is the loudness or softness of a sound, they will be able to predict why some sounds are louder than others are, and infer how to make sounds louder or softer. Lesson #5: As students learn that pitch is determined by the way an object vibrates, they will be able to predict why some sounds are high and others are low, and explain how musicians use pitch.

Third Grade

Earth Science

Sun, Moon, and Earth




GLEs: 1.1.1, 1.1.2, 1.1.4, 1.2.1, 1.2.2, 1.2.4, 1.2.5, 1.3.1, 1.3.2, 1.3.7, 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.2.5, 3.1.1, 3.1.2, 3.1.3, 3.2.1, 3.2.2, 3.2.3,

Start and finish with the K-W-L chart to help students begin to wonder. The teacher's guide for each lesson follows the same pattern of key question, advance preparation, get ready (group size and time needed), guide the procedure, assess performance and analyze and conclude. The students will receive a Science Writing Notebook, which will guide them through small group, individual activities, reflection, and science writing. Students will learn to define the essential question they hope to answer. Next, the students will predict the outcome of their investigation and learn how to write clearly the procedure they followed.

All scientific terms have been typed in bold to help assist the teacher and the students in using the scientific vocabulary when writing in their Science Writing Notebooks.

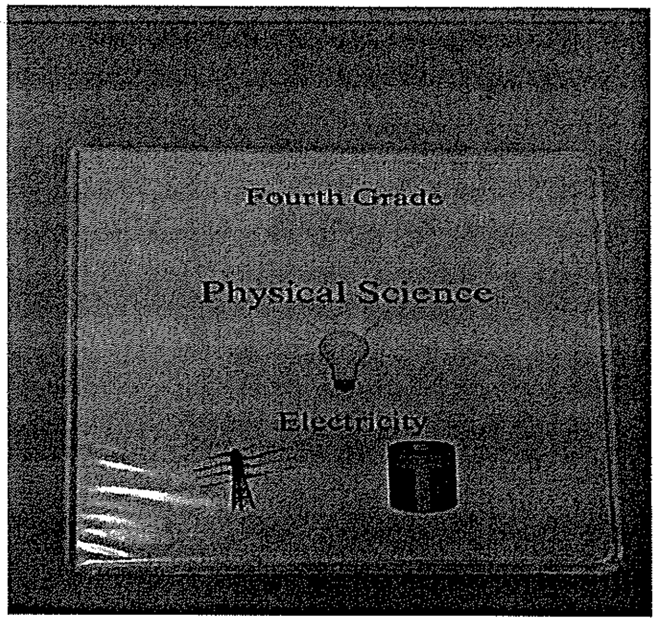
The third grade binders have 5 in-depth inquiry activities which will help the students discover the following concepts. The moon is about one-fourth of Earth's size, how craters on the moon are made, the effect the height of an incline has on the gravity (pull of two objects toward each other), how the moon's gravity affects the weight of an object, and how the Earth moves each day.

The teachers each have a binder of the activities and their lesson plans set up step by step. All activities that appear in the student Science Writing Notebook also appear in the teacher's binder. These pages have been labeled SWN so the teacher knows where to direct the students. The highlighter can be seen on the original, but will not show up when needed to be copied. In the back of the teacher binder they have a complete set of originals to be copied for the student's Science Writing Notebooks. The teachers also have a place to reflect on the unit and write themselves notes for next year.

Fourth Grade

Physical Science

Electricity




GLE: 1.1.4, 1.2.3, 1.3.1, 1.3.2, 2.1.1, 2.1.3, 2.1.4, 2.1,5, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.2.5, 3.1.1, 3.2.1, 3.2.2, 3.2.3, 3.2.4

The Science Writing Notebook on electricity begins and ends with a picture of a battery. The students are asked to write anything that they know about electricity on this sheet. This activity will make an impression on the students when they compare their responses from the beginning of the unit to the end. Teachers will be able to assess the terminology that is used on the second battery page used at the end of the unit. The unit also starts and ends with the K-W-L chart that the students are familiar with. This chart starts the questioning process. Key electricity vocabulary will be necessary to assist students in communicating scientifically. Activity #1 will teach the students the important concepts of an atom and how it relates to electricity through a dramatization. Teachers may assess students understanding of the atom with a quick assessment. Activities #2-#9 will allow for a small amount of teacher directed time and lead right into small group investigation through inquiry. The students will become familiar with the following Science Writing Notebook: Question, Prediction, Procedure, Analyze and Conclude. After each investigation the students will be given the opportunity to reflect on their performance as well as their groups performance. Activity # 10 will link the writing process to science. The students will write an **expository** paragraph by following the given expectations and prompt. *Using the information you gathered, through your science investigation, explain in one complete paragraph how you and your partner discovered what a* ***conductor*** *is.*

# CHAPTER 5

# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## Summary and Conclusion

"In order for people to live interesting, responsible, and productive lives, they must be literate in science, math and technology" (SFAA, p. 4). Students and teachers must have opportunities to experience science. Students and teachers will learn more if they participate in a science program that allows children to talk about their ideas. If students are challenged to provide evidence to explain their thinking they will produce sound conclusions. Research shows that many students are at risk for misconceptions in science content. Two ways to limit these common misconceptions is to provide an interaction between the student and a phenomenon or investigational result that directly challenges the inaccurate thinking. The second way to limit misconceptions in science is to provide adequate training, collaboration and modeling for the untrained elementary teacher. Students must construct their own meaning of science by connecting new information and concepts to what they currently know. Concepts are learned best when they are presented in a variety of contexts and ways (SFAA, 1989).

Through science inquiry, scientific methods and attitudes are applied in authentic, student-generated investigations. Science is an innate human activity, something that comes naturally to young children. The teachers need to step back and allow what comes naturally to happen. Science is what we do as human beings as we observe, question, wonder, investigate, test, re-test, discover, communicate our findings, build on our prior knowledge, share our knowledge, build on others' prior knowledge, and question some more. When each child has the opportunity to learn science content through individual hands on, investigations the classroom becomes a true laboratory with a community of individual scientists.

Once students conduct their own investigations based on their own questions, they begin conducting their own meaning by connecting new information and concepts to what he or she already believed to be true, and that is when learning takes place. As new concepts make sense with how the student understands their world, they are more likely to be remembered and useful. As students investigate they also must learn to journal, record and to apply scientific methods and attitudes in situations that are meaningful to them.

The teacher's role becomes one of facilitator. The teacher must become comfortable with the grade level expectations (GLE) and provide materials and opportunities for the students to experience science. The teacher will direct mini lessons, where the students focus on content, as well as how to ask relevant, test-able questions. In the child-centered approach, children learn science content while experiencing what it means to investigate, and how to answer their own questions in a scientific setting.

## Recommendations

1) Provide teacher collaboration time. Teachers must have time to read and understand the grade level expectations. They need to work with other teachers at their grade level to align their curriculum and decide the best way to present each (GLE).
2) Present the science WASL 5th grade scenarios so all teachers can see the end product. In this way teachers can duplicate the WASL format for their students.
3) Provide teacher investigation time. Teachers need the opportunity to science themselves. If a teacher observes the learning that happens when they are given the opportunity to question and investigate with science materials they will value this time for their students.
4) Design a system to provide science supplies to the classrooms. Science kits are a starting point but who is going to replenish them? If the supplies are not readily available, the science opportunities will not happen.
5) Provide inservices to teachers. Inservices must happen quarterly to keep all teachers focused on new concepts. When a teacher is learning something new they need many opportunities to become comfortable.
6) Provide a model. Teachers will require time to create a unit as a guide or provide one that they can duplicate for other units.

7) Incorporate science across the curriculum. Allow science to include writing by providing journaling opportunities. Incorporate spelling of scientific terms, and teach math concepts through science labs.

8) Allow teachers to take their time. All teachers are coming into science with varying degrees of background knowledge; they will all adjust at a different rate.

# BIBLIOGRAPHY

-----. (2003). *Discovery works: Teaching Guide / K, 1, 3, 4.* Boston, MA: Houghton Mifflin.

Allen, M., et al. (1991). *Electrical connections.* Fresno, CA: AIMS Education Foundation.

American Association for the Advancement of Science. (1990). *AAAS Project 2061: Science for all Americans* (Electronic Version). Retrieved March 28, 2003 from http://www.project2061.org/tolls/sfaaol.htm

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy, project 2061.* New York: Oxford University Press.

Ash, D., & Kluger, B. B. (1999). *Identifying inquiry in the K-5 classroom.*

Barba, R. H. (1998). *Science in the multicultural classroom: Guide to teaching and learning.* Needham Heights, MA: Allyn & Bacon.

Barnes, D. (1975). *From communication to curriculum.* New York: Penguin.

Black, P., & Dylan, W. (1998). *Inside the black box: Raising standards through classroom assessment.*

Butler, J. (2004). *Learning & Teaching.* Wenatchee, WA: Wenatchee School District.

Bybee, R. W. (1997). *Achieving scientific literacy: From purposes to practices.*

Chaille, C., & Lory, B. (1997). *The young child as scientist: a constructivist approach to early childhood science education.* New York: Longman.

Deal, D., & Sterling, D. (1997, March). Kids ask the best questions. *Educational Leadership.*

Dewey, J. (1910). *My pedogogic creed.* Chicago: Flanagan Company.

Doris, E. (1991). *Doing what scientists do: children learn to investigate their world.* Portsmouth, NH: Heinemann.

Duckworth, E. (1987). *The having of wonderful ideas and other essays on teaching and learning.* New York: Teachers College Press.

Dunn, S., & Larson, R. (1990). *Design technology: children's engineering.* Bristol, PA: Falmer Press.

Fosnot, C. (1989). *Enquiring teachers, enquiring learners. A constructivist approach for teaching.* New York: Teachers College Press.

Graves, D. H. *Investigate nonfiction.* Heinemann.

Harlan, W. (1985). *Teaching and learning primary science.* London: Harper Row.

Healy, J. M. (1990). *Endangered minds: why children don't think and what we can do about it.* Touchstone Publishers.

Hein, G. E., & Price, S. (1994). *Active assessment for active science: a guide for Elementary teachers.* Heinemann.

Horne, J. *North Central Education Service District.* Wentachee, WA: Wenatchee School District.

Kohn, A. (1996). *Beyond discipline from compliance to community.* Alexandria, VA: Association for Supervision and Curriculum Development.

Kohn, A. (1999). *The schools our children deserve: moving beyond traditional classrooms and tougher standards.* New York: Houghton Mifflin.

Kyle, W. C., Rubinstein, J. H., & Vega, C. J. (2000). *Real science.* Columbus, OH: SRA McGraw-Hill.

Layman, J. W., Ochaoa, G., & Heikkenin, H. (1996). *Inquiry and learning: Realizing science standards in the classroom.*

Manning, M., Manning, G., & Long, R. (1994). *Theme immersion: Inquiry-based curriculum in elementary and middle schools.* Portsmouth, NH: Heinemann.

Minstrell, J., & van Zee, E. H. (2000). *Inquiring into inquiry learning and teaching in science.*

National Research Council. (1996). *National science education standards.*

National Research Council. (2000a). *Inquiry and the national science education standards.*

National Research Council. (2000b). *Inquiry and the national science education standards. A guide for teaching and learning.*

Orrell, P. *Developmental designs.* Bothell, WA: Bothell School District.

Saul, W., & Reardon, J. (1996). *Beyond the science kit: Inquiry in action.* Portsmouth, NH: Heinemann.

Shapiro, B. (1994). *What children bring to light; A constructivist perspective on children's learning in science.* New York: Teachers College Press.

WEA Online. (2004). *Education news.* Retrieved 2004, from http://www,washingtonea.org